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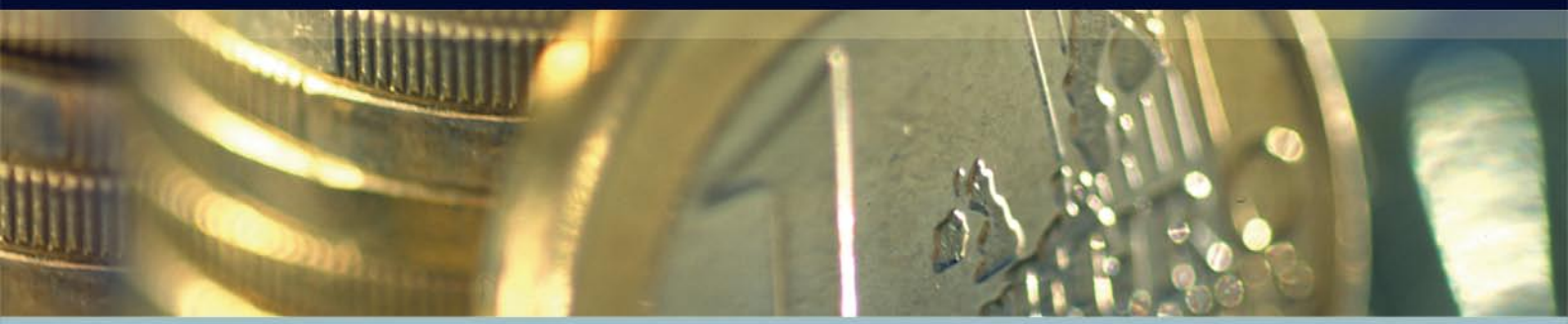

Price rigidity in the euro area — An assessment

Emmanuel Dhyne, Jerzy Konieczny, Fabio Rumler and Patrick Sevestre

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PRICE RIGIDITY IN THE EURO AREA. AN ASSESSMENT

Final Report

March 1, 2009

Emmanuel Dhyne
National Bank of Belgium and Université de Mons-Hainaut

Jerzy Konieczny
Wilfrid Laurier University and Rimini Centre for Economic Analysis

Fabio Rumler
Oesterreichische Nationalbank

Patrick Sevestre
Paris School of Economics, Université Paris 1-Panthéon Sorbonne
and Banque de France

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EXECUTIVE SUMMARY

The goal of this report is to analyze nominal rigidities in the Euro area and evaluate their importance for the functioning of markets. Under flexible exchange rates the adjustment to economic shocks that have different effects across countries can take place through changes in the nominal exchange rates, which alter the real exchange rates. Monetary policy may also be used to mitigate the effects of such shocks. With the introduction of the Euro member countries lost these channels of adjustment to asymmetric shocks. Euro-area countries are characterized by a high degree of openness, integration within the Union and have diversified economies. These features promote symmetric effects of shocks. Nonetheless, when asymmetric shocks do happen, the required adjustment has to rely on changes in prices and wages. The flexibility of prices and wages is, therefore, a crucial issue for EMU members.

The report starts with a review of the theoretical and empirical literature on nominal rigidities, with the second part concentrating on evidence for Euro-area countries. We then analyze nominal rigidities at the consumer and the producer level using available micro data. We analyze factors which affect nominal price rigidities, including competition, regulation, the role of intermediaries, marketing policies, retail structure, energy and labour shares in production costs, openness to trade, the effect of the introduction of the Euro and other variables.

In the report we distinguish between *sticky* and *rigid* prices. Prices are sticky if they change infrequently. They are rigid when their immediate adjustment following a change in demand or costs is less than full. Existing literature often treats these terms interchangeably and analyzes factors affecting the frequency of price changes, i.e. the degree of price stickiness. Following Dhyne *et al.* (2008) we argue that what is important for policy purposes is not price stickiness, but the distinction between *intrinsic* and *extrinsic rigidity*. A price is intrinsically rigid when it does not adjust, or only partially adjusts, to changes in demand and costs that have significant effects on the optimal price. A price is extrinsically rigid when the price does not adjust because demand and costs are stable and the optimal price does not vary much. This distinction is crucial from the policy point of view. While increasing price flexibility (raising the frequency of price changes) improves the functioning of the competitiveness channel and is desirable, from the policy perspective it is the intrinsic rigidity that is more important. If prices are intrinsically rigid i.e. there are large obstacles to price changing, firms do not adjust prices even though their optimal prices vary a lot. It is then advisable to consider policies that make prices more flexible, for example by reducing these obstacles or increasing incentives to change prices. On the other hand, if prices are extrinsically rigid, i.e. they are changed infrequently because costs and demand are stable and the optimal price does not vary much, there is much less scope for policy. It is possible to increase price flexibility by raising the variability of market conditions but that is, in general, not desirable.

Several proposals can be put forward to promote frequent price adjustment at the micro level and so increase price flexibility at the aggregate level. Price changes are less frequent in regulated market; this is the case both for price and product market regulation. Reducing the scope of regulation can have large effects on the frequency of individual adjustments. This is particularly important because regulated markets have some of the lowest frequencies of price adjustment and so, as pointed out in the literature, have a disproportionate influence on aggregate price flexibility. Of course this benefit of deregulation has to be weighted against the reasons for the regulation; for example it may not be advisable in markets with a natural monopoly.

The effect of competition on the frequency of price changes is not as clear. We find a positive effect across countries and little effect within countries. On the other hand, survey results invariably show a positive effect of perceived competition on the frequency of price changes. The conflicting results are due to the fact that measuring market competition is difficult. In the end we think the survey results are more reliable and conclude that the more competitive a market is the more frequent are price changes. Hence promoting competition across firms should make prices more flexible. Similarly, the more intensively consumers search for the best price, the higher is the frequency of prices change. The introduction of the Euro exerted a positive influence since it promotes market integration, raises competition and facilitates international price comparisons promoting the search for the best price.

Deregulation, promoting competition and the customer search for the best price are complex proposals as they affect many issues and may conflict with various economic policies. A much simpler and potentially very promising policy is the elimination of item pricing laws and promotion of modern price changing technologies. Such technologies (for example electronic tags) reduce the ongoing expense on price changing but require a setup investment cost. Policies that speed up the adoption of these technologies would raise the frequency of price changes at the level of individual price setter and promote aggregate price flexibility.

We now turn to a brief summary of the report. In section I we survey the theoretical literature. The survey is organized in two complementary parts. The first part reviews theoretical models that explain nominal rigidities at the level of individual price setters. The second part surveys the approaches to apply these models to macroeconomic issues.

The first part of the theoretical survey concentrates on summarizing partial equilibrium approaches to explaining why, as is commonly observed, price changes at the level of the individual price setter are infrequent and large. There are several theoretical approaches in the literature explaining nominal rigidities at the individual level. They are based on various reasons for price non-adjustment: menu costs, attractive prices (or pricing points), fair pricing and costly information. The most popular is the *menu cost* model, where firms face costs of changing their nominal prices. The optimal policy is *state-contingent*: the firm allows its real price to vary between bounds which depend on the state of the market.

The model implies that higher inflation increases the size of price changes and, in general, the frequency of price changes. While formal models of oligopolistic markets with menu costs remain to be developed, there are indications that greater *competition* results in more frequent price changes. More intensive consumer search for the best price also leads to more frequent price changes. A *pricing point* (now commonly called *attractive prices*) explanation of nominal rigidities is based on the observation that firms prefer to charge prices ending in a nine or round prices. Micro evidence shows that prices that end in a nine are changed less often than other prices. Furthermore, the more intensive is the search for the best price, the lower is the incidence of attractive prices, thus implying more frequent price changes. The *fair pricing* explanation is based on firms' reluctance to change prices to avoid anger by consumers. Customers are more accepting of price increases when costs rise than when demand increases. Hence the fair pricing theory explains the observed faster reaction of prices to cost increases reported in surveys. In the *costly information* model, the costs of getting informed prevent firms from continuously updating information about factors affecting their optimal price. This means that many firms use outdated information in price setting and so the price level depends not only on the expectations about the future but also on past information.

The second part of the survey concentrates on the recent literature that attempts to reconcile micro and macro evidence. The question theoreticians have focused on is whether, following nominal shocks, nominal rigidities at the level of individual firms can generate persistent movements in inflation and output observed in the data. The research agenda pursued by several authors is to build dynamic stochastic general equilibrium (DSGE) models with such rigidities that are consistent with both the micro evidence on the frequency of price changes and the macro data that on the dynamic response of aggregate economy to shocks and policy changes. This is an ongoing research effort. The general problem is that the observed degree of price stickiness, measured by the average frequency of price changes, is insufficient to generate the observed slow adjustment of the aggregate price level. Some progress has been made recently. Carvalho (2006) and Nakamura and Steinson (2007) show that the aggregate price rigidity depends on the differences in the frequency of price changes across sectors and is underestimated by the average frequency.

Aggregate nominal rigidity can be enhanced by introducing real rigidity: a mechanism that reduces the response of the aggregate price level to nominal shocks. These include staggered price changes of final and intermediate products, demand functions of variable elasticity etc. At this point, however, each model still has problems explaining the pattern of price behaviour at the aggregate level. Chari, Kehoe and McGrattan (2008) and Maćkowiak and Smets (2008) have recently argued that existing models are not yet able to explain aggregate nominal rigidities and so the research agenda is ongoing.

Regardless of theoretical issues or the type of model used, one common theme is that the more frequent are price changes at the micro level, the more flexible is the aggregate price level. Also, when the frequency of price changes varies across firms or sectors, the slow-

adjusting firms or sectors have a disproportionate influence on the aggregate price flexibility.

In section II we review the empirical literature, concentrating on evidence for Euro-area countries. Until recently, most of the available studies were based on limited datasets which covered a small number of firms or products. This has changed with the Inflation Persistence Network (IPN), organized in 2003 by the Eurosystem of Central Banks. This network led to the collection of numerous large data sets covering consumer and producer prices. In addition, several surveys were conducted in which firms were directly asked specific questions about their pricing policies. At about the same time, Bils and Klenow (2004) obtained US consumer price data. Subsequently, individual price data have been obtained for several countries. These large data sets, often containing millions of observations, produced a systematic body of knowledge on the behaviour of consumer and producer prices (although most of the data outside IPN are restricted to consumer prices).

These empirical analyses produced a set of stylized facts. They are summarized below.

Prices change infrequently. Overall, in the Euro area, the monthly frequency of consumer price changes is about 15% (Dhyne *et al*, 2006). Despite what a (too) simple calculation might suggest, the implied duration for consumer prices is about one year. Producer prices tend to change slightly more often: the average frequency of price changes is 21% (Vermeulen *et al.*, 2007). It seems that the retail sector adds another source of rigidity. However, on the basis of aggregate data for all goods, the conclusion that producer prices change more often can only be made tentatively. This is because there are important differences in data coverage and methodological issues.

Comparable statistics for the US show a higher frequency of price changes (over 25% per month). The difference is partially explained by frequent sales. Unlike in the Euro area, the frequency of producer price changes in the US is smaller than the frequency of consumer price changes.

The frequency of price changes varies across product categories and across countries but the differences across products tend to be larger. For consumer prices, it is the highest for energy products with a Euro area average frequency of 78%, followed by unprocessed food (28.3%), processed food (13.7%); non-energy manufactured goods (9.2%) and services (5.6%). There are also significant differences across countries. The frequency of price changes varies from a high of 23% in Luxembourg to a low of 10% in Italy; these differences are smaller than across products or groups of products.

For producer prices the frequency of price changes is the highest for energy products (72%), followed by food products and intermediate goods (between 20% and 30%) and is the lowest for capital goods, non-durable non-food items and durable manufactured products (around 10%). The differences across countries, ranging from 25% in France to 15% in Italy, appear to be of lower magnitude than those observed across products.

For both consumer and producer goods, the rankings of product groups with respect to the frequency of price changes are remarkably consistent across countries. This is important because for many countries data are not available, especially in the case of producer goods. It appears that the results from the available data can be extrapolated to other countries.

Price changes are relatively large; the size of price increases and decreases is similar although, for consumer goods, price increases are smaller. The average size of consumer price increases is 8% and of price decreases is 10%, compared to elapsed inflation between price changes of about 2%. These magnitudes vary across types of product: they are the largest for perishable foodstuffs and the smallest for energy. The magnitude of producer price changes is smaller. The median price increase is 3%, while the median price decrease is 2%. But there are many price changes exceeding 10%.

A large proportion of price changes are decreases. For consumer goods 42% of all changes are decreases. For both types of food and energy, price increases and decreases are almost equally likely (46% of are decreases); for industrial goods 43% of price changes are decreases. On the other hand, price reductions are much less common for services, for which they constitute only 20% of price changes. A possible explanation of this low proportion of price reductions in services is that the share of labour in production costs is higher than for other product types. As nominal wages and salaries are rarely reduced, a reduction in the price of a service requires productivity improvement or a cut in mark-up. For producer prices the proportion of all price changes that are decreases is about 45% and is similar in each country. Note that the prices are the actual transaction prices so that they include all price-related discounts. The large proportion of price reductions means that concerns about downward price rigidity are unwarranted.

Price changes do not tend to be synchronized within or across countries. The issue of staggering/synchronization of price changes is important for the effects of monetary policy. When price changes are synchronized, the effect of monetary policy typically lasts only for as long as prices are unchanged. At the time of price change the firm knows all other firms will simultaneously adjust and so it sets the new price at its new optimal value. When price changes are staggered, the effects of monetary policy last longer. This is because, at the time of adjustment, the firm must take into account that other prices are constant. To avoid getting its price out of line with prices charged by competitors, it does not change its price all the way to the new optimal value. Synchronization/staggering of price changes is measured using the index introduced by Fisher and Konieczny (2000), henceforth the F-K index. The index is equal to zero when price changes are perfectly staggered and to one when price changes are perfectly synchronized. The F-K index for consumer prices varies between 0.13 in Germany to 0.48 in Luxembourg. These values are much smaller than one, suggesting price changes are closer to staggering than to synchronization. In general, staggering is more pronounced in large countries.

Several factors affect the frequency of price changes. *Higher inflation*, both aggregate and sectoral, raises the frequency of price changes. This is a general result well known from essentially all empirical studies. Several authors report that higher inflation increases the probability of price increases and reduces the probability of price cuts. This has interesting implications for policy. As the inflation rate falls, the proportion of all price changes that are decreases rises, and so downward price rigidity becomes less of a problem.

Indirect tax changes and the Euro cash changeover trigger numerous price changes. The fact that, faced with unusual situations, firms respond by making additional price adjustments has important implications: it indicates that prices may be more flexible than they appear under regular circumstances. Consider a situation in the Euro area when relative prices across countries need to change. In a similar manner to a change in indirect taxes, firms may react to changes in their costs and demand by undertaking additional price changes. Therefore judging the flexibility of the nominal side of the economy by the flexibility of prices under the usual circumstances provides a lower estimate of the speed of adjustment to relative price shocks. It is important to note here that when indirect taxes change and during the euro changeover, the frequency of price changes increases and the size of adjustment falls. This indicates that, following a large shock to the economy, price changes will become more frequent. The effect on the average size of adjustment is, however, not clear. The fact that price changes become smaller following an indirect price change or during Euro changeover does not imply the same would happen when a large shock takes place. This is because a typical size of price change for consumer goods is around 10%, so it is not surprising that many firms make much smaller price changes when indirect tax changes by one or two percent.

Calendar effects and time-dependent pricing behaviour is a tendency of firms to change prices on a regular basis, for example each January. Consumer price changes are more frequent in some months In virtually all countries hazard rates have peaks at 12, 24 and 36 month durations, indicating that many firms change prices once every year, two or three years. Producer prices also tend to be changed more often in January than in other months. These time-contingent pricing policies lead to less frequent price changes. Similarly, firms that set attractive prices (prices that end in a nine or round prices) change prices less often. Surveys conducted within the IPN show that time dependent policies, which potentially lead to largest price rigidity, are used by a significant proportion of firms (more than 30% in some countries). But almost half of the firms use a mixture of time and state dependent policies, and a fifth uses mainly state-dependent policies.

Competition and the retail trade structure are believed to influence significantly the frequency of adjustment. Surveys show that, except for Austria and Portugal, firms that report facing strong competition in their markets change prices more often than those in less competitive markets. Also the frequency of price changes in larger stores is greater than in small stores and prices change more often in supermarkets than in corner stores. This may be due to a more intensive competition between stores, or due to returns to scale in price changing. The impact of competition on the frequency of price adjustments is

particularly important as it could potentially explain why the frequency of price changes is lower in the Euro-area than in the US.

The cost structure, especially the share of labour and energy, matter for price flexibility. In general, the higher is the share of labour in production costs in a given industry, the lower is the frequency of price changes. On the other hand, the higher is the share of energy and non-energy intermediate goods in production costs, the more frequently prices change. The latter effect is stronger for the share of energy costs, which are in general more volatile than non-energy intermediate products.

Surveys provide direct information on price changing policies. They allow to distinguish between two parts of the price adjustment process: an evaluation of the current situation (a price review) and the decision to actually change the price. Price changes are less frequent than price reviews, which indicates extrinsic rigidity (a price review reveals that conditions have not changed much and so the firm does not change prices).

When firms are asked about the reasons for not changing prices, they most often specify implicit and explicit contracts, cost-based pricing and coordination failures. The answers are remarkably similar across countries. The contracts involve either an explicit arrangement to deliver the product at a constant price for an extended period of time or firms keep prices constant in order to build a long-term customer relationship. Cost-based pricing implies extrinsic rigidity: the firm will not change prices as long as costs do not change. Coordination failures are a form of real rigidity. They arise in imperfectly competitive markets in which a firm's profits depend on prices of other firms. A nominal price increase, when other firms do not change prices, raises its real price and may lead to a large drop in profits and market share. For this reason, in equilibrium firms do not increase nominal prices even when their optimal prices rise.

The Wage Dynamics Network, recently set up by the European Central Bank and National Central Banks, has conducted an extensive survey of wage determination in European firms. It distinguishes between downward nominal wage rigidity, when base nominal wages are never (in the previous 5 years) cut and downward real wage rigidity, when base wages are linked to inflation. Nominal rigidities are present in 14% of firms while real rigidities are present in 10% of firms in the 15 European countries covered by the survey. Firms that face nominal rigidities tend to be more likely to use non-wage strategies to reduce labour costs indicating that nominal rigidities are a constraint on firms' ability to adjust to shocks.

In general wages are more rigid than prices: 75% of firms change wages once a year or less frequently (for prices the corresponding number is 50%). The relationship between price and wage changes is weaker in sectors with lower labour share in total costs, sectors with more competitive pressures, in firms with firm-level collective agreements, large firms and those with more flexible technology.

In section III we develop three indicators that allow the assessment of intrinsic rigidity. Intrinsic rigidity, rather than extrinsic rigidity, is crucial for the issue of adjustment to nominal shocks. Extrinsic rigidity reflects the stability of the environment and is not an integral part of the price adjustment process. When nominal shocks affect the desired price, extrinsic rigidity alone will not prevent price adjustment. Therefore the evaluation of the nominal adjustment process requires the analysis of intrinsic rigidity.

The indicators are designed to make maximum use of available data; unfortunately the IPN data are no longer publicly available. The coverage of countries and sectors by the indicators differs depending on their data requirement. The first indicator compares the frequency and size of changes in the actual and in the optimal price. The optimal price is proxied by sectoral producer prices. This indicator necessitates matching the classifications of consumer and producer goods. The second indicator compares the persistence of the CPI and PPI inflation rates. Since CPI and PPI sub-indices are available for most euro area countries from Eurostat, the coverage of countries and sectors with this indicator is larger than for the other two indicators, which rely on micro data observations. The third indicator compares the average absolute price change to the volatility of the price index. The size of the price change is related to the level of intrinsic rigidity and the volatility of the price index to extrinsic rigidity (Dhyne *et al.*, 2008).

In section IV we use the indicators to evaluate the rigidity of consumer prices. Our analysis shows that, for consumer prices, the frequency of price changes is a misleading indicator of intrinsic price rigidity, in the sense that sectors with frequent (infrequent) price changes are not necessarily characterized by low (high, respectively) intrinsic price rigidity. Crucial differences arise for food and for service prices. While retail prices of food change very often, this is caused by producer prices being very volatile. Food prices actually exhibit a level of rigidity similar to that for manufactured goods, despite the fact that the frequency of price changes for food is much higher. On the other hand the low frequency of price changes for services is due to the fact that the cost of providing services is quite stable. The largest cost component is labour, and wages are changed quite infrequently, usually once a year. The level or intrinsic rigidity for services is actually moderate, similar to the level for manufactured products, for which prices change much more often.

As the role of services in the Euro-area economies is increasing over time, this finding is important for the policy implications of nominal rigidities. A nominal shock feeds into service prices mostly through the cost of labour. That means that policies aimed at speeding up price adjustment in the service sector should focus on labour market reforms.

We find that the differences in rigidity between sectors are greater than between countries. The most rigid sectors are clothing, cultural products, food and health products. Housing products and transport have the most flexible prices, probably due to the high energy component. Two sectors with low frequency of price changes but little rigidity are alcoholic beverages and tobacco as well as durable manufactured goods.

Our results indicate that a larger number of retailers has a positive effect on price flexibility. However, the effect of the number of large supermarkets does not seem to be significant. Food products are not as flexible as one might think. This may explain the result. Another possible explanation lies in marketing policies. A Hi-Lo policy may increase the frequency of price changes in supermarkets. However, these price changes may be quite disconnected from movements in costs. In other words, when the management chooses a policy of frequent price changes, this need not imply that prices are flexible.

Section V looks at the determinants of producer price changes. While the IPN and other projects collected extensive information on the behaviour of consumer prices, less is known about producer prices since data are harder to obtain. For producer prices we can only compute the third indicator (the average size of price changes relative to the volatility of the sectoral price level). Sectors with large intrinsic rigidities are manufacturing of durable and capital goods as well as the textile sector. Sectors with a large share of raw material inputs have more flexible prices. Unlike for consumer goods, the average frequency of price changes is a reasonable indicator of intrinsic price rigidity: the ranking of sectors by the average frequency of price changes is similar to the ranking by our rigidity indicator.

Several studies analyzed factors underlying producer price rigidity in individual Euro area countries. We construct a harmonized data set and conduct a cross-sectional analysis which allows a better assessment of six factors affecting producer price rigidity across Euro area countries. We concentrate on the frequency of price changes as data needed to estimate desired prices are not available. There are no substantial differences across countries in the role of these factors. We find that prices of products with high energy content are changed more frequently and prices of products with high labour content are changed less frequently. This is due to the fact that energy and labour content influence the volatility of costs. Energy prices change often while wages change infrequently. Hence products with high energy content have very variable costs while the costs of products with high labour content are stable. Prices of complex products change less frequently; this may reflect the fact that various cost components change in different directions and so the average cost is relatively stable. External competition, measured by the import content of a product or by the degree of exposure to international trade, has no significant effects on the frequency of price changes.

Finally, our results based on a panel data set for six Euro-area countries indicate that competition may affect the frequency of price changes. The result is, however, not strong. We use two proxies for market competition. The effect of competition is significant only with one. This may be because the two measures we use are poor proxies for market competition. When firms are asked directly about the competition in their market the clear result is that the frequency of price changes is positively affected by perceived competition.

Similar results are obtained by analyzing price increases and price decreases separately. One important difference is that greater competition leads to more frequent price increases but has no significant effect on the frequency of price cuts. This suggests that more intense competition, by reducing mark-ups, makes firms more sensitive to cost increases.

Section VI is devoted to analysis of several issues based on country studies. The study of regulated and unregulated prices in Austria shows a very significant effect of regulation on the frequency of adjustment.[1] Firms subject to price regulation change prices three times less frequently than unregulated firms. Regulated prices change by a smaller amount. Deregulation leads to more frequent price changes. The effect of regulation is more pronounced for price decreases (both frequency and size) than for price increases. Regulated prices are rarely cut. They are characterized by strong seasonality: a very large proportion of price changes is in January. These results are consistent with the menu costs theories of price adjustment. Changing prices of regulated products requires significant amount of management time. Apart from determining the new optimal price (as unregulated firms need to do as well), the regulatory application must be produced and the permission of the regulatory authority secured. Given the complexity of the process, a regulated firm is unlikely to reduce price when it experiences a drop in its costs or demand that it perceives to be temporary.

The introduction of the Euro required that firms convert prices from the old to the new currency. We analyze the effect on pricing policies with data from Austria and Belgium that end almost five years after the changeover, thus providing a sufficiently long period to study the long run effects of Euro introduction. Around the time of the Euro conversion price changes became more frequent and much smaller; the effect on adjustment size was much more pronounced, especially in January 2002 when price changes (both increases and decreases) were particularly small. We do not, however, find permanent effects of the changeover on price flexibility. In Austria the frequency of price changes is higher after the changeover but the increase actually starts two years earlier. It may be caused by deregulation of electricity and gas prices or by the change in the composition of sampled goods. In Belgium, the frequency of price changes is higher than before the changeover for a few years but then returns to the pre-Euro level.

There has been concern recently about the fast increase in food and energy prices in the Euro area. This trend has been replaced since September 2008 by rapid disinflation. We look at the effect of inflation on the frequency of food price changes in Belgium, and on the frequency of price changes in Austria. In Belgium, higher inflation leads to more frequent price changes and has a limited effect on their size. More precisely, the frequency of price increases rises significantly, while the frequency of price cuts falls a little. In

[1] About 19% of all items in the Austrian CPI are classified as (price) regulated which cover all the goods and services whose prices are either fully (directly) set or mainly (to a significant extent) influenced by the government (central, regional, local government or national regulators).

Austria both increases and decreases become more frequent but the effect on decreases is smaller.

The response of price changes in Belgium is consistent with other studies, in particular Gagnon (2007). The effect of inflation on the size of price changes is limited. The response of the frequency of price increases and decreases to higher inflation is asymmetric. When inflation rises, price increases become more frequent and price decreases less frequent. This is important for two reasons. First, some studies find little effect of inflation on the frequency of price changes. This is the artefact of the effects on the frequency of increases and decreases cancelling each other. Second, as inflation rate falls, price decreases become more frequent and so prices become more flexible downward. Thus concerns about downward price rigidity are not justified.

Further information on the behaviour of producer prices is obtained from detailed firm surveys conducted by the National Bank of Belgium and the Banque de France. We find that, in Belgium, the average frequency of producer price changes is 20%. This number varies between 25% in manufacturing and the trade sectors, 20% in the construction sector and 9% in the B2B sector. Price reductions are about as frequent as price increases, also in the B2B sector. This is in contrast to consumer services in which price increases are about four times as common as price decreases. The analysis of factors affecting price adjustment concludes that the main determinant of the sectoral frequency of price changes are input costs and, to some extent, the share of imported inputs.

Business surveys conducted by the Banque de France provide extensive information on factors affecting producer price changes in France. We find that producer prices are indeed rigid: of firms that report change in their environment in a given period, almost 80% leave prices unchanged. Firms are more likely to respond to cost than to demand or production changes. As in Belgium, intermediate input prices are the main driver of price changes. Wage changes do not have an immediate impact on prices, consistent with the fact that a majority of firms declare no link between the timing of price and wage changes. Finally, firms respond more rapidly to cost increases than to cost decreases.

Our analysis, combined with results in the existing literature, leads to several policy recommendations. Price regulation is identified as a major factor slowing nominal adjustment. The difference in the frequency of price adjustment between regulated and unregulated prices is very large. This is implied by the standard menu cost models, where the frequency of price changes depends negatively on the costs of price adjustment. Regulation imposes additional price adjustment costs on firms even when price adjustment is fully justified by changes in production costs and other factors. The cost of price adjustment for regulated products is higher as the firm usually has to request each price change and has to convince the regulatory authority that the price change is, indeed, justified. This raises the amount of management time needed to conduct the price change and so raises its cost. Two solutions are possible. The first involves minimizing the scope of price regulation. But of course in some industries it is made necessary by the market

power of the producer (producers). In that case, mechanisms should be developed to streamline the regulatory process. In particular, some price adjustments, for example those needed to keep the relative price constant, could be made automatic, with an ex-post regulatory control.

Price regulation has greater effects on price decreases than on price increases. Price decreases are rare, and small, in regulated industries. This means that the benefits of deregulation are larger when inflation is low. In the current low-inflation (and possibly disinflationary) environment price deregulation is especially important.

The evidence on the effect of competition on the frequency of price changes is mixed. The most likely reason is that the competition proxies used in empirical studies are deficient. When firms are asked in surveys about the perceived competition in their market, the clear result is that the frequency of price adjustment is higher in markets perceived as more competitive. We believe that the survey results present a more accurate picture of the relationship between competition and the frequency of price changes. On this basis we believe that promoting competition would increase price flexibility.

When prices differ across sellers, customers search for the best price. The frequency of price changes is affected by search intensity as it increases the losses to the firm from having a price far from the optimal level. Policies facilitating search for the best price would therefore lead to more flexible prices. Such policies include simplification and harmonization of product regulations and standards, requirements of posting actual prices, prohibition of hidden charges and joint transactions, disclosure of the payment schedule for multi-payment transactions and, in some cases government – sponsored product comparisons. Product regulations and varying standards are often used by firms to create the impression of product differentiation and reducing competition. Posting actual prices permits price comparisons; they are further facilitated if firms are required to post the actual transaction price including all elements (for example, prohibiting airlines to post prices net of taxes, fuel surcharges etc.). When firms provide incomplete cost of the purchase and/or hide some of the cost, their motivation is usually to make price comparison more difficult and build some pricing power. Joint transactions, by linking the price of one product to another, make price comparisons difficult and reduce incentives for search for the best price. Such practices are common in many countries for cell phone purchases, when the phone is subsidized whenever long-term contract is entered at the time of the purchase. Government-sponsored comparisons provide purchasers information that allow them to assess the benefits of switching to lower-cost products, for example generic medication.

The effect of sticky individual prices depends on the distribution of the frequency of price changes across products. The stickiest prices have a disproportionally large effect on overall price adjustment, slowing the price response and increasing the output response to shocks. The intuition is as follows. When a heterogeneous economy is hit by a shock, the initial price adjustment takes place in firms in the fast adjusting sectors. As prices in slow

adjusting sectors do not change, this adjustment is incomplete, i.e. prices are rigid. This means that the presence of sectors with infrequent price changes slows down price adjustments in other firms as well.

Policy should therefore pay particular attention to slow – adjusting sectors. Services are such a sector: the frequency of price changes of consumer services (but not of B2B services) is lower than for goods. As the role of services in the economy is increasing over time, the stickiness of their prices becomes more important. It is important to note here that prices of services change infrequently due to a large share of labour in costs. Wages and salaries change infrequently, once a year or a few years. Therefore making service prices more flexible requires a comprehensive labour market reform, which would increase the flexibility of labour costs.

These recommendations focus on the frequency of price changes. This is because all theoretical models imply that a higher frequency of price changes leads to faster aggregate adjustment. Thus, from the point of view of aggregate nominal flexibility, policies that increase the frequency of price adjustment at the level of individual firms are desirable, regardless of whether the rigidity is intrinsic or extrinsic. Reduction of intrinsic rigidity means reducing the obstacles to price adjustment and so is uncontroversial. On the other hand affecting extrinsic rigidity requires careful analysis of benefits and costs. Prices are extrinsically rigid when costs and demand are stable. The low frequency of adjustment is then the result of firms' optimal policies. Making costs and/or demand more volatile to raise the frequency of price changes is often not a good idea. But in several cases measures that reduce extrinsic rigidity are beneficial. The most important example are services, where extrinsic rigidity is caused by the stickiness of labour costs. Comprehensive labour market reform would make wages more flexible and raise the frequency of changes of service prices. Similarly, in sectors where costs are stable due to lack of competition, pro-competitive policy may be beneficial.

Reducing regulation, promoting competition and implementing comprehensive labour market reforms are complex policies that are influenced by many factors other than price adjustment considerations. There are several relatively simple policies that focus on facilitating price adjustment. As argued above, some changes in regulated prices can be greatly simplified, reducing their costs to the firm. Item – pricing laws, under which a price sticker has to be attached to every item) increase the costs of price adjustment and should be eliminated. Price transparency promotes price comparisons and facilitates customer search for the best price which, as explained below, raises the frequency of price changes.

Our results indicate that promoting large stores is not necessarily the best way to foster competition at the retail level. It is not clear how competitive is a market with few large stores as opposed to a market with many small stores. This result, however, should be further examined by analyzing the impact of local competition on prices.

Finally, a policy that is probably relatively inexpensive and potentially very beneficial is the policy of subsidizing technologies that facilitate price adjustment. One example of such technology is a system of electronic shelf tags. Changing prices involves inputting the new price into a central computer, which then transmits it wirelessly to the relevant tag. The price change is immediate, mistakes in pricing are avoided and the cost of such price change is greatly reduced in comparison with paper tags, raising the frequency of price changes. Such technologies have a clear positive externality: apart from reducing adjustment costs for the firm, they make its prices (and possibly also prices of its competitors) more flexible, which is a social benefit. A technology of this kind typically involves a substantial initial fixed cost but reduces operating costs. In a situation when total benefit from more flexible prices and lower adjustment costs exceeds the cost of the technology, but the reduction in adjustment costs alone does not, a modest subsidy may make the introduction of the technology profitable. Once the technology is implemented, the costs of adjustment fall drastically and price adjustment becomes much more frequent.

I. SURVEY OF THE THEORY.

1.1. Introduction.

The survey of the theoretical literature is organized in two complementary parts. The first part reviews theoretical models that explain nominal rigidities at the level of individual price setters. The second surveys the approaches to apply these models to macroeconomic issues.

Before we summarize the findings, it is useful at this point to introduce the distinction between *price stickiness* and *price rigidity*, and the related concepts of *intrinsic* and *extrinsic* rigidity. Many authors use these terms interchangeably but, for a policy-oriented survey, this distinction is crucial because an observation that prices adjust infrequently does not necessarily mean that policy intervention is called for. Prices are called sticky if they are adjusted infrequently. Since few prices outside of auction markets are adjusted all the time, a more useful concept is the degree of price stickiness: the lower is the frequency of price changes, the stickier are prices. Prices are called rigid if they do not adjust fully to changes in the optimal price (which in turn depends on the underlying costs and demand). The more muted is the response of prices to a given change in the optimal price, the more rigid are prices. While the two concepts are related, they are not the same. For example a price is sticky if there are fixed costs of adjustment (for example the cost of changing price labels). It is also rigid between adjustments.[2] But when the adjustment eventually takes place, the price is set at the optimal level and so it is not rigid. Conversely, when the cost of changing price is quadratic, it is rigid but not sticky as it is adjusted to the new optimal level through a series of small, frequent changes.

As is common in the literature, we will not make a similar distinction for flexibility. Both prices that are not sticky (i.e. adjust frequently) and prices that are not rigid (i.e. adjust fully to the optimal price) will be called flexible prices. This is a common terminology. Whenever we need to point out that prices are not sticky we will simply say that they adjust frequently.

The second distinction is between intrinsic and extrinsic rigidity. There are two reasons for infrequent adjustment. The first one is when the price does not change for reasons inherent to the price setting process, for example because the costs of price adjustment, discussed extensively below, are large. Dhyne *et al.* (2008) call this *intrinsic rigidity*. The second reason is that the economic environment is stable and so there is little need to change prices. In this case, which Dhyne *et al.* (2008) call *extrinsic rigidity*, the price is not changed even when the obstacles to adjustment inherent to the price setting process

[2] This is probably the reason some authors use the terms sticky and rigid interchangeably.

(for example the cost of changing prices) are small.[3] We will call prices *sticky* when they are changed infrequently due to either intrinsic or extrinsic rigidity, and we will call them *rigid* if they are changed infrequently due to intrinsic rigidity.

The distinction is important for policy recommendations. While increasing price flexibility (raising the frequency of price changes) improves the functioning of the competitiveness channel and is desirable, from the policy perspective it is the intrinsic rigidity that is more important. If prices are rigid i.e. there are large obstacles to price changing, the firm does not adjust prices even though its optimal price varies a lot. It is then advisable to consider policies that make prices more flexible, for example by reducing these obstacles or increasing incentives to change prices. On the other hand, if prices are changed infrequently because costs and demand are stable (i.e. prices are sticky but not rigid) and the optimal price does not vary much, there is much less scope for policy. It is possible to increase price flexibility by raising the variability of market conditions but that is, in general, not desirable.

To illustrate, prices of services are changed infrequently, i.e. they are sticky, while prices of energy products change frequently, i.e. they are not sticky. That does not necessarily mean that policy should concentrate on increasing the flexibility of services and not of energy products. As we discuss later in the report, we find that the reason for the difference in the frequency of adjustment between service and energy prices is due to differences in extrinsic rigidity. Demand and supply conditions in the service sector are quite stable while they vary a lot in the energy sector. Service prices are less rigid, and prices of energy products are more rigid than they appear. Therefore, from the policy point of view, price flexibility in the energy sector should be examined, even though prices change frequently. On the other hand, stickiness of service prices is less of a problem than the low frequency of price changes suggests. In other words, while the low frequency of service price changes may, at first look, suggest that markets do not function properly, in fact it is the optimal response of a firm which faces stable demand and costs.

The first part of the survey reviews partial equilibrium approaches to explaining why, as is commonly observed, price changes at the level of the individual price setter are infrequent and large. They are based on various reasons for price non-adjustment: menu costs, sticker costs, attractive prices (or pricing points), fair pricing and costly information. The most popular is the menu cost model, where firms face costs of changing their nominal prices. A pricing point (now commonly called attractive prices) explanation of nominal rigidities is based on the assumption that firms prefer to charge prices ending in a nine or round prices. Fair pricing is based on the notion that the firms and customers develop long-term relationship and customers do not like being taken advantage off. The costly information approach is somewhat different in that it is assumed price changing is costless but

[3] Technically, those situations should be called intrinsic and extrinsic stickiness. Below we will use Dhyne *et al.* (2008) terminology. Note that the price appears sticky when the reason for infrequent adjustment is that the optimal price changes infrequently. But such price is not rigid.

information is not and some firms make their pricing decisions without being completely informed.

The second part of the survey concentrates on recent applications of the micro-based nominal rigidities to explaining macro effects of nominal shocks. The main question is whether nominal rigidities, which appear not to be too large, can generate persistent movements in inflation and output following nominal shocks. Empirical evidence on pricing indicates that individual prices, while fixed for extended periods of time, change quite often and by a lot. The research agenda pursued by several authors is to build general equilibrium models with such rigidities that are consistent with both micro data that individual price changes are not very rigid and macro data that, in the aggregate, inflation is persistent and nominal shocks have long-lasting effects on output. This is an ongoing research effort. Carvalho (2006) shows that such model is possible when price changes are generated by Calvo-type mechanism, or in a time-contingent model. When price changes are state-contingent, however, the aggregate price level is more flexible, because of what is called in the literature a selection effect. In a time-contingent model, firms that change prices are randomly selected. Some of those firms may have changed prices recently and so they adjust prices only a little. On the other hand in a state-contingent model firms that change prices are those whose prices are the furthest from the desired values, and so all price changes are large. As a result, aggregate nominal rigidity is smaller. Nominal rigidity can be enhanced by introducing various sources of real rigidity: staggered price changes, staggered changes in the prices of intermediate products, demand functions of variable elasticity etc. At this point, however, each model still has problems explaining the pattern of price behaviour at the aggregate level and so the research agenda is ongoing.[4]

1.2. Partial Equilibrium Models of Nominal Rigidities.

There are several theoretical approaches in the literature explaining nominal rigidities at the individual level. They are based on various reasons for price non-adjustment: menu costs, sticker costs, attractive prices (or pricing points), fair pricing and costly information. The most popular is the *menu cost* model, where firms face costs of changing their nominal prices. A version of this approach is the *sticker cost* model of Diamond (1993), in which the costs apply to changing the price of the good already in the inventory. Kashyap (1995) proposed a *pricing point* (now commonly called *attractive prices*) explanation of nominal rigidities, whereby firms prefer to charge prices ending in a nine or round prices. Rotemberg (2005, 2006) argues that firms may not change prices to avoid anger by consumers and so engage in *fair pricing.* Mankiw and Reis (2002, 2006) and Reis (2006a, 2006b) developed a *costly information* model, where costs of getting informed prevent firms from continuously updating information about factors affecting their optimal price.

[4] Klenow and Kryvtsov (2008) discuss the performance of several models in detail.

These approaches are of different importance for the requested study. The menu cost model is central, as it has been the most popular, the most widely tested and supported by the data. The costly information approach has been introduced to explain the behaviour of prices and inflation at the macro level and has important policy implications. The fair-pricing approach was relevant during the conversion to the Euro and is helpful to explain asymmetric drivers of price increases and decreases evidenced by survey results. The tendency to charge attractive prices has a negative impact on the frequency of price changes in the Eurozone, as evidenced by numerous empirical studies. The sticker cost model has limited ability to explain data as, in most industries, the cost of pricing the product for the first time is similar to the cost of changing the price of the good in inventory.

1.2.1. The Costly Price Adjustment Model.

We start the survey with the menu cost model. The formal concept of menu costs has been introduced by Barro (1972) and developed by Sheshinski and Weiss (1977) and others but it is mentioned much earlier in the works of Hicks (1935), Means (1935, 1936), Galbraith (1936) and Scitovszky (1941). The idea follows from a simple reasoning. Assume that changing a nominal price is costless. Then a firm will try to maintain its nominal price at the profit-maximizing level. Whenever demand or costs change, the nominal price will be adjusted to the new optimal value. In particular, under conditions of general inflation, the nominal price will be adjusted continuously to keep up with changes in the general price level. Yet we observe that nominal prices are left unchanged for extended periods of time. This means that price changing is costly and these costs prevent firms from changing prices in a continuous manner.

The basic model, due to Sheshinski and Weiss (1977), considers a monopolistic or a monopolistically competitive firm producing a perishable product.[5] The firm operates in a nonstochastic environment, with stationary real demand and costs and a constant rate of inflation. The stationary environment implies the optimal real price is constant. Inflation erodes the real price the firm charges, inducing it to raise the nominal price. In the absence of price changing costs, the nominal price will be increased continuously at the same rate as the general price level. But changing the nominal price is costly. The costs are assumed to be lump-sum: fixed and independent of the size or the frequency of adjustment. In other words, the cost of changing price by 1% or by 10% is the same, and the cost of each price change is the same regardless of whether the price was last changed the day before or a year ago. Under those assumptions, Sheshinski and Weiss (1977) show that the optimal pricing policy is of the (s , S) type. The firm sets two bounds for the real price: s and S. The real price is allowed to fluctuate between those bounds. As the nominal price is kept constant, the inflation rate reduces the real price. Once it falls to the lower bound, s, the adjustment takes place. The nominal price is raised to such a level that the new real

[5] The firm cannot be competitive since it sets its own prices, rather than taking them as given.

price is equal to the upper bound, *S*. Over the pricing period, the real price fluctuates around the optimal frictionless price (the price the firm would have charged in the absence of price changing costs). The adjustment overshoots the optimal frictionless real price so that at the beginning of the pricing cycle, the real price starts above the optimal frictionless value. It is then eroded by inflation and, at the time of adjustment, it is below the optimal frictionless value.

The optimal policy is an example of a *state-contingent* policy. The nominal price is increased when a particular state is reached. In this simple setup, this state is when the real price is eroded by inflation to the optimally determined threshold, *s*.

Sheshinski and Weiss (1977) derive the comparative statics results for the simple model. As the inflation rate increases, the price bounds *s* and *S* are set further apart: the upper bound *S* increases while the lower bound *s* decreases. This means price changes become larger. The effect on the frequency of price changes is, somewhat surprisingly, ambiguous. With higher inflation the real price is allowed to decline more between adjustments, but the decline is faster. Sheshinski and Weiss provide an example under which price changes become less frequent as the inflation rate rises, and a sufficient condition under which the correlation between inflation and the frequency of price changes is positive.[6] Higher adjustment costs lead to larger and less frequent price changes. A higher real interest rate lowers both price bounds and has ambiguous effect on the frequency of price changes.

1.2.2. Generalization of the Costly Price Adjustment Model.

The basic model has been generalized in many directions. Researchers analyzed stochastic inflation, storable goods, costs of adjustment that are not lump-sum, the choice of price adjustment technology, and nonstationary demand and costs. Sheshinski and Weiss (1983), and Danziger (1983, 1984) consider stochastic inflation. In Sheshinski and Weiss (1983), the rate of change of the price level may be either positive or zero. The distribution of time spent in each state is assumed to be exponential. The authors show that there is a certainty-equivalence rate of inflation so that the optimal pricing policy can be reduced to the nonstochastic case as long as the real interest rate is zero. Zero discount rate means that the only thing that matters over time is the expected length of time spent in the inflationary state.[7] The comparative statics are as follows. An increase in the average rate of inflation, (which can happen either through a higher rate of inflation in the inflationary state, or by increase in the amount of time spent in that state) lead to an increase in the certainty-equivalence inflation rate and so to an increase in *S* and a decrease in *s*; this also means that price changes become larger. The effect on the frequency of price changes is ambiguous, as in the nonstochastic Sheshinski and

[6] The condition restricts the shape of the profit function. It is equivalent to the requirement that the profit function be concave in the log of the real price.

[7] With positive discounting, the timing of shocks will matter.

Weiss (1977) model. The stochastic framework allows deriving the effect of uncertainty on the size and the frequency of price changes. An increase in the variability of inflation, keeping the average rate of inflation constant, raises the certainty-equivalence inflation rate and so leads to larger and less frequent price changes. The intuition is straightforward. The more uncertain is the behaviour of the price level, the lower is the option benefit of adjusting price and the more likely is price adjustment delayed. In Danziger (1983) inflation follows geometric Brownian motion. As in the previous paper, it is possible to show that there exist a certainty-equivalence inflation rate and interest rate. An increase in the expected rate of inflation separates the price bounds further apart and leads to an increase in the size of adjustment. The effect of inflation uncertainty depends on the shape of the profit function; under some circumstances price changes may become smaller. Similar results are obtained in Danziger (1984) where inflation is assumed to follow a compound Poisson process. Higher expected rate of inflation or higher adjustment costs increase the initial real price and reduce the terminal real price and so lead to larger price changes (and in case of higher adjustment costs, less frequent price changes). The effect of increased uncertainty is, in general, ambiguous and depends on the shape of the profit function and the way risk is increased. The effect of higher expected inflation and inflation uncertainty on the frequency of price changes is, in general, ambiguous.

Under stochastic inflation the state-contingent nature of the optimal policy is more meaningful, in the sense that price changes take place in irregular intervals of constant length. For a given inflation rate process the lower bound is optimally determined and the time it is reached is a random variable. Hence price changes are not regular.

Firms considered in these models produce perishable goods. This avoids the problem created by the predictable variations in the nominal price. If customers can solve the firm's problem and compute the lower bound, s, they can predict when the next price adjustment will take place. Actually, solving the firm's problem is not necessary. In the nonstochastic case price changes take place regularly and so the next price change is easy to predict. In the stochastic case, as long as customers know what price index the firm uses to deflate the nominal price and have contemporaneous information on the index,[8] they can compute the value of the real price and so figure out when it falls to the lower bound. The fact that the good is perishable makes this prediction useless. If, on the other hand, the good is storable, customers can increase purchases just before the price increase and consume out of their inventories after the price has been raised. The firm would then sell a lot when the price is low and little when it is high. In the extreme, when all customers are repeat buyers and the storage cost is not too high, demand will be discontinuous and sales will take place only prior to price increase. Consumers will come to the store before price is increased and buy sufficient stocks to last them until the end of the next pricing cycle. Following the price increase firm's sales will fall to zero and nothing will be sold until the

[8] Empirical studies suggest that what matters for the optimal pricing policy is not the CPI but price level of similar goods, indicating that the latter is used to deflate the nominal price. In general, firms have informational advantage with respect to sectoral price indices over their customers, especially in retail markets.

price falls back to the lower bound. Bénabou (1989) considers a firm producing a storable goods and facing the costs of price adjustment. He shows that the optimal pricing policy involves a random timing of price changes. The randomization of the timing of price adjustment deters speculative storage. It happens even in a purely deterministic setting, with stationary demand and costs and a constant inflation rate. Thus inflation creates uncertainty at the individual level, even in the absence of any aggregate uncertainty.[9] Arigaa, Matsui and Watanabe (2001) consider a similar model in which the good is storable and customers differ in their willingness to pay. The willingness depends on whether they buy the good for immediate consumption or for storage. Their storage capacity is limited. They show that firms' pricing depends on the amount of good in consumer storage. Following a price increase, consumers reduce purchases and use up their stocks. The only active buyers are those who are without stock and purchase for immediate consumption. As stocks fall, the potential size of the market increases. The firm then randomly introduces a sale. The reduction in the profit per unit is compensated by the increase in the volume of sales. This creates a dynamic pricing cycle with random, occasional price reductions.

The firms studied in the basic model are not regulated. There are no theoretical models of a regulated monopoly operating under a fixed adjustment costs. As the goal of the regulatory authority typically differs from profit maximization, the optimal pricing policy need not be similar to that in the basic model. A puzzling feature of price regulation is that it is usually conducted in nominal, rather than real terms (this is the case in markets studied by Sheshinski, Tishler and Weiss, 1981, and by Dahlby, 1992). There is no reason why nominal price increases aimed at maintaining a constant real price (in terms of some price index mutually agreed upon by the monopolist and regulatory authority) should not be automatic. Yet, as empirical evidence suggests, regulated prices are changed significantly less often than prices that are not regulated. A regulated firm, apart from determining the new optimal (or desired) price, must prepare regulatory filing and go through a regulatory process. That means that adjustment is more costly, leading to less frequent, and larger, price changes. Furthermore, in a stochastic environment the firm may be reluctant to apply for a permission to change price for shocks that are perceived as transitory. These considerations imply that price changes of regulated products should, on the average, be less frequent than price changes of unregulated products. Evidence from IPN studies supports this view.

The standard model analyzes a firm that produces a single good. Sheshinski and Weiss (1992) and Midrigan (2006) analyze a monopoly firm which produces several goods. The motivation of both papers is different. The analysis in Sheshinski and Weiss (1992) is aimed at studying conditions under which the optimal policy involves staggering or bunching of price changes. They show that two factors matter: interaction between prices of both goods in the profit function and the form of adjustment costs.

[9] When the economy consists of many such firms, their optimal policies aggregate to a smoothly increasing price level.

When the two prices are strategic complements, in the sense that raising one increases the optimal value of the other, the firm tends to change both prices together, i.e. price changes are synchronized. For example when the single-copy price of a magazine increases, the firm tends also to raise the subscription price. When goods are strategic substitutes, the firm tends to stagger price changes over time. Overall, the model does not make unambiguous predictions as to whether price changes should be staggered or synchronized. The form of the adjustment costs matters as well. If there are increasing returns to scale in price changing, firms tend to synchronize price changes of the goods they sell. A typical example of increasing returns to scale is when the firm produces a price list (a menu). When one price is changed, the firm needs to issue a new menu. As the cost of printing and delivering the new price list is already paid, the cost of additional price changes is smaller and so it is optimal to change prices of other products. A less obvious example of increasing returns involves the process of price changing. If a detailed analysis of market situation is needed, or when pricing is done by a multitasking manager (i.e. manager who is not completely dedicated to pricing) then there are benefits from concentrating price changing in one period. Midrigan (2006) develops a model in which there are complementarities in price adjustment of the type described above. The goal of the model is to explain why many observed price changes are small. This fact is inconsistent with the standard menu cost model where the adjustment takes place only when the loss from not changing price is large, and so price changes are large. But under complementarities in price adjustment, whereby adjusting several prices involves a fixed cost – printing the new menu, and a small variable cost, small price changes would be observed (Lach and Tsiddon, 2007, make this point as well). This type of adjustment requires that price changes be synchronized within stores, or for similar products; Midrigan provides evidence supporting this conclusion.

In menu cost models the cost of price adjustment is treated as fixed and beyond the firms' control. But in recent years there have been significant changes in the way prices are adjusted. Indeed, the Levy *et al.* (1997) analysis of the size of price changes arose in the process of introducing new price changing technology in supermarkets. Under the old technology, store personnel had to change price labels on store shelves. The new technology involved electronic, wireless price tags which replaced the paper price labels. Prices are changed in the central computer, and the changes automatically show up on the electronic tags. Thus, after paying the fixed cost of introducing the new system, the cost of price changes is lower. Konieczny (1993) considers the decision to invest in technologies reducing the variable cost of price changes. An increase in the variability of desired prices (which can be caused for example by a switch to a common currency and elimination of the exchange rate adjustment to nominal changes) may trigger firms to invest in such technologies. That means that increased variability of desired prices may lead to, subsequently, greater flexibility of nominal prices. Note that the increase in nominal flexibility depends on the technology being introduced, and so there is no limit on how much it may increase. For example, the electronic tags described above, once implemented, permit indexing and near continuous adjustment (subject only to limitation

of the last price digit). In other words the effect on the frequency of price changes may be quite dramatic even when introduction of the new technology is barely profitable.

Cecchetti (1986) considers a case in which demand and costs are not stationary. He shows that, as the optimal frictionless price (that would have been charged in the absence of adjustment costs) varies due to changes in demand and costs, so do the price bounds. Dhyne *et al.* (2008) analyze a model in which, given the costs of adjustment, price changes do not take place when either the costs of adjustment are large, or when the desired price is stable. This is the distinction between intrinsic and extrinsic price rigidity. Also Golosov and Lucas (2007) stress the role of idiosyncratic shocks as the reason for price changes. The intuition is that observed price changes are much larger than implied by aggregate shocks.

1.2.3. How Large are the Adjustment Costs?

There has been significant discussion in the literature on the nature and consequences of price adjustment costs. The obvious costs are the literal costs of printing and attaching new price labels, issuing price lists and advertising. These costs are presumed to be small and so critics of the menu cost approach argued that they cannot explain much. Mankiw (1985), Akerlof and Yellen (1985) and Dixit (1991) showed, however, that even small menu costs can lead to price rigidity with large aggregate consequences. The idea is simple. Under costly price adjustment the real price fluctuates around the optimal, frictionless profit-maximizing price. When the nominal price is increased, the real price is set above the optimal frictionless price; at the time of adjustment it is below the momentary profit-maximizing value. When the cost is small, the real price varies in the neighbourhood of the frictionless optimal real price, where the profit function is flat.[10] This means that non-adjusting the price leads to second-order losses to the firm. But social losses are of first order. This is because, as already mentioned, the firm has some monopoly power and so its optimal frictionless price is higher than the socially – optimal value. A small cost of changing price may be greater than the second-order loss to the firm from not adjusting, but the social loss is first order. Hence even small menu costs may have large social consequences.

The precise value of menu costs has proven difficult to extract from existing data. Levy *et al.* (1997) provided the first estimate of such costs. Their results were obtained by direct observation in a chain of supermarkets. Essentially researchers shadowed the work of personnel changing prices and computed the total cost of this activity. The expenditure on changing prices is equal to 0.7% of all revenues, or 35% of net margins. These figures are quite substantial. Given the type of stores observed, they can be taken as the upper bound. Supermarkets change prices very often; in Levy *et al.* (1997) this happens once every 6 weeks on the average. Moreover, the supermarket business is based on very small net

[10] The derivative of the profit function with respect to price is zero at the optimal frictionless price.

margins (around 2% of revenue); hence the ratio of adjustment costs to net margins is so high.

In a subsequent paper, Zbaracki *et al.* (2004) take a similar approach to studying the costs of price adjustment in an industrial firm. Using field interviews, nonparticipant observations and analysis of the company records related to price changes, they identify several types of costs, beyond the traditional literal costs of price changing, related to price adjustment. These are managerial costs which consist of expenses on information gathering, decision-making and communication costs (to employees), as well as customer costs which consist of costs of communicating and negotiating with customers. When a firm decides to change price to an important customer, it usually sends a pricing manager to explain the reason for the decision and assure the customer that they are not being taken advantage off. In many cases the price change is not accepted and the price of the good that is eventually established is set in the process of direct negotiations with the customer. It turns out that, for the firm they study, the total adjustment costs are substantial: they constitute 1.23% of total revenue and over 20% of net margin. These numbers are similar to the costs reported in the earlier study of supermarkets. What is completely different, however, is the composition of the costs. The literal adjustment cost (changing labels, printing new price lists etc.) constitutes only 3.3% of the total cost while managerial costs constitute almost 23% and customer costs constitute 74% of the total cost. In other words, managerial costs are seven times greater, and customer costs are over twenty times greater than the physical, literal costs of adjustment.

These findings suggest that the assumption of lump-sum costs may be an oversimplification. While the physical costs of changing price (attaching labels, posting a new price etc) as well as advertising costs are independent of the size of price changes, the managerial and customer costs would, in general, depend on either the size or the frequency of price changes. A customer is more likely to object to a large price increase than to a small one, or to an increase that follows shortly after a previous increase. This generalization of the basic model has been considered by several researchers. Rotemberg (1982) assumes that adjustment costs are quadratic in the size of adjustment. Convex costs imply that numerous small changes are cheaper than fewer large changes. If the desired price departs from the actual price, the firm catches up by making several small adjustments. Hence the optimal policy involves frequent and small price changes. Tsiddon (1993) studies linear costs. More generally, Cecchetti (1986) studied magazine prices and argued that their behaviour suggests price changing costs depend on the size and/or frequency of price changes. Konieczny (1993) considers this suggestion in a formal model, assuming adjustment costs are functions of the size of price changes and, separately, the frequency of adjustment. The optimal pricing policy is similar to that in the basic model, but the effects of inflation on price bounds and adjustment frequency are ambiguous. The author derives restrictions on the adjustment cost functions under which standard results (higher price dispersion and frequency as the inflation rate rises) hold. The restrictions are quite complicated (the cost function must meet second order differential inequalities); simple examples which generate opposite results are provided.

He therefore concludes that the direction of the effects cannot be determined theoretically and is an empirical matter. It turns out that this theoretical ambiguity is not a problem in empirical studies: as discussed in the empirical survey, empirical results are clear-cut: higher inflation always leads to a higher frequency of adjustment, while the size of price changes generally increases, with a few exceptions (for example in Kashyap, 1986, and in Lach and Tsiddon, 1992, the size of price changes sometimes falls as inflation increases, but these effects are not statistically significant).[11]

1.2.4. Pricing Points.

Kashyap (1995) proposes a novel theory of price rigidities. According to this theory, firms prefer to set prices equal to certain values even if the optimal price may be a bit different. These prices are called pricing points and, in many countries, they end up in a nine, i.e. the last significant digit is nine. So, for example, the firm will choose to charge 6.49 when the optimal price is 6.51 or 6.47 (or 649.00 when the optimal price is 651.00 or 647.00). The tendency of firms to charge such prices is familiar and has been analyzed extensively by Aucremanne and Cornille (2001), Levy *et al.* (2007), as well as by several studies in the IPN network (Alvarez and Hernando, 2005, Aucremanne and Dhyne, 2004, 2005, Baumgartner *et al.*, 2005, Dias *et al.*, 2005, Lunnemann and Matha, 2005 and Veronese *et al.*, 2005). The general conclusion of this empirical work is that firms often charge prices equal to pricing points, and prices equal to pricing points have longer duration than other prices.

A typical explanation of the pricing point phenomenon is related to information processing costs. Customers typically make numerous transactions during each day. Paying attention to exact price values in each transaction imposes large burden on their information processing ability. To save on processing costs, customers may choose not pay attention to the last digit of the price. Since this means that demand is the same whether the price is, say, 6.41 or 6.49 (or any value in between), it is optimal for the firm to set the last digit equal to nine.[12] This argument assumes firms are fully rational while consumers are not. Basu (1997) introduces consumer rationality. He assumes that, by observing prices in the past, consumers know the probability distribution of the last digit. They then observe the price and assume that the last digit is equal to its expected value. Knowing this, firms set the last digit equal to nine; consumers, in turn, know that the probability distribution of the last digit is degenerate and rationally expect the last digit to

[11] Diamond (1993) considers a model in which the cost of setting price is zero when a product is priced for the first time but the cost of repricing the good is prohibitive. More recently menu costs that vary over time have been analyzed by Dotsey, King and Wolman (1999), Klenow and Kryvtsov (2008), Caballero and Engel (2006), Nakamura and Steinsson (2007) and Konieczny and Rumler (2006); the first four papers assume the costs are random in order to develop general equilibrium models; the last paper considers deterministic variations to explain the existence of attractive prices.

[12] More generally, they do not pay attention to the last few digits, which explains popularity of prices like 2.99 or 9.99.

be nine. Their expectations are correct in equilibrium. This practice hurts firms as they are facing a stepwise demand function: demand is flat for the last digit between 0 and nine and increases discretely when the second last digit is reduced. This stepwise demand is to the left of the actual demand function (that would have obtained if customers observed all price digits).
Another explanation of the pricing point phenomenon is psychological: customers perceive a price like 6.49 to be equal to 6.40. They then feel they are getting a bargain. These explanations are popular in marketing literature, but they assume customers are irrational in the sense discussed above: there is no reason they should expect the last digit to be zero. Marketers also believe that, by reducing price below a round number, firms demonstrate to customers that they make every effort to cut prices. Using this argument, Wal-Mart, whose customers are very price sensitive, frequently sets the last digit equal to 8, to convey the notion that they try even harder.

These explanations can motivate only prices ending in a nine (or in an eight, as in Wal-Mart). Such prices are often called attractive prices. But it is quite common in some countries to set round prices. A good that might costs 9.99 in Germany would often cost 10.00 in Italy. A possible explanation that encompasses both attractive and round prices is based on multitasking (Holmstrom and Milgrom, 1991). Consider a manager who is responsible for several tasks, including pricing. In general, pricing decisions are easier to observe by the principal than other decisions (for example workflow organization). The principal will then assess the manager's performance excessively on the basis of the easily observable pricing policy. Knowing that he/she will be assessed mostly on how he/she sets prices, the manager may end up spending an inordinate amount of time deciding what prices to charge. Other activities that are more difficult to monitor by the principal would be neglected, resulting in poor overall performance. To remove this bias to concentrate excessively on pricing decisions, the principal restricts manager's choice set to prices ending in a nine, or to round prices. This facilitates the pricing decision and offsets the excessive bias of the manager to concentrate on pricing. This explanation has two advantages. The first is that it does not involve any departures from rationality. The second, and more important, is that unlike the other explanations it can explain not only the custom of setting attractive prices, but also the custom of setting round prices. Round prices would be predominant on countries where such prices are preferred to attractive ones.

Data collected by the IPN and other researchers show large element of time dependence in price changing, often called seasonality. A large number of firms change prices once a year, or once every two years, etc. This is evidenced by the observed unconditional hazard functions that are, in general, decreasing but show large peaks at 12, 24 and 36 months (see, for example, Álvarez *et al.*, 2008). There are other time-contingent elements observed in price setting; for example price changes are more frequent than average in January and in the early fall and less frequent in December and in the summer. Seasonality is a factor in price adjustment in every IPN study of consumer and producer prices (see Sabbatini *et al.*, 2007). A large portion of the seasonal behaviour of price changes can be

attributed to exogenous, calendar related causes; for example sales of clothing happen at the beginning of the year and the beginning of the summer; prices of fresh fruits and vegetables fall in the spring/summer and increase in the fall etc. Multitasking provides another explanation. Organizing the price changing process (which, as Zbaracki *et al.*, 2004, showed, can be quite involved) on a regular basis improves the work flow of a multitasking manager and allows personnel to better plan their activities.[13] As firms operate, in general, on calendar schedules (due to tax reporting requirements, seasonal goods, demand or cost variations etc.), a multitasking manager would schedule price changing work on a calendar – related basis. The simplest example of such calendar-related basis is once a year (or multiple of years), with the particular date being of secondary importance. This explains the large peaks in the unconditional hazard function at 12, 24 and 36 months that are commonly observed.

1.2.5. Fair Pricing.

Rotemberg (2005, 2006) developed a theory of consumer anger at price changes. The underlying idea is that consumers analyze price behaviour of firms from the point of view of fairness. They are willing to penalize a firm perceived as unfair (for example one that raises prices of flashlights during a power outage) by not patronizing it in the future even if it offers the best prices. Knowing this, firms sometimes do not change prices even though their optimal desired prices change. If the nominal price is held fixed, under general conditions consumers can be expected not to update their beliefs. For example, in an inflationary environment, when the nominal price is not changed they are getting a better deal than before, suggesting it is unlikely price became less fair.[14] An increase in the nominal price induces consumers to reflect on the fairness of prices they are being offered. Firms know this and, to avoid potential anger, they may refrain from changing prices. This framework makes price changes responsive to macroeconomic conditions. For example, following a period of rapid inflation, consumers are likely to tolerate (or accept) when the firm increases its own nominal price. In general, firms will raise prices when they perceive reduced customer reluctance to higher prices. An additional consideration is the size of price changes. Consumers are likely to react more to large price changes than to small ones. They consider as fair price increases that are in proportion to increases in costs. Given their limited knowledge of firms' costs, they are more likely to treat an unusually large price increase as unfair. The main difference between Rotemberg's approach and other explanations of price rigidity is that it implies price changes depend on macroeconomic conditions. Changes in macroeconomic conditions provide customers with information about the behaviour of costs and allow them to better assess the fairness of price changes. Knowing this, firms are more likely to increase prices when aggregate

[13] This can also explain why price changes are more frequent in large stores, which may employ managers solely responsible for pricing.

[14] Price may have become less fair if, at the same time, costs fell a lot. But customer knowledge of costs is usually limited.

changes indicate optimal profit maximizing prices have risen. These considerations were important during the conversion to the Euro, as well as whenever sales taxes are changed, as consumers would check whether firms use it as an opportunity to make an unjustified price increase.
In a companion paper, Rotemberg (2006) considers pricing of goods sold to repeat customers. The customers have preference for fairness: they perceive prices as fair if they indicate the firm shows some altruism towards them. When the price increases, consumers are assumed to experience a loss greater than the additional cost. This additional cost is brought about by regret: they could have bought the good before or they could have bought greater stocks. Under those assumptions firms are more likely to raise prices when their costs increase than when their demand rises – a fact observed in numerous IPN surveys. Furthermore, when intermediate product costs increase, a firm's incentive to raise prices depends on whether it has the inventory of the intermediate product. If it does, an increase in costs means a higher profit (as inventories were purchased at the old, lower price) and so the increase in price is considered unfair by customers. On the other hand if the firm holds no inventories an increase in price is considered to be fair. Hence firms with inventories of the intermediate product raise prices less.

The model is capable of explaining the occurrence of sales that are followed by the return of the price to the previous level. Such sales are frequently observed and led Rotemberg (2005, 2006) and Nakamura and Steinsson (2008), among others, to distinguish between regular prices and sale prices. The standard explanation of sales is that they are due to demand or cost shifts. But it is not clear why the after-sale price is equal to the before-sale price. In Rotemberg's (2006) model firm gains reputation for fairness by passing cost reductions to customers through a sale. This goodwill may be lost if the new price following the sale is higher than the original price and the sale is perceived as a sneaky way of increasing the regular price.

1.2.6. Costly Information.

The final theory to be considered is the costly information theory of Mankiw and Reis (2002, 2006) and Reis (2006a, 2006b). They assume that getting informed about the current economic conditions is costly. There is a large number of firms in the economy. Each period, a fixed proportion of the firms can update its information relevant to their pricing policies. The remaining firms make pricing decisions based on outdated information. This structure is similar to the model of Calvo (1983) where, each period, a fixed fraction of firms can change their prices. Unlike in the Calvo model, however, all firms change prices all the time. But pricing decisions depend on past history. This is because some sellers, who have not been able to update their information, are setting prices based on old decisions and old information. Mankiw and Reis (2002) argue that such model fits better macroeconomic facts. In particular, disinflations are always recessionary but, since agents have rational expectations (and only suffer from not up-to-date information) credibility matters in the sense that the more in advance is a disinflation

announced, the smaller is its recessionary effect. Furthermore, when disinflation is undertaken, the model implies a slow decline in inflation, which is consistent with evidence. In Mankiw and Reis (2006), they ask what kind of stickiness is needed for a macro model to generate facts consistent with three empirical observations: (a) increasing inflation when the economy is expanding (and decreasing inflation when the economy is shrinking), (b) smaller variability of real wages than of productivity and (c) gradual response of real variables to shocks. They show that models based on inattentiveness for one type of agents (consumers, producers or labour suppliers) do not generate the required dynamic patterns of behaviour. On the other hand when firms, consumers and workers all update their information infrequently, the model generates behaviour consistent with empirical observations.

1.3. From Micro to Macro.

The importance of infrequent price adjustment in macroeconomics is that it provides a potential explanation for large and persistent real effects of aggregate shocks to nominal demand and spending, something that is difficult to do with Real Business Cycles (RBC) models. The realization that it is difficult to explain real effects of nominal shocks within the RBC framework led to interest in alternative explanations based on nominal rigidities. When prices are perfectly flexible, nominal shocks affect only prices and have no effect on quantities. On the other hand if there are obstacles to price adjustment then nominal changes are going to have at least temporary effects on real variables. In actual economies, of course, nominal shocks do have real effects and so models with nominal rigidities provide a possible explanation of this phenomenon. Since 1970s it was well known how to construct macroeconomic models in which nominal shocks affected real variables. A more difficult problem was to develop a macroeconomic framework in which nominal shocks lead to persistent movement of output of the kind observed in actual economies. As the survey shows, the current task of building such models tries to resolve two issues: how to obtain large aggregate nominal rigidity from a model with relatively small individual frictions, and how to build a model in which the observed dynamic behaviour of the aggregate price level is consistent with stylized facts.

Regardless of theoretical issues or the type of model used, one common theme is that the more frequent are prices changing at the micro level, the more flexible is the aggregate price level. Also, when the frequency of price changes varies across firms or sectors, the slow-adjusting firms or sectors have a disproportionate influence on the aggregate price flexibility. These findings are relevant for the effects of real shocks. Asymmetric shocks that affect some countries more than others require fast adjustment of nominal variables which offset the initial shock. This competition channel is especially important in the Euro area which cannot rely on the adjustment of the nominal exchange rate. Less frequent price changes at the level of individual firms lead to more persistent inflation and slower adjustment of the aggregate price level. This undermines the operation of the competitiveness channel.

1.3.1. Exogenous Frequency of Price Changes: Taylor and Calvo - type Models.

Modern analyses of macroeconomic models with price rigidities start with models based on Taylor (1980). In that model nominal prices are fixed by assumption for a certain number of periods. Duration of nominal prices is the same for all firms. Price changes are perfectly staggered over time, in the sense that each period the same number of firms changes prices. Whenever the price is changed, its new value is set optimally. Since the firm knows it will not be able to adjust the price for an extended period of time, the new price is based on forward-looking behaviour: it takes into account the expected future evolution of macroeconomic variables. But past price decisions of other firms affect the newly set price as well. This is because, at the time of adjustment, there are old prices in the economy set on the basis of old information. These prices comprise the price level and the new price is set taking the current price level into account.

In other words each price is set relative to prices existing in the economy. This means that shocks are passed on through consecutive price setting. As price changes are staggered, the nominal shocks affect prices set for an extended period of time. Given that prices do not adjust completely, this leads to persistent effects on output (and inflation) of nominal shocks.

The advantage of the Taylor assumption over the traditional Keynesian assumption of fixed prices is that there is no long-run trade-off between money and output in the sense that unemployment equals the natural rate regardless of steady state rate of inflation. An obvious criticism of the Taylor-based models is that the assumption of all prices being fixed for extended periods of time is arbitrary, and so is the assumption of perfect staggering of price changes. Furthermore, as is well known and has been discussed extensively in the empirical survey, the frequency of price changes differs greatly across products and product categories, and so does duration of prices. In the Taylor-type model, with prices fixed for N periods, the hazard rate is zero for all duration but N, for which the hazard rate is one. This is at odds with empirical evidence.

Chari, Kehoe and McGrattan (2000) raised a more fundamental objection to the Taylor-type model. They ask how much aggregate nominal rigidity is generated by staggered price setting from a given amount of exogenous nominal rigidity at the individual level. As they argue, the preferable approach to explaining output and inflation persistence is to start with small nominal frictions and build a model in which these small frictions lead to large aggregate rigidity. They measure the effect of staggered price setting on output persistence by contract multiplier. The contract multiplier is defined as the ratio of half-life of output deviations after a monetary shock with staggered price setting to the half-life of output deviations with synchronized price setting. In the data, the half-life is 10 quarters. Under synchronized price setting, the half-life is about half of the period between price changes. Given that prices change on the average once every 6 months (Bils and

Klenow, 2004), the required contract multiplier to match the data is 10.[15] They consider a model in which monopolistically competitive firms produce differentiated goods using capital and labour. Household have preferences over consumption, leisure and money. Price changes are uniformly staggered. In the benchmark specification,[16] the contract multiplier is one, i.e. it is an order of magnitude too small. It means that to generate the observed persistence of output, the underlying frequency of price changes would have to be once every 20 quarters.

The authors then explore various ways of increasing the persistence of output for given frequency of price changes. Essentially what is required is that the optimal response of prices to nominal shocks is small. To achieve this they modify assumptions to make costs less sensitive to output changes, and prices to be less sensitive to changes in costs. The first is accomplished by assuming consumption and leisure are near perfect substitutes. Then an increase in output, which requires an increase in work effort, has little effect on wages and so on costs. To make prices less sensitive to changes in costs they assume Kimball (1995) type preferences, where demand elasticity for intermediate goods increases as their relative prices rise. With these preferences prices increases less than in proportion to an increase in costs. This is because an increase in costs raises the firm's price but, since demand elasticity increases, the desired mark-up falls. While these changes raise the contract multiplier, intertemporal links through capital accumulation and money holdings lower it. Overall, when they consider the model with all elements and sensible parameter values, the contract multiplier is 2, i.e. it is much too small. They conclude that the model cannot exhibit sufficient persistence to generate observed responses to nominal shocks.

A very popular alternative of the Taylor (1980) based models is an approach based on Calvo (1983). In the Calvo model, the probability of a price change is constant. Each period, a fixed proportion of firms are able to change prices; the remaining firms keep their nominal prices fixed. Firms that are able to change their prices set them optimally, knowing that the new price will be fixed for an extended but, unlike in the Taylor (1980) model, uncertain length of time. The probability of being able to change price is the same for all firms, regardless of when they changed price last. This means that the hazard rate is constant. While the expected duration of all prices is constant, the actual duration varies across firms. The likelihood of finding a price fixed N periods ago is decreasing exponentially with N, but is positive for each value of N. Hence at any moment of time there is a variety of prices in the economy of different vintages, with the older prices being less common.

[15] Chari, Kehoe and McGrattan (2000) take the average duration of prices to be one quarter and so require the multiplier to be 20. Subsequent data on the frequency of price changes show that price duration is twice higher than they assume.

[16] Unit elasticity of substitution between consumption and leisure, constant elasticity demand for intermediate goods and constant returns to scale technology.

Christiano, Eichenbaum and Evans (2005) show that, under some assumptions, a model with Calvo-type pricing and wage contracts can generate inflation inertia and output persistence in response to monetary shocks even though nominal rigidities are not large. They consider a standard model in which there is a final good produced by competitive firms. The final good production uses a variety of intermediate goods, which are produced by monopoly firms. This two stage production process, proposed by Blanchard (1991) is able to generate significant persistence. They assume that investment involves adjustment costs and capital utilization varies over the business cycle. Variable capacity utilization is crucial to generate persistent output response. It reduces the large increase in the rental rate of capital that would otherwise occur following a monetary shock and increased output. Together with sticky wages, it assures that marginal costs are affected little by changes in output and so the price response is muted.

It turns out, however, that aggregate nominal rigidity is generated by sticky wages, and not sticky prices. Results are little affected when the authors assume prices are flexible while wages are sticky. On the other hand with only nominal price rigidities the model cannot generate persistent movement of output unless they assume prices are fixed for extremely long periods.

Carvalho (2006) makes a big step towards showing that macro models with realistic micro rigidities can generate large nominal rigidities at the macro level. He points out that, in actual economies, there is substantial heterogeneity in the frequency of price adjustment. This has been stressed long ago by Okun (1980). Indeed, as discussed extensively in the empirical study, prices change quite infrequently for some goods while for others they change all the time. The paper considers interactions between the fast adjusting sectors (for example fuels or perishable food) and slow adjusting sectors (for example services or capital goods). In the presence of pricing complementarities the slow adjusting sectors have a disproportionally large effect on overall price adjustment, slowing the price response, and increasing the output response to shocks. The intuition is as follows. When a heterogeneous economy is hit by a shock, the initial adjustment takes place by firms mostly in the fast adjusting sectors. As time passes, a larger proportion of firms that still have to adjust are firms in the slow-adjusting sectors. As a result, the speed of adjustment slows down over time. Carvalho (2006) calls it the *frequency composition effect.*[17] In other words, the adjustment process is dominated initially by high frequency adjusters and later by low frequency adjusters.

If there were no strategic complementarities in price setting, firms in the fast adjusting sectors would adjust their prices fully and rapidly and the economy would exhibit a rapid adjustment of price level and little output effect. But in the presence of strategic complementarities, fast adjusting firms have to take into account the existence of the slow adjusting sector where prices change slowly. An example is useful. Pricing decisions for

[17] The composition effect leads to the declining unconditional hazard functions, discussed in the theoretical survey.

fresh orange juice would have to take into account the fact that prices of frozen juice are not changing.[18] Sellers of fresh juice cannot adjust price fully, as it would lead to a large relative price change vis-à-vis the slow adjusting price of frozen juice. Given strategic complementarities this is not desired and so adjustment is only partial. The presence of slow adjusters and strategic complementarities slows down price adjustment in the fast adjusting sectors.

Firms in the slow adjusting sectors, when they eventually get to change their prices, must similarly take into account prices in the fast adjusting sectors. But they are relatively less influenced by pricing decision of fast adjusting firms. Consider a firm selling frozen juice. Given strategic complementarities, it takes into account the price of fresh juice when it changes its price. But it knows that, during the period the price of frozen juice will stay constant, the price of fresh juice will change many times. Therefore the current price of fresh juice is not as important and has a small influence on the frozen juice pricing decision.

The net result is that the slower-adjusting sectors have a disproportionate effect on nominal adjustment and slow down price response to nominal shocks more than their weight in the economy would have suggested. This means that price adjustment in a heterogeneous economy is slower, and price and output behaviour more persistent than in a homogeneous economy with the same average frequency of adjustment.

To see how big the effect is, Carvalho (2006) compares heterogonous and homogeneous economies with the same average frequency of price changes and with the same average duration of price spells. The differences in the dynamic response are significant. To obtain a rough comparison, he looks for a single frequency in an identical firms' model that would generate similar response to that in a heterogeneous economy. This, in general, depends on the whole distribution of frequencies of price changes so he uses data from Bils and Klenow (2004) to calibrate the model. It turns out that the effect is large: the extent of nominal rigidity differs by a factor of three. Hence he concludes that the link between the micro and macro rigidities in identical firms' models significantly understate the implied macro rigidity.

1.3.2. Endogenous Frequency of Price Changes – Models with State-Dependent Pricing.

The big advantage of the Calvo (1983) approach is that this type of price rigidity can be relatively easily incorporated into a standard macroeconomic model. The effect of nominal rigidities on the time-path of endogenous variables can then be studied either analytically or numerically. These models therefore provide a rich environment which allows assessing the effect of nominal rigidity on variables of interest, for example on

[18] Levy and Young (2006) show that prices of fresh orange juice change more often than of frozen juice.

inflation persistence. The big disadvantage is that Calvo pricing, apart from being artificially imposed, is suboptimal. Models based on Calvo pricing use this approach for simplicity, and as an approximation of reality. Some authors argue this approximation is appropriate. Analyzing US data, Klenow and Kryvtsov (2008) show that most of adjustment to inflation takes place through a changing mix of price increases and decreases and the frequency of price changes is relatively constant. When the inflation rate rises, firms cut prices less often and increase them more often. Similar results have been reported by Gagnon (2006) on the basis of price data from Mexico. This suggests that the assumption of constant frequency of price changes may not be so bad and that time-contingent models may be a good approximation of reality. Such behaviour is, however, not common. There is overwhelming evidence from consumer and producer prices as well as from surveys that pricing policies contain significant state contingent elements. More importantly, the use of Calvo-type models generates misleading amounts of aggregate price rigidity. As discussed below, for a given average frequency of price changes, the price level is more flexible when pricing policies are state-, rather than time-contingent. The intuition is as follows. Under time continent policy of Calvo, firms that adjust prices are selected randomly. Some of those firms have changed prices recently and do not need to do it again. Hence they will change their prices only a little. On the other hand, in a state contingent model, firms that choose to change prices are those for whom the current price has departed the most from the optimal value and so all adjustment will be relatively large. This selection effect makes the aggregate price level adjust more rapidly to nominal changes when firms follow state-contingent, rather than time-contingent pricing.

The extreme case of the difference between time and state-contingent policies has been demonstrated by Caplin and Spulber (1987). They consider an economy in which all firms are identical, with the exception of the timing of their price changes, and in which the inflationary process is determined as in Sheshinski and Weiss (1983). Firms face costs of price adjustment and so they optimally choose the price bounds, s and S. Price changes are uniformly staggered over time and so real prices have log-uniform distribution. This means that the rate of inflation, which is obtained by aggregating individual prices, is consistent with expectations underlying the optimal policies being aggregated. At each moment of time firms with the lowest real price raise their price to the upper bound, while the real price of all remaining firms is eroded a little and so the log-uniform distribution of firms' prices is not affected. Even though individual prices change in a discrete fashion, the aggregate price level is smooth. Furthermore, an increase in inflation rate (such that the expected inflation does not change and so the price bounds s and S remain unaffected) would just raise the proportion of firms changing prices each period and maintain the log-uniform distribution of real prices. This means that inflation has no real effects. Nominal shocks are completely absorbed by changes in the price level.

This example is drastic and is based on the fact that the optimal pricing policy involves two price bounds and the price level moves in one direction only. Caplin and Leahy (1991) develop a dynamic model with state-contingent pricing in which monetary policy has systematic real effects. The difference is that the money stock follows a

symmetric Brownian motion with no drift. This means that the optimal pricing policies involve two extreme bounds, [-*S, S*] and a return point, which is in the middle of the interval [-*S, S*]. In this model, changes in the money supply have real effects, which depend on the current situation. Monetary expansion raises output more when current output is low, and monetary contraction lowers output more when current output is high. Overall, the model links state-dependent micro policies to state-dependent macro effects.

While these considerations suggest that the appropriate approach to incorporating nominal rigidities in a macro model is to aggregate state-contingent policies, this is a difficult task and, until recently, there have been few macro models based on state-contingent pricing at the level of individual firm. In recent years, however, such models were developed by several authors, allowing the analysis of the effect nominal rigidities at the level of individual price setter have on the general price level as well as on the effect of nominal shocks on inflation and real variables.

Danziger (1999) develops an optimizing model of a dynamic economy in which firms face costs of price adjustment and there are idiosyncratic and aggregate productivity shocks as well as nominal shocks. The theoretical model is not aimed at replicating stylized facts, but rather at demonstrating that consistent aggregation of state-contingent policies can be done, and some interesting questions can be answered in this framework. He shows that there exist a staggered equilibrium in which prices are determined by an (*s*, *S*) strategy for mark-ups. The price is kept unchanged as long as the current mark-up is within the (*s*, *S*) interval and the firm adjusts the price once it falls outside of the interval. The probability of adjustment depends on idiosyncratic shocks and is independent of aggregate shocks as well as the time elapsed since the previous adjustment. Higher adjustment costs and lower trend rate of growth in the money supply lead to less frequent price changes. The author derives the effect of changes in productivity on welfare of households and firm owners.

Dotsey, King and Wolman (1999) develop a model in which firms are monopolistically competitive and face price adjustment costs that, unlike in earlier studies (for example Danziger, 1999) are not the same for all forms. The costs are drawn by firms from a continuous distribution and so are random across firms. In equilibrium, therefore, not all firms choose to adjust; the decision whether to adjust depends on the comparison of the firm's value if it adjusts, its value if it keeps the price constant, and the current value of the adjustment cost. As future draws of adjustment costs are history-independent, each firm that adjusts price sets the same new price. At any moment of time, therefore, firms in the economy differ with respect to the time when they last changed price (vintage). To make the number of vintages finite the authors assume that the adjustment costs are bounded from above. With general inflation the loss from not adjusting increases without bounds and so each firm will eventually change price, limiting the number of vintages. This makes the model manageable. In general equilibrium consumers and firms optimize, expectations are rational and all markets clear. The authors calibrate the model and analyze its response to various exogenous changes. An increase in the inflation rate raises the proportion of firms changing prices in a given period, reduces the expected time to

next adjustment and reduces the number of vintages, thus limiting the maximum length of time any firm will keep its price constant. Inflation also raises desired mark-ups, relative price variability and the expense on price changing. These results are not surprising. The main contribution of the model is to consider dynamic responses to changes in money and compare them to time-contingent framework. When the rate of growth of the money supply rises unexpectedly, the price response is greater, and the output response smaller, in the state-contingent economy than in the time-contingent economy. The difference comes from the fact that in the state-contingent economy an increase in the rate of growth of the money supply raises the proportion of firms that change prices, while in a time-contingent economy the proportion is fixed. The effect is weaker than it would have been if all firms faced the same adjustment costs. This is because a shock causes adjustment for firms whose price is far from desired *relative to* the adjustment cost. If a firm happens to have a very low adjustment cost, it will change its price a little. When adjustment costs are the same for all firms, all price changes are large.

Golosov and Lucas (2007) point out that adjustment to catch up to aggregate inflation cannot explain individual price behaviour. Klenow and Kryvtsov (2008) report that each month 22% of firms change prices, the average inflation rate is 2.5%, yet the average size of price change is almost 10%. To fit these stylized facts Golosov and Lucas consider a model with idiosyncratic productivity shocks and menu costs. Firms change prices when the current nominal price they charge falls outside of the range of inaction. Following a nominal shock, this is the case for firms whose prices are the furthest from desired prices. This means that price changes are large, and so is the price level response to the nominal shock. Such behaviour is contrasted in that in a Calvo-type economy, in which firms change prices at exogenously determined moments of time. Current prices of these firms are not necessarily far from the desired prices and so many price changes are small. As a consequence, there is little aggregate nominal rigidity

Gertler and Leahy (2006) develop a state-dependent pricing model that is as tractable as a typical time-dependent model. By introducing several restrictions they are able to derive an approximate analytical solution unlike in other models that allow only numerical solutions. In their model firms are subject to idiosyncratic shocks, as in Golosov and Lucas (2007). By restricting the firms' objective function and the distribution of shocks they derive a Phillips curve that is built on the basis of state-contingent pricing policies of individual firms and is comparable in its simplicity to the standard New Keynesian Phillips curve based on time-contingent pricing. As it turns out, the state-contingent economy exhibits more flexible price level than the corresponding time-contingent economy. This is again caused by the selection effect: when individual policies are state contingent, firms that adjust are those that are subject to the largest idiosyncratic shocks, and so they change their prices a lot. On the other hand, in a time contingent economy firms are randomly selected to adjust. Idiosyncratic shocks of firms that adjust are not necessarily large and so price adjustments are smaller, and the price level less flexible, than in the state contingent case. But this contrasts holds only in the absence of real rigidities. When real rigidities are present the model generates significant nominal rigidity

also when individual pricing policies are state contingent. Real rigidities are generated by sector-specific labour markets that are subject to idiosyncratic shocks. These shocks are staggered over time, which leads to staggering of price changing over time. This produces strategic complementarity in pricing decisions that strengthens aggregate nominal rigidity.

In Carvalho (2006) price changes are determined according to the Calvo framework and several time-dependent sticky information models. Nakamura and Steinsson (2007) consider the effect of heterogeneity when pricing policies are state-contingent. They develop a multi-sector menu cost model and calibrate it to the empirical data in Nakamura and Steinsson (2008). The degree of monetary non-neutrality in the multi-sector model is three times greater than in a single-sector model with the same average frequency of price changes. This is because monetary non-neutrality is a convex function of the inverse of the frequency of price changes and so, by Jensen's inequality, the average value of monetary non-neutrality is greater than the average frequency of price changes would generate in a single-sector model.

Nakamura and Steinsson (2007) also show that the introduction of intermediate goods provides a source of strategic complementarity in pricing and further increases nominal rigidities. The intuition is straightforward. Following a nominal shock, a firm that wants to adjust its price is still paying largely unchanged prices for intermediate goods and so its price change is smaller than it would have been in the absence of intermediate goods. Over time, as more firms change prices and output the prices of intermediate goods adjust and the economy reaches new equilibrium. The initial slow price response is speeded up, but the process of adjustment is dragged out over time.

Intermediate goods as a source of strategic complementarity allow avoiding the problem pointed out by Klenow and Willis (2006) for demand-side sources of complementarity. These are based on Kimball's (1995) demand functions with varying elasticity. In that approach there are many varieties of goods and price elasticity is decreasing in the relative quantity consumed of a given variety. This means that firms that raise their relative prices (and so reduce sales) face higher demand elasticity and so their desired mark-up falls. Under a nominal shock a firm that raises its price due to, for example, higher costs, moderates the price increase as its desired mark-up declines. Therefore price response (as long as price changes are staggered) is muted, resulting in aggregate nominal rigidity. Klenow and Willis (2006) show, however, that to generate the observed changes in relative prices requires, under Kimball's preferences, excessive idiosyncratic shocks. They conclude that demand-side sources of complementarity cannot be squared with the observed size of individual price changes.

1.3.3. Models Based on Costly Information.

Maćkowiak and Wiederholt (2007) take a different approach to explaining micro and macro behaviour of prices, based on costly information. There are no costs of price

adjustment so prices change all the time. The optimal price depends on the aggregate price level, real aggregate demand and firm-specific idiosyncratic conditions. The crucial element of the approach is a trade-off that firms face in paying attention to aggregate and to idiosyncratic conditions. Unlike in Mankiw and Reis (2002), the decision to acquire information is endogenous. The choice of information to acquire is optimally determined by the benefits. So if the idiosyncratic conditions are more important or more variable than aggregate conditions firms pay more attention to them and pay only limited attention to aggregate conditions (and vice versa). This means that the economy responds sluggishly, and weakly, to changes in aggregate conditions but quickly and strongly to changes in idiosyncratic conditions. Furthermore, the neglect of aggregate conditions creates a feedback effect. For a given aggregate change, if prices are strategic complements, firms respond less than they would have under complete information. This further reduces the variability of aggregate conditions and leads firms to pay even less attention to them.

The model explains why, even though individual prices appear quite flexible, the aggregate price level is quite sluggish. The authors calibrate the model to Bils and Klenow (2004) and to Klenow and Kryvtsov (2008) US data, where price changes are frequent (half of consumer prices change more often than once every 5 months) and large (when prices change, the average absolute size of adjustment is 13%). To match these numbers the variability of idiosyncratic shocks must be much larger than the variability of aggregate shocks, implying that firms pay little attention to aggregate variables. As a consequence, while individual prices change often and a lot, they respond sluggishly, and little, to aggregate changes and nominal shocks have long-lasting real effects.[19]

Maćkowiak and Wiederholt (2007) point out that the undesirable feature of their model is the fact that prices are changed continuously and suggest that the solution would be adding costs of adjusting prices. The friction in the model is the fact that many price setters base their decisions on outdated information. But given the information they have, they formulate optimal pricing plans for the future. In the absence of other frictions, these plans involve some form of indexation to the general, or sectoral, price level. So while the model is consistent with macro evidence, it is not consistent with micro evidence. To remedy this problem, Klenow and Willis (2006) and Knotek (2006) combine costly information updating with costly price adjustment. The consequence of using both assumptions is that prices are not changed all the time (since this is costly) and when they do get changed, the new prices reflect old macro inflation innovations that were known at the time of the previous price change. This is because price changes do not coincide with getting informed about the state of the economy. Knotek (2006) infers the micro features of the economy by adjusting parameters so that they match general macroeconomic behaviour. The results are that firms update information once every 7 quarters on the

[19] This is in contrast to Mankiw and Reis (2002) where an exogenous proportion of firms receive perfect information every period. Under this assumption, all disturbances elicit the same price reaction and so their model cannot explain fast individual adjustment and slow propagation of nominal shocks.

average, the median frequency of price change is 2 quarters (and the average frequency is four quarters) and about 10% of prices remain unchanged for over 2 years. These results are consistent with empirical evidence in Bils and Klenow (2004) and in Klenow and Kryvtsov (2008) and so he concludes that the model is consistent with both macro and micro facts.

Gorodnichenko (2007) also considers an economy in which both price changing and information are costly. The innovation is that information can be inferred from what other firms do. Firms face menu costs, which prevent continuous price adjustment. They also face a cost of obtaining information about macroeconomic conditions. They can get informed by either paying the cost or by observing the actions of other firms. When other firms change prices, their actions are reflected by the behaviour of the aggregate price level that can be observed costlessly. This creates an information externality. A firm pays the full cost of price adjustment, but its actions provide other firms with the benefit of better information about current conditions. Of course the better informed is a firm. the better price it is going to set (in the sense that price set will be closer to the full information price) and so the higher are its profits. This gives firms an incentive to postpone price adjustment. Following a shock, firms delay price adjustment in the expectation that learning from other firms' actions would lead to a superior pricing choice. Consequently few firms change prices and information is revealed slowly. The response of inflation to nominal shocks is slow and hump-shaped, and inflation is persistent. These results follow in the absence of pricing complementarities, and inflation is persistent without resorting to rule-of-thumb pricing or indexation.

1.4. Conclusions and Implications.

This survey reviews the theoretical models of infrequent nominal price adjustment at the level of individual firms, and presents selected macroeconomic models incorporating these nominal rigidities in a general equilibrium framework. The second task is an ongoing research project, due mainly to technical difficulties in the building of dynamic general equilibrium models with nominal rigidities. Significant progress has been made recently both in terms of relatively simple analytical models, but mainly through the use of numerical techniques. At this point, a model that can account for both the micro facts on price changes, as well as for the observed price stickiness at the aggregate level has yet to be developed. The main problems are generating sufficient aggregate nominal rigidity from small nominal frictions, as well as generating the observed dynamic patterns of changes in inflation and output following a nominal shock. Many elements of such a model have been developed in recent years and this theoretical area is progressing fast.

What are the implications of the analysis for the purpose of the current project? The link between micro and macro is still being worked out. What is clear, however, is that the crucial role in adjustment to nominal shocks is played by the average frequency of price changes, and the heterogeneity in the frequencies. The more frequently prices change on

average, the more flexible, in every macro model, is the general price level and the less persistent is the reaction of output and inflation to macroeconomic shocks. On the other hand, there are indications (Carvalho, 2006, Nakamura and Steinsson, 2008) that the slow-adjusting sectors have a disproportionate effect on aggregate price sluggishness. So a policymaker concerned about a common currency, which eliminates a channel of adjustment to asymmetric nominal shocks, could focus on policies that would speed up the frequency of price changes. Such policies can be used in several areas. Below we briefly discuss competition, price and product regulation, service standardization and the promotion of technologies reducing costs of price adjustment.

The main factor affecting the frequency of price changes is competition. Alvarez and Hernando (2007) review the evidence on the effect of competition on price adjustment. They show that competition, as perceived by firms, has a positive effect on the frequency of price changes. This may explain the difference between the US and Euro-area frequencies of price changes. The US market, in general, is more competitive given its size and shopping patterns (less long-term relationships between sellers and buyers). The promotion of competition would therefore be the main policy-oriented conclusion. It should be noted here that the introduction of the Euro, by making price differences more transparent, does have a positive effect on competition and so can be expected to increase price flexibility at the micro level. Indeed, Glatzer and Rumler (2007) report that the frequency of price changes in Austria significantly increased following the introduction of the Euro. From January 1996 to December 2001 it was 13.8%, and from January 2002 to June 2006 it was 18.2%, an increase of over 30%. Moreover, the frequency increases across the board, for every product category.[20] It is difficult to say whether this is specifics to Austria; data from other countries are not available for the most recent period. The increase in the frequency of price changes is roughly equal to half of the difference between the average frequency of price changes in the Euro-area and in the US[21] - see Table 2.2 of the empirical survey.

There is a lot of evidence that prices of regulated goods change less often than other prices. For example Glatzer and Rumler (2007) report that, in Austria, the frequency of price changes of regulated services was three times lower than of unregulated services. The explanation is straightforward: even if the good is produced by a private, profit oriented firm, the cost of adjustment is higher. Hence a reduction of price regulation is a number one goal. Of course there are often reasons for price regulation that are more important than the effect on price flexibility, and such a process will not eliminate all regulated prices. But an examination of price regulations can reduce their scope and raise the average frequency of price changes. For goods where price regulation remains, it may be made more responsive to economic conditions. One way to do it is to simplify

[20] Of course there may be other reasons for the increase in the frequency of price changes than more competition. Glatzer and Rumler (2007) point out the effect of reduced regulation on adjustment frequency.

[21] With the latter based on Bils and Klenow (2004) rather than Nakamura and Steinsson (2008).

regulatory approval in case of changes in supply and demand for the regulated products. Of course this requires the regulatory authority has sufficient knowledge of market conditions in the regulated market. If its knowledge is insufficient to allow this, firms could be permitted to increase prices in line with inflation, preferably sector-specific inflation, without regulatory approval. Inflation is easier to observe than more detailed market conditions and so the appropriateness of such price changes is easier to verify.

Product market regulation is another area where reforms may lead to an increase in the frequency of price changes. Glatzer and Rumler (2007) point out that the liberalization of the telecommunication, electricity and natural gas markets in Austria led to a significant increase in the frequency of price changes. For telecommunications, the frequency has doubled. Alvarez and Hernando (2007) provide evidence that product market regulation has strong negative effect on the frequency of price adjustment.

As the survey of empirical consumer prices showed, there are significant differences between sectors in the frequency of price changes. The main concern is the low frequency of price adjustment in services. This is particularly important since, as shown by Carvalho (2006) and Nakamura and Steinsson (2007), the slow-adjusting sectors have a disproportional role on price sluggishness at the aggregate level.

There are several explanations of the sectoral differences in price adjustment. One concentrates on price flexibility of inputs. Bils and Klenow (2004) suggest that prices of raw goods (i.e. goods that have not undergone significant processing) change more often than prices of processed goods. Álvarez, Buriel and Hernando (2005) report that the share of labour in costs has a negative effect on the frequency of adjustment, and the share of raw materials has a positive effect. The higher is the share of labour in costs, and the lower is the share of raw materials, the more stable are costs and so the less frequently prices changes. This means that reforms aimed at increasing labour market flexibility would also raise the flexibility of prices. Another explanation of the low price adjustment frequency of services might again be regulation. Glatzer and Rumler (2007) report that the frequency of price changes of market-based services (excluding all services subject to regulation) is slightly higher than the average frequency of price changes for the whole basket and more than three times as high as for regulated services. Thus, reducing price regulation is a policy measure particularly relevant for the service sector.

An alternative explanation of the factors affecting the frequency of price changes, and sectoral differences, has been proposed by Konieczny and Skrzypacz (2007). They develop a model in which customers search for the best price. The more intensive is search for the best price, the more frequent are price changes.[22] They argue that search for the best price can explain sectoral differences in price adjustment. The argument is as follows. For a given price dispersion search is intensive for products that are homogeneous (for example apples) and is not intensive for heterogeneous products (for

[22] This phenomenon can contribute to higher frequency in the US than in the Euro-area.

example dental services). As discussed at length in the empirical survey, price changes are the most frequent for energy, followed by unprocessed foods, processed foods, manufactured products and services. This ranking is consistent with heterogeneity of products in these groups: energy is the most homogeneous, followed by unprocessed foods, processed foods and manufactured products; services are the most heterogeneous. This implies that the low frequency of price changes for services is due to the fact that consumers do not search for the best price of, say, dental services, as these differ a lot across providers. Those considerations indicate that promoting search for the best price (by setting information standards) and helping product (and service) standardization may help increase the frequency of price changes. Standardized products and services would lead to increased competition and search for the best price and make prices more flexible. The benefit from greater flexibility of service prices is going to be particularly large, given their growing role in the economy and their disproportional effect on the sluggishness of aggregate price level. It should be mentioned that an important factor facilitating the search for the best price in an integrated Europe was the introduction of the common currency. It facilitated cross-boarder price comparisons and enhanced price transparency. This is confirmed by a convergence of price levels across euro are countries since 2002 as measured by the coefficient of variation of HICP-based national price levels in the euro area.

The policy proposals above are complex. Reducing product and price regulation, promoting competition and introducing product and service standards across the Euro – area require careful considerations of pros and cons, getting interested parties to agree to these reforms, long-term preparation which would include mitigating negative effects of such policies and implementation that may be difficult. There is, however, one policy that is relatively easy to implement and has few drawbacks: the lowering of price adjustment costs. This can be done in three ways. First, as already discussed, the scope of price regulation should be reduced. Second, item pricing laws[23], if any, can be removed.[24] Finally, one could recommend a policy of promoting technologies that reduce price adjustment costs. An example is the electronic tag technology described above. It may often be the case that the private benefits of introducing these technologies are smaller than the cost saving. But there are positive externalities from such technologies: prices are more flexible, reducing output effects of nominal changes. Furthermore, as firms are more likely to change prices, the price level becomes more informative and so there are additional benefits of positive informational externalities, as described in Gorodnichenko (2007). Unlike other proposals, this one is relatively easy to implement and is likely to be supported by all parties.

[23] An item pricing law is a law requiring attaching a sticker with price to every item, rather than posting the price on the shelf.

[24] Item pricing laws facilitate price checking by consumers; the loss of this convenience has to be weighed against the benefit of more frequent adjustment. As such laws are relatively rare, we think that the convenience to consumers is not large.

II. SURVEY OF THE EMPIRICAL RESULTS.

2.1. Introduction

While the economic environment can be considered to evolve almost continuously, prices of goods and services are not changed all the time. This 'price rigidity' is of course interesting for microeconomics, but its main relevance is for macroeconomics and policy analysis. Price rigidity is of crucial importance following the introduction of the Euro. Under flexible exchange rates, adjustments to asymmetric shocks are facilitated by changes in the nominal exchange rate. This channel of nominal adjustment disappeared once the single currency had been adopted. Changes in the price level can replace changes in the exchange rate, but this requires flexible prices. Furthermore, the adoption of common currency removed the ability of central banks in member countries to conduct independent monetary policy. Hence, the analysis of nominal price rigidities is important for the understanding of adjustment under new conditions created by the common currency.

While price rigidity, which means that prices do not fully and immediately incorporate changes in costs and demand conditions, is the relevant economic concept, the empirical literature has mostly considered one dimension of price rigidity: the infrequent observation of price changes or price stickiness.

Price stickiness at the level of individual firms has been studied since 1920s. Mills (1927) analyzed wholesale prices for over 200 goods obtained from Bureau of Labour Statistics. His conclusion was that there are two types of products in the economy: the first is traded in flexible price markets, with prices changing often while for the second type prices are changed quite infrequently. Means (1935) called the second type of prices 'administered' prices (Wolman, 2007, describes the history in detail). Subsequently, the behaviour of prices has been studied by numerous authors using a variety of data sets.[25] Until recently, these data sets covered a small number of firms (or a small number of consumer goods and services) and so the understanding of individual price behaviour was limited. They can be divided into studies using data from high inflation countries: Sheshinski, Tishler and Weiss (1981) and Lach and Tsiddon (1992) for Israel, Tommasi (1993) for Argentina, Ratfai (2007) for Hungary and Konieczny and Skrzypacz (2005) for Poland, those using data from low inflation countries: Cecchetti (1986), Kashyap (1995) and Kackmeister (2001) for the US, Dahlby (1992) and Fisher and Konieczny (2006) for Canada, Loy and Weiss (2004) for Germany, as well as two studies based on internet data: Lünnemann and Wintr (2006) and Chakrabarti and Scholnick (2007). The studies were mostly concerned with testing the menu-cost model of price adjustment, described in detail in sections 1.2.1 and 1.2.2. The general conclusion was that, even under the

[25] Wolman (2007) lists the numerous empirical studies

conditions of extreme inflation, price changes are infrequent and the frequency and the size of price changes are (with some exceptions for the size) positively affected by inflation. Price decreases are relatively rare and, somewhat counterituitively, the proportion of price changes that are decreases is actually higher in countries with high inflation rates. While the results of these studies are interesting, they are only tangential to the task of the survey.

Availability of data has changed with the Inflation Persistence Network (IPN), organized in 2003 by the Eurosystem of Central Banks. This network led to the collection of numerous large data sets covering consumer and producer prices. In addition, several surveys were conducted in which firms were directly asked specific questions about their pricing policies. At about the same time, Bils and Klenow (2004) obtained US consumer price data. Subsequently, individual price data have been obtained by Baharad and Eden (2004) for Israel, Coricelli and Horvath (2006) for Slovakia, Gabriel and Reif (2007) for Hungary, Gagnon (2006) for Mexico, Hansen and Hansen (2006) for Denmark, Kovanen (2006) for Sierra Leone, Goueva (2007) for Brazil, Nakamura and Steinsson (2008) for the US, Saita *et al.* (2006) and Masahiro and Saita (2007) for Japan and Hofstetter (2008) for Colombia. These large data sets, often containing millions of observations, produced systematic body of knowledge on the behaviour of consumer and producer prices (although most of the data outside IPN was restricted to consumer prices, with the notable exception of Nakamura and Steinsson, 2008). In particular, they overturned some of the conclusions of the studies based on small samples.

We now turn to reviewing the empirical finding of this body of literature. We start by summarizing what is known about the behaviour of consumer prices, followed by a survey of producer price evidence and finally summarize evidence from firm surveys. The analysis is aimed at summarizing what is known about price stickiness, and whether there is a role for government action to affect the degree of price flexibility in the economy. We focus on the Euro area data as they are the most relevant.

2.2. Evidence from Consumer Price Data.

Consumer price data provide most of the information on price adjustment. Under the auspices of the IPN, national statistical offices provided to central banks in most Euro-area countries raw data used to calculate the consumer price index. These data have been obtained in Austria, Belgium, Finland, France, Germany, Italy, Luxembourg, Netherlands, Portugal, and Spain. These countries cover 97% of Euro area GDP. Table 2.1 below shows the coverage of the data across the different countries.

The data are collected by statistical office inspectors who visit stores. A typical record may contain the report date (month and year), a code that indicates where the price was checked, a product category code, the packaging of the product, its price as well as codes indicating temporary sales, temporary unavailability, and product and store replacements.

Product categories are classified according to the COICOP classification, a UN system that classifies products consumed by purpose – for example food and beverages, clothing and footwear etc. A series of such price records constitutes a price trajectory. Some price trajectories cover the entire observation period of the data but in many cases trajectories are shorter. This is due to changes in the product (a product of brand X replaced by a similar product of brand Y), outlet replacement or temporary unavailability. A few examples of price trajectories are given in Figure 2.1 below (from Dhyne *et al.*, 2006). They illustrate various patterns in the data. Gasoline prices change frequently and by small amounts. The prices of jeans and haircuts change less often. These trajectories also illustrate that, while price decreases are common for gasoline, for the price of some services (almost) never fall.

Table 2.1: Data Coverage

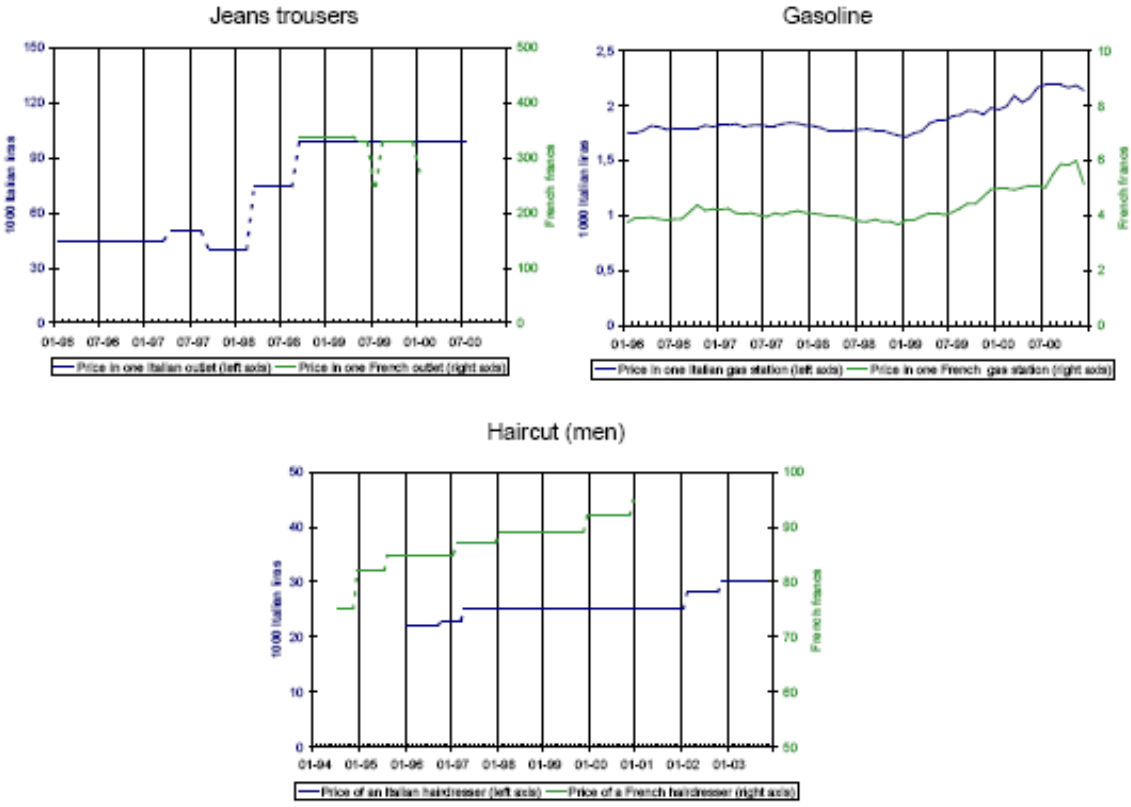
Country	Reference	Percentage of CPI covered or number of product categories	Period covered
Austria	Baumgartner, Glatzer, Rumler and Stiglbauer (2005)	90 % (80% considered)	01-1996 - 12-2003
Belgium	Aucremanne and Dhyne (2004)	68%	01-1989 - 12-2001
Finland	Vilmunen and Laakonen (2005)	100%	01-1997 - 12-2003
France	Baudry, Le Bihan, Sevestre and Tarrieu (2004)	65%	07-1994 - 02-2003
Germany	Hoffmann and Kurz-Kim (2005)	52 product categories (20%)	01-1998 - 01 2004
Italy	Veronese, Fabiani, Gattulli and Sabbatini (2005)	50 product categories (20%)	01-1996 - 12-2003
Luxembourg	Lünnemann and Mathä (2005)	100%	01-1999 - 12-2004
Netherlands	Jonker, Folkertsma and Blijenberg (2004)	49 product categories (8%)	11-1998 - 04-2003
Portugal	Dias, Dias and Neves (2004)	100% (95% considered)	01-1922 - 01-2001
Spain	Álvarez and Hernando (2004)	70%	01-1993 - 12-2001

Source : Dhyne *et al.* (2006)

The coverage of data across countries varies for several reasons. Due to confidentiality requirements, national statistical offices did not release prices of goods or services sold by a small number of outlets as such data may potentially allow identification of pricing policies of individual sellers. For example, the Austrian statistical office did not provide prices of tobacco products, cars, daily newspapers and mobile phone fees. Prices collected centrally and by other agencies are also missing. For example in Spain, housing rents, prices of energy, telecommunications, car prices, tobacco, financial, insurance and

household services, hospital and dental services, and hotels are not available.[26] In several cases administered prices are not available. Finally, as can be seen from Table 2.1 the period covered by the data vary across countries.

Figure 2.1: Examples of Price Trajectories.



Source : Dhyne *et al.* (2006)

The goal of the IPN was to obtain price information for individual countries, as well as conduct a comparison across countries. However, comparative analysis of price behaviour across the Euro-area countries was not possible with the entire data sets, for several reasons. First, the raw CPI data are confidential and were released to central banks under strict restrictions. Therefore, sharing the data across countries was not allowed and researchers in each central bank had to analyze their respective data separately.[27] Second,

[26] The most common missing item is housing rents.

[27] These studies are Álvarez, Burriel and Hernando (2008) and Álvarez and Hernando (2005) for Spain, Aucremanne and Dhyne (2004, 2005) for Belgium, Baudry, Le Bihan, Sevestre and Tarrieu (2004) and Fougère, Le Bihan, Sevestre (2005) for France, Baumgartner, Glatzer, Rumler and Stiglbauer (2005) for Austria, Dias, Dias and Neves (2004) and Dias, Robalo Marques and Santos Silva (2005) for Portugal , Hoffmann and KurzKim (2006), for Germany, Jonker, Blijenberg and Folkertsma (2004) for Holland, Lünnemann and Mathä **(**2005b**)** for Luxemburg, Veronese, Fabiani, Gattulli and Sabbatini (2005) for Italy and Vilmunen and Laakkonen (2005)) for Finland.

data coverage varied across countries. Third, the content of price information differed across countries. For example, in some cases the change of store or of product was not recorded. Different procedures are also used by national statistical agencies to deal with missing data, sales etc. Finally, as described in Table 2.1, some countries had to restrict their analysis to a subset of product categories. To make comparison across countries possible, a comprehensive subsample of 50 goods common across the 10 euro area countries that participated to this project was therefore selected.[28] The sub-sample was selected so as to be representative of 2-digit COICOP categories, with the exception of health care services and education, for which few data were available. The detailed description of the choice of the sample is in Dhyne *et al.* (2006), p. 38-39.

In what follows we summarize the results mostly for the subsample, referring to larger data sets only when necessary. There are several reasons for concentrating on the subsample rather than on the entire data sets. If the entire data sets were used, frequency of price changes and other statistics would depend on the period covered by the data, coverage, data preparations procedures etc. This would make cross – country comparisons questionable. The subsample has been carefully chosen to make the data across countries comparable. In the analysis of the subsample IPN researchers followed, as much as possible, the same procedures to dealing with the data.[29] The sample was chosen to be representative of the entire data sets; indeed, the average monthly frequency of price changes in the 50-product sample for the Euro area is almost identical to the average frequency in the larger samples (15.1% versus 15.3%).[30]

The main findings[31] are as follows.

1. Prices change infrequently.
2. The frequency of price changes varies across product categories and across countries but the differences across products tend to be larger.
3. Price changes are relatively large; the size of price increases and decreases is similar but, on the average, price increases are a bit smaller.
4. A large proportion of price changes are decreases, with the notable exception of services.
5. Price changes do not tend to be synchronized either across or within countries.
6. The hazard rate (the probability that a price that has been constant for *x* months is changed in a given month) is declining.
7. Pricing policies are, to some extent, time-contingent.

[28] The sample for the Netherlands is slightly smaller.
[29] Some differences remained: the treatment of sales differs (in some countries price data for sales exclude rebates) and for Finland and Luxemburg, the period starts and ends later.
[30] The differences at the country level are of course larger.
[31] Most of these findings (especially 1-5) summarize data statistics and do not require complex econometric analysis.

2.2.1. Prices Change Infrequently.

The average monthly frequency of price changes is 15.1%. As already mentioned, this is essentially identical to the average frequency in the entire samples (15.3%). If outliers are eliminated, by excluding the countries with the highest and the lowest frequency, the resulting frequency of price changes is 16.9%. On the average one in six prices is changed every month. The average duration of price spells (i.e. the average length of time for which a price is unchanged) is about four to five quarters. This is substantially longer than the implied 'pseudo frequency' obtained by inverting the average frequency of price changes (1/15.1% = 6.6 months). The reason for the difference is technical and depends on the heterogeneity in the data.[32]

A lot of discussion has been raised by these numbers, in light of the fact that comparable statistics for the US show significantly higher frequency of price changes. Bils and Klenow (2004) report that the average frequency in the US for 1995-97 period is 26.1%; Klenow and Kryvtsov (2008) report a monthly frequency for the 1998-2003 period of 29.3%. Similarly, the implied average price duration in the Euro area (about 13 months) is much longer than in the US (6.7 months in Bils and Klenow, 2004). Finally, Table 2.2 below shows the average frequency for each Euro-area country and for the US (the number for the US are for the 50 goods sample). Overall, and for every type of products, the frequency in the US is higher. It appears that prices change significantly less often in Europe than in the US.

Recently, however, Nakamura and Steinsson (2008) provide an alternative calculation of the frequency of price changes in the US, which produces numbers much closer to the numbers obtained for the Euro-area countries. They report that for regular prices (i.e. prices that are not sale prices) the median frequency of price change is 8.7% in 1998-2005 and 11.1% in 1988-1997, implying the median duration of 11 and 8.5 months, respectively, not far from Euro area numbers and much lower than the numbers reported by Bils and Klenow (2004). The difference comes from three sources. The inflation rate is lower in the later data (1998-2005) and the data are for identical products, eliminating price changes due to product substitution. Each of these factors reduces the probability of price change by one or two percent. The biggest effect on the probability comes from the elimination of sales. The procedure Nakamura and Steinsson use to eliminate sales data is controversial so we describe it in some detail. Bils and Klenow (2004) data contain only the probability of price changes for grouped goods. They correct for sales using the proportion of sales in overall data. Nakamura and Steinsson's (2008) data include price level information, so that sales can be eliminated directly. Nakamura and Steinsson treat as a sale a situation in which a price falls temporarily and then increases. In such situation no price change is recorded. The controversial assumption is that they do not record a

[32] A detailed explanation for the difference is in Dhyne *et al.* (2006), p. 43-4. In principle, it is possible to calculate duration directly from the data, but censoring is a problem in particular when price trajectories are short.

price change even when the post – sale price is different than the pre-sale price. For example, if prices in consecutive observations are 2,2,1,3,3, the procedure concludes there was no price change. Many would conclude that the price did change (from two to three).

As the proportion of sales in the US data is very high (over 20% of prices), disregarding sales has a large impact on the average frequency of price changes. Figure 2.5 below includes a comparison of the frequency of price changes in Bils and Klenow (2004) and in Nakamura and Steinsson (2008) with that in several European studies. The frequencies in European countries all are between the two US estimates: they are lower than the number reported by Bils and Klenow (2004) but higher than the number reported by Nakamura and Steinsson (2008).

One tentative interpretation is that, while the probability of price changes is higher in the US than in the Euro area, the difference is mainly due to the more frequent use of sales by the US retailers. This may be related to retail price competition, which generally is perceived to be stronger in the US than in the Euro area.

2.2.2. Frequency of Price Changes Across Product Categories.

The aggregate figures mask substantial heterogeneity across product categories and countries. The probability of price changes is the highest for energy products, followed by perishable and durable foodstuffs, manufactured goods and services. These differences are illustrated in Figure 2.2. Each observation is the frequency for one product category in one country.

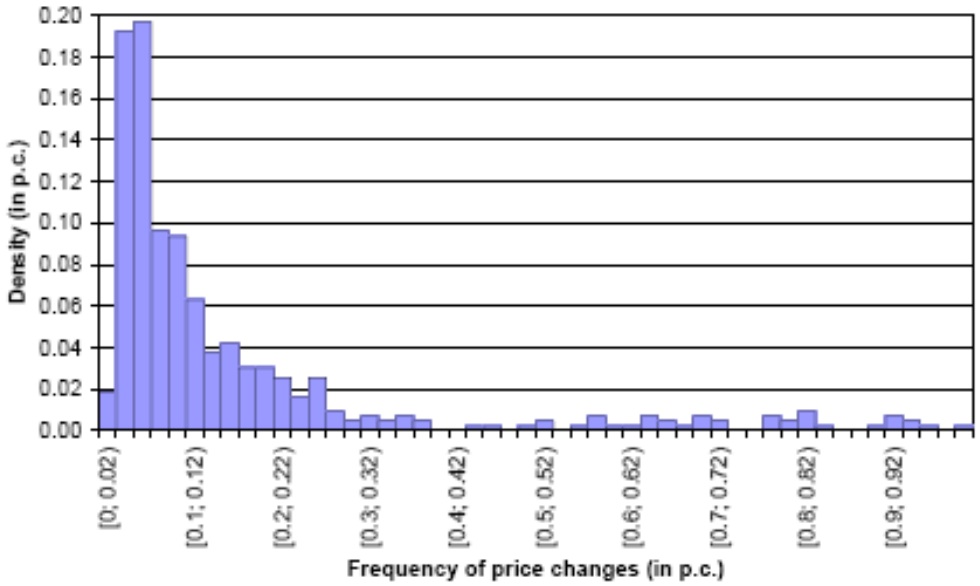
Figure 2.2 shows the large heterogeneity of the frequency of price changes. The strong positive skewness of the distribution reflects the fact that price changes are quite infrequent for a large proportion of goods and services; in particular there are numerous products for which the frequency of price changes is between 2% and 6% per month. As discussed in more detail later, many of these are services. There are also several goods for which prices are changed almost every month, but they are less common than goods with infrequent price changes.

More information on the heterogeneity of the frequency of price changes across goods and across broad product categories is in Table 2.2.

Across countries, the frequency of price changes varies from a low of 10% in Italy to a high of 23% in Luxembourg. Excluding these two extremes, the frequency varies between 13.3% in Spain and 21.1% in Portugal. The differences in the frequency of adjustment are, in part, due to the structure of consumption. The numbers in the last column of Table 2.2 are obtained using country weights. If common Euro area weights are used (i.e. assuming the same consumption patterns in all countries) the differences are much smaller: the frequency varies from 12% in Italy to 20.4% in France. Other reasons suggested for the

variation across countries are differences in the retail structure (small stores tend to change prices less often as shown in Baudry *et al.*, 2007 and in Veronese *et al.*, 2005), variations in the importance of regulated prices (which are changed less often than unregulated prices) and methodological differences, especially reporting of sales.

Figure 2.2: The Distribution of the Frequency of Price Changes.



Source : Dhyne *et al.* (2006)

Table 2.2: The Frequency of Price Changes by Type of Product and Country.

Country	Unprocessed food	Processed food	Energy (oil products)	Non-energy industrial goods	Services	Total
Austria	37.5	15.5	72.3	8.4	7.1	15.4
Belgium	31.5	19.1	81.6	5.9	3.0	17.6
Germany	25.2	8.9	91.4	5.4	4.3	13.5
Spain	50.9	17.7	n.a.	6.1	4.6	13.3
Finland	52.7	12.8	89.3	18.1	11.6	20.3
France	24.7	20.3	76.9	18.0	7.4	20.9
Italy	19.3	9.4	61.6	5.8	4.6	10.0
Luxembourg	54.6	10.5	73.9	14.5	4.8	23.0
Netherlands	30.8	17.3	72.6	14.2	7.9	16.2
Portugal	55.3	24.5	15.9	14.3	13.6	21.1
Euro area	28.3	13.7	78.0	9.2	5.6	15.1
US	47.7	27.1	74.1	22.4	15.0	24.8

Source : Dhyne *et al.* (2006)

2.2.3. The Differences in the Frequency of Price Changes across Countries are Smaller than Across Goods.

As can be seen from Table 2.2, there are large differences in the frequency of price changes across broad types of products. Price changes are the most frequent for energy, (in the sample - oil products) with 78% changed each month, followed by unprocessed food (28.3%), processed food (13.7%), non-energy industrial goods (9.2%) and finally services (5.6%). A remarkable feature of these differences across product types is that they show up consistently in all countries, with very few exceptions.[33] The rankings are the same when the entire data sets are used (see Álvarez and Hernando, 2005, Aucremanne and Dhyne, 2004, Baudry *et al.*, 2004, Baumgartner *et al.*, 2005, Dias *et al.*, 2004, Lünnemann and Mathä, 2005 and Vilmunen and Laakonen, 2005).[34] Similar rankings have been reported by Konieczny and Skrzypacz (2007) for Poland, Saita *et al.* (2006) for Japan and by Dhyne *et al.* (2006) for the US; the US numbers are included in Table 2.2 for comparison with the European data.[35]

It is clear from Table 2.2 that, apart from being remarkably consistent across countries, the differences in the frequency of price adjustments are larger across types of goods than across countries. The country average frequencies, calculated using country weights, are all between 23% (Luxembourg) and 10% (Italy) or a ratio of about two to one. Using common Euro area weights they are between 20.4% (France) and 12% (Italy). The ratio of processed food to service frequency is two to one for 8 out of 10 countries; the ratio for fresh food to service frequency is three to one for all countries. Energy prices change even more frequently than fresh food. For a majority of goods the average frequency is outside these ranges. At the Euro-area level (for each product the figures are aggregated from country numbers using HICP country weights); the frequencies vary from 2% for video tape rental to over 80% for one type of fuel. The average frequency of price changes is below 10% or above 23% for 36 out of the 50 goods.

There are several potential explanations of these sectoral differences in the frequency of price changes. The standard explanation is that the frequency depends on the importance of labour input in production. Since wages are changed infrequently, high labour input leads to low frequency of price changes. This reasoning can explain the low frequency of adjustment in services, but does not provide satisfactory explanation for the differences between other product types. For example, in half of the countries (Austria, Germany,

[33] The exceptions are Portugal where prices of energy change relatively infrequently and Luxembourg and Finland where prices of non-energy industrial goods change more often than prices of processed food. Energy prices were regulated in Portugal and sales are common for non-energy industrial goods in Luxembourg.

[34] Using entire data sets produces two additional exceptions: in Austria the frequency of price changes for services is higher than for durable food and for manufactured goods, and in France the frequency for manufactured goods is higher than for durable foods.

[35] Bils and Klenow (2004) report that prices of raw goods change more often than prices of processed goods. The division of their sample by type of product was done by Dhyne *et al.* (2006).

Italy, Portugal and Spain) the difference in the adjustment frequency between services and manufactured goods is much smaller than between manufactured goods and processed food. The differences may be due to more frequent supply shocks in the energy and perishable food sectors, as in Golosov and Lucas (2007). A related explanation, based on Dhyne *et al.* (2008) is that prices change less often for goods for which supply and demand conditions are stable. The differences may also be due to the fact that the more intensively customers search for the best price, the more frequently prices change (Konieczny and Skrzypacz, 2007). Search for the best price is more intensive for homogenous goods, (energy or fresh food), than for heterogeneous products (manufactured goods and services).

2.2.4. Price Decreases are Very Common.

There is no stronger downward nominal price stickiness, with the possible exception of services. For all goods, the frequency of price increases is 8% and the frequency of price decreases is 6%; in other words, 42% of all price changes are decreases. The proportion of price changes that are decreases varies between 6% for taxi fares and 57% for fax machines (this product is classified as a service).

For both types of food and energy price increases and decreases are almost equally likely (46% of price changes are decreases); for industrial goods 43% of price changes are decreases. On the other hand, price reductions are much less common for services, for which they constitute only 20% of price changes. A possible explanation of the low proportion of price reductions is that, for services, the share of labour in production costs is higher than for other product types. As nominal wages and salaries are rarely reduced, a reduction in the price of a service requires productivity improvement or a cut in mark-up.

The large proportion of price reductions means that concerns about stronger downward price rigidity are unwarranted for consumer prices.

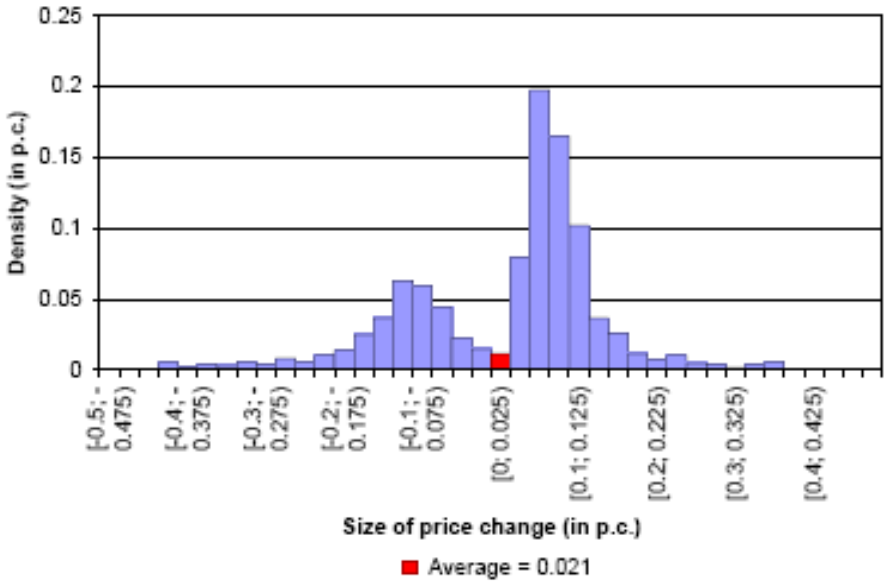
2.2.5. Price Changes are Large Relative to Elapsed Inflation since the Previous Price Change.

The size of price changes, in general, exceeds elapsed inflation since the previous price change. Figure 2.3 shows the distribution of the size of price changes. The average size of price increases is 8% and of price decreases is 10% while the elapsed inflation since the previous price change is, on the average, less than 3%.

The size of price changes varies across types of product: they are the largest for perishable foodstuffs and the smallest for energy. The extreme values are over 30% for lettuce and under 3% for the two types of fuels in the sample. The large price changes mean that

adjustment involves more than just a catch-up to the target real price as some models (for example the menu cost model) imply. Since the average duration of prices is about 4 or 5 quarter, adjusting to make up for elapsed inflation since the last price change would in general imply price increases of less than 3%. Nor do price decreases represent a catch-up to elapsed decrease in the price level. The CPI is almost always increasing. Inflation rates are more variable for disaggregated data, which is more relevant for price behaviour (Konieczny and Skrzypacz, 2005, find that product-specific inflation is a better determinant of price changes than CPI inflation), but downward trends are not very common at the disaggregated level either, except for electronic equipment.

Figure 2.3: Distribution of the Size of Price Changes.



Source : Dhyne *et al.* (2006)

The observation that price changes are relatively large led Golosov and Lucas (2007) to suggest that price changes are due to idiosyncratic shock affecting a given market. These shocks change the desired price; if they are large enough they explain both the large size of price changes, and the large proportion of price changes that are reductions. This will be important for the explanation of the degree of price rigidity. Dhyne *et al.* (2008) argue that a distinction should be made between intrinsic and extrinsic rigidity. Intrinsic rigidity is related to the price-setting mechanism, while extrinsic rigidity is related to the process driving the optimal price. Infrequent price changes may be the result of stable environment in which the target price does not vary much over time.

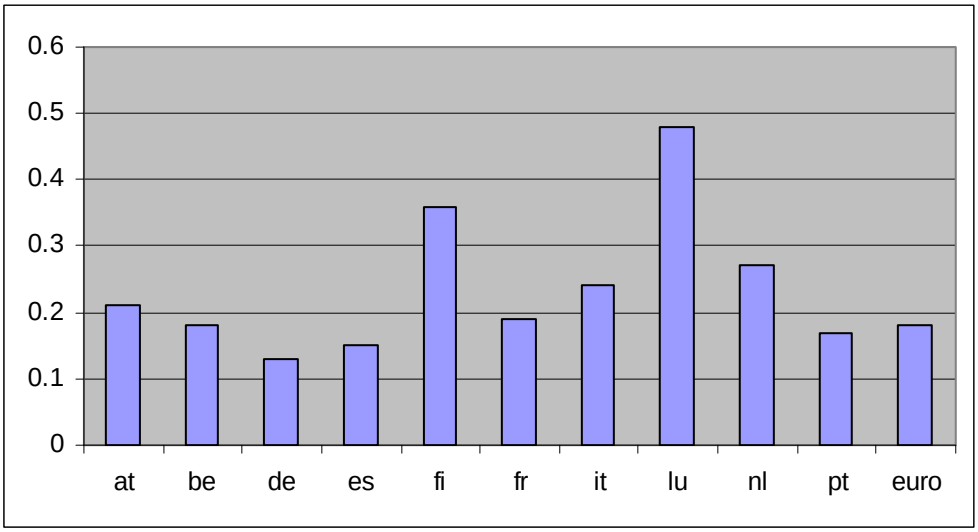
In general, the average size of a price decrease is larger than the average size of a price increase. As already mentioned, the average price increase over all goods is 8% and price decrease is 10%. Price decreases are larger than increases for 43 out of the 50 goods in the sample. They are almost twice larger for wheel balancing and 30% smaller for heating oil.

As can be seen from Figure 2.3, the smaller average size of price increases is due to the fact that small price increases are more numerous than small price decreases. In other words, when firms reduce their prices, they tend to do it by a large amount; while they are more likely to raise them by a few percent. Well over a half of price decreases exceed 10%, while the majority of price increases are smaller than 10%. Similar asymmetry in price adjustment has been reported for a US grocery chain by Chen *et al.* (2008). Small price increases are much more frequent than small price cuts. The difference is not caused by inflation; it remains even in products with stable price level.

2.2.6. Staggering/synchronization of Price Changes.

Price changes appear staggered rather than synchronized. The issue of staggering versus synchronization of price changes is important for the effects of monetary policy. If price changes are synchronized, any effect of a monetary change will last only as long as the price duration; then all firms will be able to change prices to the target level without changing a relative price. If price changes are staggered, a change of nominal price is equivalent to a change in the relative price. Since relative prices matter for the optimal allocation of consumption across goods, the price is not adjusted all the way to the target level and adjustment is spread over time. Hence, the effects of monetary policy are long-lasting (Fischer, 1977, Taylor 1980).

Figure 2.4. The Values of the F-K Index.



Source : Dhyne *et al.* (2006)

The staggering/synchronization of price changes is measured using the index introduced by Fisher and Konieczny (2000), henceforth the F-K index. It is equal to the ratio of the

sample standard deviation of the proportion of prices changed each month to the standard deviation of a perfectly synchronized series with the same average adjustment frequency.[36] For a perfectly staggered series, the value of the index is zero; for a perfectly synchronized series, it is equal to 1. Figure 2.4 shows the values of the F-K index for each country. It varies between 0.13 in Germany to 0.48 in Luxembourg. These values are much smaller than one, suggesting staggering rather than synchronization of price changes. The values are higher in small countries. This is consistent with the findings of Veronese *et al.* (2005) and Dhyne and Konieczny (2007) who report a greater degree of synchronization in cities than in the entire country.

2.2.7. The Unconditional Hazard Rates.

The hazard rate is the probability that a price of a given vintage (i.e. a price last changed x months ago) is going to be changed in a given month. Standard models imply that the longer the period elapsed since the last price change, the more likely will the price be changed, i.e. that the hazard rate is increasing. In the data, however, hazard rates are decreasing.

The declining hazard rate is the consequence of heterogeneity in the probability of price adjustment. The argument is straightforward. Assume that all goods are the same and prices remain unchanged for 3 months. Then the hazard rate is zero for prices that have been changed 3 months ago or later, and one for prices that were changed four months ago. In other words, for homogenous data, the hazard rate is increasing. The reason the observed hazard rates are decreasing is that there are numerous goods for which price changes are frequent, and relatively few goods which change prices infrequently (see Figure 2.2). For a price changed recently there is a high likelihood that the good is a flexible price good and so the probability of the occurrence of a price change is high; for a price that has been unchanged for a long time it is likely that the good is a sticky price good and the probability of price change is low. Hence the empirical hazard rate is downward sloping.[37]

2.2.8. Time-contingent Elements in Price Adjustment.

Pricing policies have both state and time contingent elements. In theoretical models of price adjustment, there is an important distinction between time- and state-contingent pricing policies. Under a time-contingent policy the decision to change price depends only on time. Under a state-contingent policy the decision depends on the state of the economy

[36] Dhyne and Konieczny (2007) provide detailed description of the index.

[37] Álvarez, Burriel and Hernando (2005) discuss the issue in detail. Baumgartner *et al.* (2005) and Fougère *et al.* (2005) find that when the hazard function is estimated on disaggregated data, it is non-decreasing.

and, in particular, on how far the current price is from the desired price. While time-contingent policies are, in general, suboptimal, they have been used in macroeconomic models as they are relatively easy to aggregate. The most popular assumption is that each firm has the same probability of changing price in each period (Calvo, 1983).

Empirical evidence shows that while, in general, the decisions to change prices depend on wider considerations than just time, there are many examples where pricing policies are time-contingent. Price changes are more frequent in some months (in the first quarter, especially in January) and in September, and less frequent in the summer (in France, price changes are relatively rare in December). Of course the reason for this may be that these regular changes are due to regular changes in costs or demand. The second type of evidence for time-contingent pricing is provided by hazard rates. In virtually all countries the hazard rates have peaks at 12, 24 and 36 month durations. This means that many firms tend to change prices once every year, two or three years (of course not necessarily in January).

2.2.9. Other Factors Affecting Price Changes.

We conclude by briefly describing other factors affecting price changes. These results have been obtained by regressing the probability of an individual price change, or the proportion of price changes, on several variables suggested by theory. There is plenty of evidence that higher aggregate inflation, as well as higher sectoral inflation, raise the frequency of price changes. This is a general result well known from essentially all empirical studies. Furthermore, higher inflation raises the probability of a price increase and lowers the probability of a price decrease (Álvarez and Hernando, 2004, Aucremanne and Dhyne, 2005, Baumgartner *et al.,* 2005, Fougère *et al.*, 2007). The effect of inflation on price increases is stronger than of price decreases and so the frequency of price changes is higher.[38] This has interesting implications for policy. As the inflation rate falls, the proportion of price decreases rises, and so downward price rigidity becomes less of a problem. This is indeed a virtuous circle. Many economists and central bankers are concerned that reducing inflation is going to be made difficult by the resistance of firms to cut prices. Recently, there has been significant concern about potential deflation. At the level of individual price adjustment the difference between, say, 1% deflation and 1% inflation is a slightly higher proportion of price decreases. It is similar to the difference between 1% and 3% inflation. In other words, from the narrow point of view of product markets, deflation does not appear to be a problem.

Events like changes in indirect taxes or the Euro cash changeover lead to additional price changes. Glatzer and Rumler (2007) describe in detail the behaviour of prices in Austria

[38] This is similar to the recent finding of Gagnon (2008) who studied price adjustment in Mexico and found that the response of price changes to inflation was exactly that: more price increases and fewer price decreases.

over the period of the Euro-cash changeover. The frequency of price changes (both up and down) has increased in advance of the changeover, while the size of price changes (both up and down) has fallen dramatically. Similarly, Baudry *et al.* (2004), Baumgartner *et al.* (2005), Cornille (2003), Jonker *et al.* (2004), Lünnemann and Mathä (2005b) and Veronese *et al.* (2005) show that the changeover has led to higher frequency of price changes before and after the date of the changeover. Álvarez and Hernando (2004), Aucremanne and Dhyne (2004, 2005), Baudry *et al.* (2004), Dias *et al.* (2004), Hoffman and Kurtz-Kim (2005) and Jonker *et al.* (2004) all find that an increase in indirect taxes raises the frequency of price changes.

Information on the type of outlet was available in some countries (Baudry *et al.*, 2007, Jonker *et al.*,2004, Veronese *et al.*, 2005). In all cases, it turns out that the frequency of price changes in larger stores is greater than in small stores. Prices change more often in supermarkets than in corner stores. This may be due to a more intensive competition between stores, or due to increasing returns to scale in price changing.[39]

The fact that, faced with unusual situation, firms respond by making additional price adjustments has important implications for this project. Consider a situation when relative prices across countries need to change but, given the adoption of the Euro, the nominal exchange rate cannot provide the necessary adjustment. Evidence from announced changes in indirect taxes and from the cash changeover implies that, at least to some extent, firms will respond to these announcements by synchronizing their price adjustments with the event. Therefore judging the flexibility of the nominal side of the economy by the flexibility of prices under the usual circumstances may provide a lower estimate of the speed of adjustment to relative price shocks.

2.2.10. Comparison with Other Studies.

Prior to the IPN data as well as data used by Bils and Klenow (2004) and by Nakamura and Steinsson (2008), infrequent price changes were studied on small data sets. Sheshinski, Tishler and Weiss (1979) analyzed prices of coffee and noodles, Lach and Tsiddon (1992) prices of meats and wines, Tommasi (1993) prices of several grocery items, Ratfai (2007) prices of meats, Konieczny and Skrzypacz (2005) prices of 55 goods, mostly groceries, Cecchetti (1986) prices of magazines, Kashyap (1995) prices of several catalogue goods, Dahlby (1992) prices of automobile insurance and Fisher and Konieczny (2006) prices of newspapers.[40] The price information was used just because researchers were able to collect these particular data.

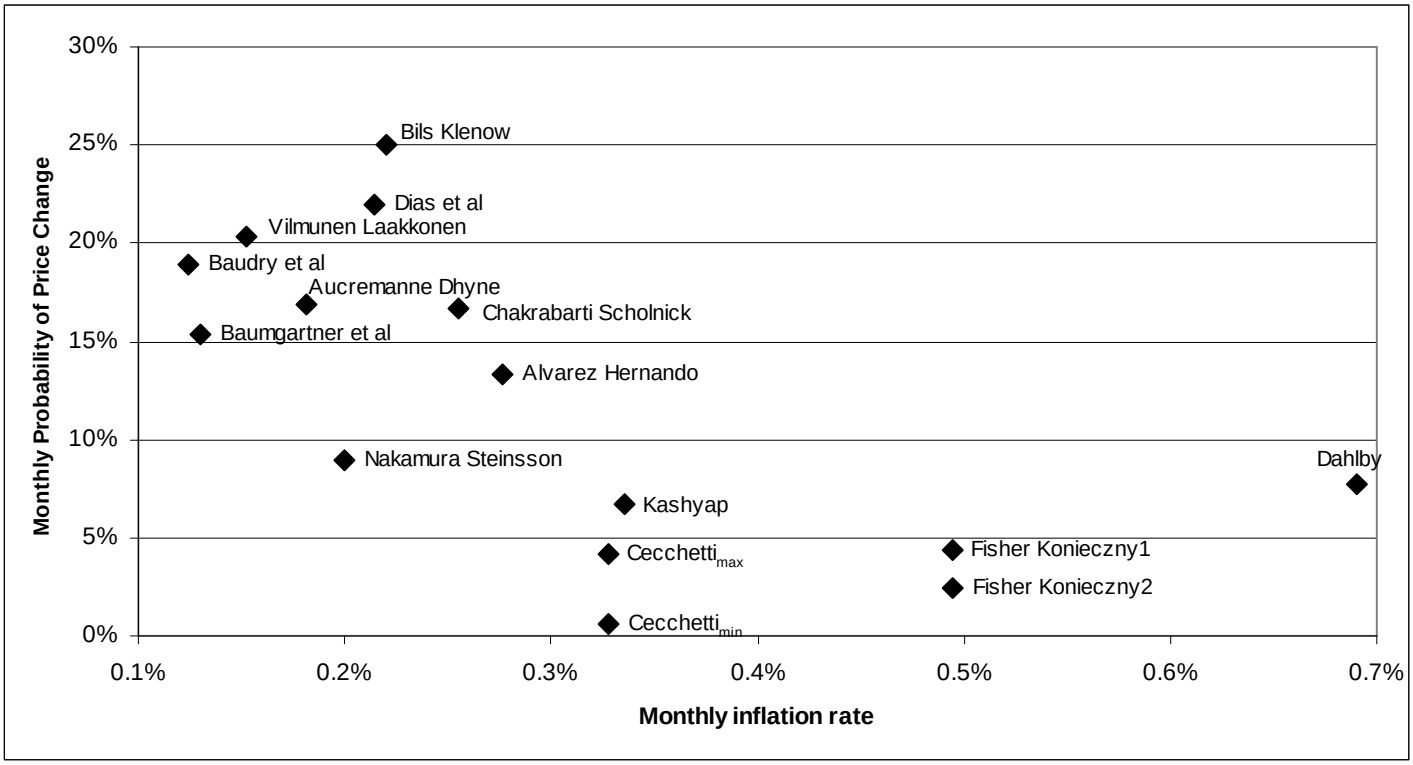
[39] Increasing returns in price changing arise due to the fact that, when price changing is costly and involves decision costs, changing several prices at once is cheaper than changing them separately. The scope for joint price changes is greater in larger stores.

[40] These are just some examples. A complete list is in Wolman (2007).

These studies were mostly concerned with the testing of implications of the standard menu cost model of Sheshinski and Weiss (1977). They consider a single monopolistic firm producing a single product and facing a constant rate of inflation. Changing the nominal price involves a fixed, lump-sum cost which is independent of how frequently or how much the price is changed. The optimal policy for the firm is to set two real price bounds, *s* and *S*. Nominal price is kept constant and inflation erodes the real price until it reaches the lower bound, *s*; the nominal price is then increased so that the new real price is equal to the upper bound, *S.* The model implies that the frequency and size of price changes depend on the inflation rate and the size of the adjustment cost. Higher inflation leads to a lower *s*, higher *S* and so to larger price changes. In general, higher inflation does not imply higher frequency of price changes; Sheshinski and Weiss (1977) give an example when the frequency falls while inflation increases and provide a sufficient condition for the positive relationship between inflation and the frequency of price changes. Higher costs of price adjustment lead to less frequent and larger price changes. An additional question sometimes asked was whether price changes were staggered over time. These empirical studies all found that the frequency of price changes increased with inflation, but in some instances price changes became smaller (Lach and Tsiddon, 1992, Kashyap, 1995) or were not affected by inflation (Sheshinski, Tishler and Weiss, 1981, Cecchetti, 1986). Price changes appeared to be staggered (Lach and Tsiddon, 1992 and 1996, Tommasi, 1993, and Fisher and Konieczny, 2000).

These results are consistent with the results reported using the new large data sets. So, in this sense, the small-scale studies were on the right tract. As it turns out, however, the frequency of price changes was unusually low. In Figure 2.5 below we show the average values of inflation and the frequency of price changes for a few older studies and for the new comprehensive data sets. It is clear that the two types of data produce a different picture. The inflation rate for the older studies (Kashyap, 1995, Cecchetti, 1986, Fisher and Konieczny, 2000 and Dahlby, 1992) is higher than in the newer studies, yet the frequency of price changes is lower. This point was made by Bils and Klenow (2004) who placed the frequency numbers reported to earlier studies in the distribution of the frequency in their data. The previously reported numbers were all near the upper tail of the distribution. In other words, it seems that, by accident, the data available earlier provided quite misleading picture of the frequency of price changes, suggesting that prices are much more rigid than they actually are. It also means that the results in the older studies may not be robust and cannot be relied on. But of course the new data are free from these problems.

Figure 2.5: Inflation and the Frequency of Price Changes.



Source: own calculations.

2.3. Evidence from Producer Price Data.

The second part of the survey summarizes what is known about the behaviour of producer prices on the basis of individual producer price data. Producer prices are, in general, difficult to obtain. While some consumer prices are posted and can be collected by hand (for example Cecchetti, 1986), or by computer (for example Chakraborti and Scholnick, 2007), few if any producer prices are publicly available. When producer prices can be found, those are always list prices. But of course what matters for price adjustment is transaction prices, rather than list prices. Transactions prices differ from list prices due to promotions and discounts, which can vary by customer and are usually a trade secret. A further problem is that transactions between producers and their customers are complicated. They may involve the cost of transportation, quality requirement, after sale service and delivery lags, all of which affect the effective price of the product to the buyer but is not reflected in transactions prices.[41]

[41] It is not clear whether the analysis of price rigidity should focus on the effective price or on nominal transaction price. If economic conditions change, the seller may react by changing non-monetary conditions of the contract while keeping transactions price constant (for example provide faster delivery

Because of these problems, few studies of individual prices existed prior to IPN. Some of the price information used by Mills (1926) and Means (1935) involved producer prices. Stigler and Kindahl (1970) collected US transactions data for a number of intermediate products used in manufacturing. These data, which are based on a relatively narrow sample of goods, were analyzed by Carlton (1986).

As part of the IPN project, comprehensive data sets were obtained from National Statistical Institutes on producer prices in 6 countries: Belgium (Cornille and Dossche, 2006), France (Gautier, 2006), Germany (Stahl, 2006), Italy (Sabbatini *et al.* 005), Portugal (Dias, Dias and Neves, 2004) and Spain (Álvarez *et al.*, 2005). The data cover between 83% and 100% of the PPI baskets, with the exception of Italy where prices for only a representative sample of 60 goods were obtained; they constitute about 44% of the PPI basket. The period covered differs across countries. For example, Spanish data are for the 1991-99 period while Belgian data are from 2001 to 2005. This has to be taken into account when comparing results across countries.

Price record contained information on the actual transactions price, a code for the product, an establishment code,[42] a code for product replacement and month and year of the record. For all countries but Spain the product code allows to identify the product. The information from individual price records was aggregated within NACE industries using national PPI weights; these differ across countries as their industrial structure is not identical.

The analysis of the producer price data led to the establishment of five 'stylized facts'.

1. Producer prices change infrequently.
2. The frequency varies substantially across industries: it is the highest for energy products and the lowest for capital goods, non-durable non-food items and durable products.
3. The ranking of industries in terms of the frequency of price changes is similar in all countries.
4. There are numerous price decreases, indicating little if any downward price rigidity
5. Price changes are relatively large compared to the elapsed inflation.

rather than lower the price). The changes in contract conditions adjust the transaction to the new economic situation, playing the same role as a change in transactions price. It seems reasonable to treat such new transaction as an equivalent of a price change. But contract conditions are rarely known and in practice researchers have to rely on transactions prices.

[42] The firms cannot be identified from the establishment code.

2.3.1. Prices Change Infrequently.

Table 2.3 shows the frequency of price changes across countries. The average frequency of price change for all goods varies between 15% per month in Italy to 25% in France. Excluding Italy, the frequency of price changes lies in the narrow range from 21% to 25%. The same holds for price increases and decreases which range respectively from 12% to 14% and from 9% and 11%.

The low figure observed in Italy might be related to the fact that it is based on a small number of product categories. Another reason for the difference between Italy and other countries is that Italian data do not include energy which, are the most flexible of all prices. But this cannot explain the entire difference. As will be seen below, in many product categories, prices change less often in Italy than in other countries. It appears that producer prices in Italy are stickier than elsewhere. Note that, as already seen, prices of consumer goods were changed relatively infrequently in Italy.

Table 2.3: Monthly Frequency of Price Changes by Country

	Frequency of price		
	changes	**increases**	**decreases**
Belgium	0.24	0.13	0.11
France	0.25	0.14	0.11
Germany	0.22	0.12	0.10
Italy	0.15	0.09	0.07
Portugal	0.23	0.14	0.10
Spain	0.21	0.12	0.09
Euro area	0.21	0.12	0.10

Source : Vermeulen *et al.* (2007)

2.3.2. The Frequency of Price Changes Varies Substantially Across Industries

There are large differences in the average frequency of price changes across industries. It is the highest for energy products and the lowest for capital goods, non-durable non-food items and durable products. Table 2.4 shows the frequency of price changes in each country separately for six product categories. At the Euro area level, products can be classified into three categories on the basis of the frequency of adjustments. It is the highest for energy products, takes on medium values for food and intermediate products and is the lowest for non-durable final products and for capital goods. The difference between the three categories is large. The frequency of price changes for energy is 72%;

for food and for intermediate products it is between 20% and 30%, and for the remaining product categories it is around 10%. This ranking is generally the same in each country, with the sole exception of Portugal where price changes of durable products were more frequent than of intermediate products.

Data for the Euro area suggest that the heterogeneity in the frequency of adjustment across product categories is greater than the heterogeneity across countries. These differences are larger than the narrow range 21% to 25% across all countries for all goods.

Table 2.4: Monthly Frequency of Price Changes by Product Category

	Energy	Food	Intermediate products	Non-durable non-food	Durable products	Capital goods
Belgium	0.50	0.20	0.28	0.11	0.14	0.13
France	0.66	0.32	0.23	0.10	0.13	0.12
Germany	0.94	0.26	0.23	0.14	0.10	0.10
Italy	n.a.	0.27	0.18	0.10	0.07	0.05
Portugal	0.66	0.21	0.12	0.05	0.18	n.a.
Spain	0.38	0.24	0.28	0.10	0.10	0.08
Euro area	0.72	0.27	0.22	0.11	0.10	0.09

Source : Vermeulen *et al.* (2007)

Table 2.4 suggests that the frequency of price changes is inversely related to the degree of processing: price changes are frequent for products that have gone through little transformation, and they are infrequent for highly processed products. This observation is consistent with what Bils and Klenow (2004) report for consumer goods in the US. It suggests that price changes are related to volatility of costs. For products that have undergone little processing from input to end product (energy, foods and intermediate products) the total cost is closely related to the cost of the raw input, which changes often. On the other hand, for products that are highly processed, the total cost depends on the cost of many factors and intermediate products that go into their production (labour, raw materials, R&D, marketing etc). If these costs are not too volatile, or if they change at different times, the total cost fluctuates little and so the final price of the product changes infrequently.[43]

As can be seen from Table 2.4, there is substantial heterogeneity in the frequency of price changes in two dimensions: for a given country across product categories, and for a given product category across countries. The differences across countries for a given product category appear smaller than the differences across product categories for a given country.

[43] For example the frequency of price changes of flour in Italy and in Portugal is over 40%, while for bread it is only 6%

Across countries (excluding Italy), the frequency for capital goods varies between 8% and 13%, for durable products between 10% and 18%, for intermediate products between 12% and 28%, for food between 20% and 32% and for energy between 38% and 94% (the low frequency in Spain appears to be an outlier).On the one hand, price changes in the country with the most flexible prices are roughly speaking about twice more frequent than price changes in the most rigid country. On the other hand, in each country, prices of energy change about 5 times more frequently than prices of capital goods or non-food products. As for consumer prices, heterogeneity across groups of goods is greater than across countries.

As can be expected, the frequency of price changes varies more at a more disaggregated level. At the two-digit industry level, excluding energy, the frequency varies from a minimum of 1% in Italy to 72% in Belgium.

2.3.3. The Ranking of Industries in Terms of the Frequency of Price Changes is Similar in All Countries.

Vermeulen *et al.* (2007) calculate the correlation coefficient of the frequencies of price changes at the two-digit industry level for each pair of countries. Energy prices are excluded as they are an outlier and would greatly raise the correlation coefficient. For each country pair the correlation is positive; it varies from a low of 0.3 for the Belgium-Italy pair (which is the only correlation below 0.5) to a high of 0.89 for the France-Spain pair. The correlations are particularly high for Germany, France and Belgium. This provides further indication that industry differences are more important determinants of the frequency of price changes than country differences. This is important as it indicates that the results can be extrapolated to other Euro-area countries.

2.3.4. Price Decreases are Frequent.

As for consumer prices, price decreases are frequent, suggesting little, if any, downward stickiness. The relevant statistics are in Table 2.3. Price increases and price decreases are almost as common; the proportion of all price changes that are decreases is about 45% and is similar in each country. Note that these prices are the actual transaction prices so that they include all price-related discounts. It is quite possible that list prices do not fall as often but, as argued above, list prices are unimportant in the case of producer prices. The high proportion of price decreases is perhaps surprising since, as discussed above, firms can adjust to changing market situation by varying contract conditions: delivery lags, quality of product, after – sale service etc; for example rather than reducing price, the seller of capital goods may offer better warranty conditions. Despite this fact price reductions are very common, indicating little downward rigidity.

2.3.5. Price Changes are a Little Larger than Elapsed Inflation.

Over the sample periods, PPI inflation was between 0.7% in France and 2.1% in Spain. As the average frequency of price changes is over 20%, elapsed inflation since the previous price change would in general be between 1% and 2%. Price changes are somewhat larger: the median price increase is 3%, while the median price decrease is 2%. There are many price changes exceeding 10%. A similar finding was obtained for consumer prices, where it was stronger as the average consumer price change is much larger than the average producer price change.

2.3.6. Comparison of the Behaviour of Consumer and Producer Prices.

We now turn to the comparison of the reported behaviour of consumer and producer prices. The main differences are that price changes for producer goods are more frequent and smaller. The main similarities are that the differences in the frequency across groups of products are greater than across countries. For both consumer and producer goods there exist a ranking of product types that is remarkably consistent across countries. The frequency of price changes depends on the degree of processing. Price changes are large relative to elapsed inflation. Finally, it appears that price changes in Italy are less frequent than in other countries.

Table 2.5 compares the frequency of price changes for consumer and producer goods in the countries for which both types of data are available. Apart for statistics for all items we provide the data for narrower groups. For all goods, the frequency of adjustment is higher for producer prices in every country. At the Euro-area level (the six countries in the sample), the average frequency of price changes is 21% for producer prices and 14% for consumer prices; in other words, producer prices change 1.5 times more often than consumer prices. The difference is the largest in Germany (where the frequency of producer price changes is twice higher) and in Belgium, and it is the smallest in Portugal, where the frequencies are very similar.

On the basis of aggregate data for all goods, the conclusion that producer prices change more often can only be made tentatively. This is because there are important differences in data coverage and methodological issues. The composition the producer and of the consumer baskets are quite different. Service prices, which change infrequently, are included in the consumer basket but not in the producer basket. Producer prices include non-energy intermediate goods, which have relatively flexible prices. The weight of energy products (which change very often) in PPI is typically much higher than in CPI..[44]

[44] In addition, PPI includes only domestic goods prices while CPI also includes prices of imported goods. Indirect taxes are included in prices of consumer goods but not in prices of producer goods.

These differences in coverage raise the frequency of producer price changes relative to consumer price changes.

Table 2.5: The Frequency of Price Changes for Consumer and Producer Goods

	All items		Processed food		Non-food, non-energy consumer goods	
	Consumer	**Producer**	**Consumer**	**Producer**	**Consumer**	**Producer**
Germany	0.11	0.22	0.10	0.26	0.07	0.15
France	0.19	0.25	0.18	0.32	0.16	0.11
Italy	0.11	0.15	0.09	0.27	0.06	0.09
Spain	0.15	0.21	0.18	0.24	0.07	0.10
Belgium	0.14	0.24	0.14	0.20	0.07	0.12
Portugal	0.21	0.23	0.25	0.21	0.14	0.09
Euro area	0.14	0.21	0.13	0.27	0.09	0.12

Source : Vermeulen *et al.* (2007)

To provide a more reliable comparison we show two comparable sub-baskets of consumer and producer prices: processed food and non-food, non-energy consumer goods. It turns out that the picture is similar: producer prices change more often, with the exception of Portugal as well as non-food, non-energy consumer goods in France.

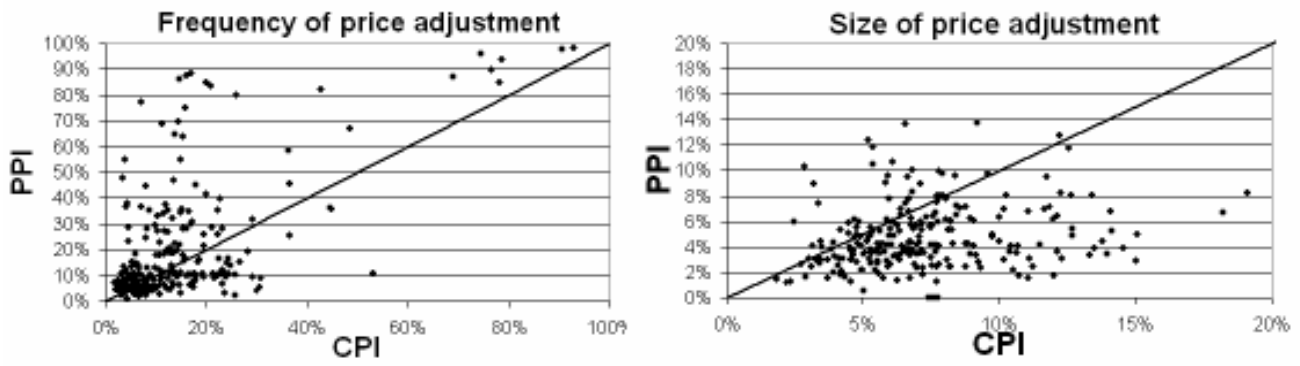
The third way of comparing the frequency of consumer and producer price changes is by comparing pairs of matched producer-consumer products. Unfortunately exact comparisons are not possible. Classifications of CPI and PPI items differ: consumer goods use COICOP classification while producer goods use PRODCOM classification. Correspondence tables between the two classifications do not exist, so the matching had to be done manually.[45] The comparison was done in each participating country. Below we show the results from observations pooled from all six countries. There are 240 pairings, ranging from fewer than 20 in Germany, Italy and Spain to over 80 in Belgium. The left panel of Figure 2.6 shows the relationship between the frequency and size of price changes at the CPI and PPI level; each dot on the graphs corresponds to one pair of prices of corresponding consumer and producer categories. A dot above the diagonal means that the relevant value is larger for PPI than for CPI.

As can be seen from Figure 2.6, for the majority of pairings the frequency of price adjustment is larger, and the size of adjustment is smaller for producer than for consumer prices. This is further supported by performing the nonparametric Wilcoxon signed rank test. The test allows to assess whether number of one series are larger than numbers in another series. The test shows that the frequency of adjustment is higher and size of

[45] For example the CPI 'beers' entry is matched with the PPI 'manufacture of beer' entry and the CPI 'clothing materials' entry with the PPI 'textile weaving' entry.

adjustment lower for producer than for consumer prices and the results are significant at the 1% level. The same results are obtained for individual countries, with the exception of Portugal.

Figure 2.6: The Frequency and Size of Price Changes: PPI versus CPI



Source : Vermeulen *et al.* (2007)

Overall, we can conclude that, despite the fact that products covered by the PPI and CPI indices differ, consumer prices change less often and by larger amounts. It seems that the retail sector adds another source of rigidity.

Why it is the case is not clear. One possible explanation is based on the fact that consumer products have more inputs than producer products. If changes in the additional costs (retail salaries, rents etc) are not synchronized with changes in the producer good costs, the overall costs of consumer products are going to be smoother than the overall costs of producer products. But this reasoning explains only the lower frequency of adjustment of consumer products and cannot explain the greater size of consumer price changes. The additional element needed to explain the second fact may be larger adjustment costs for consumer goods, per unit of product. The relationship between adjustment costs for consumer and producer products is difficult to assess. Zbaracki *et al.* (2004) provide an extensive case study of price adjustment for a manufacturing firm. The firm has three costs of price adjustment: the literal costs of changing price (deciding on the new prices, changing labels etc.), managerial costs (collecting information, deciding on the new price, communicating the price change) and customer costs (advising and negotiating with customers). Customer costs constitute the bulk of the cost (about 74%). As customer costs are absent in the case of consumer products, the costs per price change are larger for producer products. But what matters is not costs per price change, but costs as a percentage of revenue (or profits). Industrial firms sell a relatively small assortment of products in large quantities, and the cost of changing a price is shared among the numerous units sold. On the other hand retail stores sell many goods in low quantities and so the cost of price adjustment is shared among relatively few units and cost per unit is high. Overall it is not clear which factor dominates. We note, though, that costs of

adjustment that are larger for consumer than for producer prices explain both the lower frequency, and larger size, of consumer price changes.

There are several similarities between the behaviour of price changes for consumer and for producer goods. First, in both cases, differences across countries are smaller than differences across groups of products. This is more visible for producer prices, where the average frequencies of price increases and price decreases are really close across countries (excluding Italy). Second, both consumer and producer goods can be divided into groups with respect to the frequency of price changes. For consumer goods price changes are most frequent for energy products, followed by perishable food, durable food, manufactured products and services. For producer goods price changes are most frequent for energy products, followed by food and intermediate goods, and are the lowest for non-durable non-food, durable products and investment goods. These rankings of groups with respect to the frequency of price changes are remarkably consistent across countries. Both facts suggest strongly that the behaviour across countries is similar. This is important because data are not available for many countries, especially in the case of producer goods. Yet it appears that the results from the available data can be extrapolated to other countries.

2.3.7. Factors Affecting the Behaviour of Producer Prices.

As it is the case with consumer prices, the micro nature of the data makes it difficult to analyze the factors affecting the frequency and size of price changes. This is because other data are usually available at a more aggregated level. Available data, however, allowed providing a rich set of empirical results on the factors affecting price adjustment.

The use of input-output tables permits assessment of the effect of cost structure. Firm surveys as well as some additional data allow assessing the effect of competition. Price data enable to study the effect of inflation, pricing points and the tendency for price changes to be more frequent in certain months. As the coverage of the data differs across countries, unlike for consumer prices the analysis was done separately in each national study. Here we summarize briefly these results.

Cost structure. Using input-output tables as well as various additional statistics researchers assessed the effect of cost structure on price adjustment. Theoretically what matters is the variability of costs. Under monopolistic or monopolistically competitive pricing, changes in costs lead to changes in optimal prices. If the benefit of adjustment exceeds the cost, actual prices change. This is in particular the case when firms use simple mark-up pricing rules. Therefore when input costs are relatively stable, price changes are infrequent; while input prices are very volatile, prices change often.

The national studies of producer prices distinguish energy costs, non-energy intermediate inputs and labour costs. The results are as expected. The higher is the share of labour in

production costs in a given industry, the lower is the frequency of price changes. On the other hand, the higher is the share of non-energy intermediate goods, and of energy, in the production costs, the more frequently prices change. The latter effect is stronger for the share of energy costs, which are in general more volatile than non-energy intermediate products.

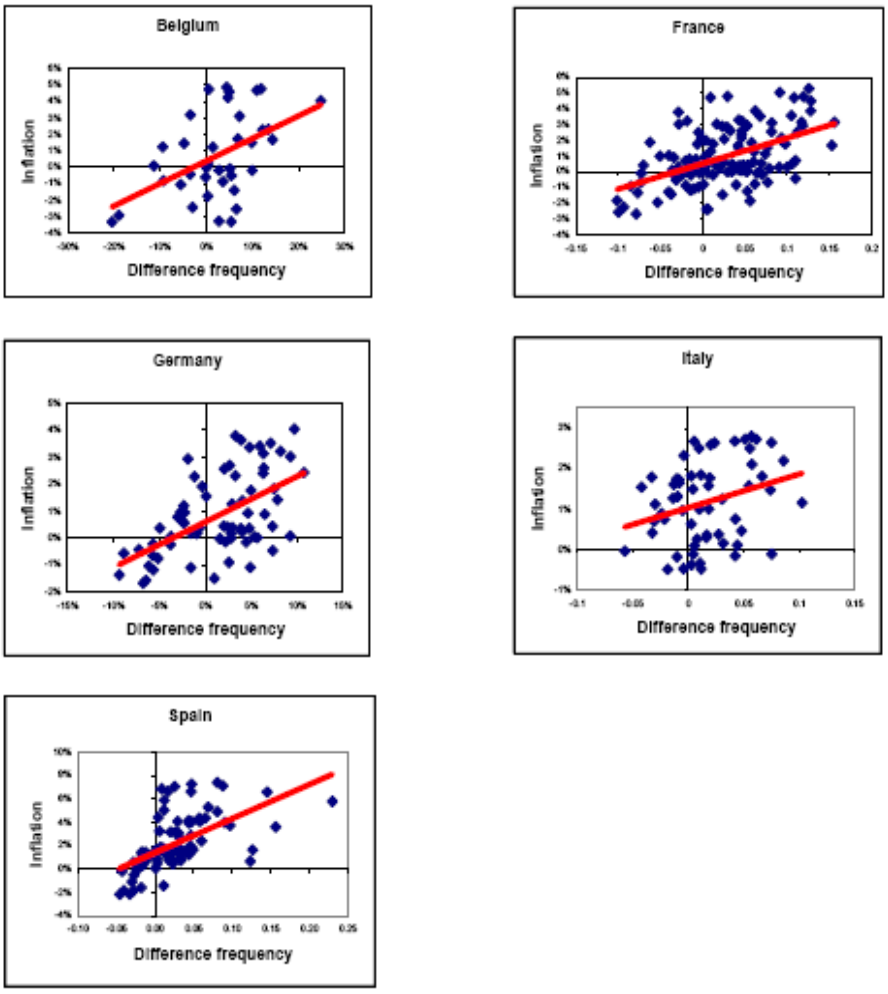
Competition. From the point of view of the project, the role of competition on the frequency of price adjustment is particularly important as it could potentially explain why the frequency of price changes is lower in the Euro-area than in the US. The authors of national studies measure competition usually on the basis of surveys of price behaviour. This is because the usual measures of competition (for example four firm concentration ratio) may be misleading. In many markets the number of firms is small while competition is intense ; in other markets firms may be numerous but have local monopoly power and not compete intensively with each other (for example restaurants). Even though the national studies use different proxies for competition and take different approaches to estimating the effect, the results show that the greater is competition in a given industry, the more flexible are prices.

Inflation. A general conclusion of theoretical models of price adjustment is that the higher is the inflation rate, the more frequent are price changes.[46] The basic idea is straightforward. The firm targets its real price. When the nominal price is kept constant, under inflation the real price departs from it desired nominal value. The larger is the rate of inflation the faster does the real price deteriorate and the more often it will be adjusted. Such *state contingent* policy (so called because the firm makes the adjustment on the basis of the state – in this case the difference between the actual and desired real price) is often contrasted with a *time contingent* policy, in which the timing of adjustment depends on the date only. The data are consistent with the state-contingent view: national studies show that the higher is the rate of inflation, the more frequent are price changes.

Figure 2.7 below shows, for all countries except Portugal, the relationship between the level of aggregate inflation and the difference in the frequency of price increases and price decreases. The relationship is positive, and the correlation varies between 0.34 in Italy and 0.57 in Spain. Gagnon (2006) reports similar findings for Mexico. What this means is that, in reaction to higher inflation, firms are more likely to increase prices and less likely to decrease prices. In other words, inflation changes the composition of price adjustments. We observe fewer price decreases and more price increases. The effect on the number of price increases is stronger and so overall price changes become a bit more frequent.

[46] The original menu cost contribution by Sheshinski and Weiss (1977) is a notable exception. They show that the relationship is in general ambiguous and provide a sufficient condition for the positive relationship between inflation and the frequency of price changes.

Figure 2.7: The Inflation Rate and the Difference
in the Frequency of Price Increases and Price Decreases.



Source : Vermeulen *et al.* (2007)

This finding is novel and important for the purpose of the current project. Before IPN data, the general evidence (and thinking) was that an increase in the rate of inflation led to more frequent price increases, and little was known about price decreases. This suggested that a monetary policy which reduces the rate of inflation would lead to fewer price adjustment and so make prices stickier. It turns out this is not correct. A lower inflation, by increasing the frequency of price cuts, makes prices more flexible downward. Thus concerns of downward nominal rigidity are not justified.

What is the possible explanation of this phenomenon? Own inflation rates differ across sectors. Given the dispersion of sectoral inflation rates and the average aggregate inflation

rate, a proportion of sectors experience negative inflation rates. As the inflation rate falls, a larger proportion of sectors experience falling prices and so the proportion of price decreases rises and the proportion of price increases falls.[47]

Seasonality. Empirical results show that firms have a tendency to concentrate the timing of price changes in particular months, and like to charge specific prices. The first phenomenon is called seasonality, the second attractive prices. In all national studies the highest frequency of price changes is in January. For the Euro area, 32% of all prices are changed in January, compared to the average frequency of 21%. The concentration of price changes in January differs across countries: in Belgium 54% of prices change in January, compared with overall frequency of 24%; in Portugal 29% changes are in January, compared with an overall frequency of 23%. In addition, price changes are a bit less frequent in December and in some summer months. This means that there are time-contingent elements in price setting.

Attractive prices. Firms tend to charge prices that end in a particular digit. For most countries, the predominant ending is a nine; in some, prices are round. There are various theories which try to explain this seemingly irrational behaviour. Basu (1997) and Levy *et al.* (2008) argue that the reason is limited ability of customers to process the last digit of the price. It is therefore ignored by the buyer and so it is advantageous for the seller to charge a nine. There are two reservations to this explanation: in some countries (Italy, Spain) attractive prices are actually round prices, so that the last digit is zero (and sometimes five). Also, the prices are producer prices that are negotiated by professionals; it is not likely they are ignorant of the last digit. The alternative explanation is that, to simplify managerial decisions, firms choose only a subset of all possible prices and bargain over this subset. In other words, it is not worthwhile to bargain about the last digit (Konieczny and Rumler, 2006). This explanation permits the existence of round prices, and holds for prices bargained upon by producers and their (industrial or wholesale) customers.

Empirical analysis shows pricing points matter. Álvarez *et al.* (2005) and Stahl (2006) show that the proportion of prices set at attractive level has a negative effect on the frequency of price changes. Álvarez *et al.* (2005) reports that the frequency of price changes for attractive prices is lower, and the size of adjustment larger than for all prices. This is consistent with a situation in which the firm has a preference for an attractive price and, in some circumstances, delays adjustment until it can set the new price at an attractive level.

[47] There is a positive relationship between inflation and its sectoral variability (for example, Vining and Elwertowski, 1977) but it is weak.

2.3.8. Comparison with US data.

The only data set available that is similar to the PPI price data from Europe is the PPI Research database for the US used by Nakamura and Steinsson (2008). It is a detailed set of US producer prices collected through a survey of firms. The goods are very precisely defined and prices are transactions prices rather than list prices. The methodology and division of goods into groups differ between the US and Euro-area data. This should be kept in mind while comparing the results.

The US data are divided into finished goods, intermediate products and raw materials. The median probability of price change is 10.8% for finished goods, 13.3% for intermediate products and 98.5% for raw materials. It turns out that producer prices in the US are, excluding raw materials, significantly more rigid than in Euro-area countries. On the other hand, as for Euro-area goods, the frequency of price changes is inversely related to the degree of processing.

Unlike in the Euro-area where producer price changes were much smaller than consumer price changes, the size of price changes is similar for consumer and producer goods: the median price change for consumer goods is 8.5% and for finished producer goods it is 7.7%. This holds also for more detailed comparison when goods are divided into several major groups. The frequency of price changes for producer goods is similar to the frequency of price changes for consumer goods excluding sales.

Producer price changes in the US show strong seasonality: price changes in January are more than twice more frequent than the average from the other months. The seasonality is stronger than that in five out of six Euro-area countries; Belgium being an exception.

2.4. Evidence from Survey Data

Surveys provide another source of data used to study the behaviour of prices. Survey data are of different nature from the price data discussed above and their use has important advantages and disadvantages. They allow asking questions that cannot be answered on the basis of price data. On the other hand survey answers may, for many reasons, be unreliable. Therefore surveys cannot replace the analysis of price data. They provide additional, and often very useful, information which improves our understanding nominal rigidities.

The main advantage in using survey data is that a lot of additional information can be obtained by asking judicious questions. Firms can be asked directly questions of interest to researchers, for example about their motives for changing prices. What factors do they take into account when deciding whether to adjust prices? Do they change prices in response to a demand increase, and how fast? Does the decision depend on whether such

an increase is perceived as permanent or temporary? Or do they wait for the resolution of the uncertainty as to how persistent the change in demand is? Is the price change the same for all customers or do they price-discriminate? What does price discrimination depend on? Do their pricing policies depend only on aggregate variables (and which aggregate variables?) or do they depend on what other firms do? The answers to these questions, which are of course very relevant to the understanding of pricing policies, cannot usually be obtained from individual price data since little information is available at the same level of disaggregation.

Survey data, unlike raw price data can provide information on price reviews. There are two parts of the price adjustment process: an evaluation of the current situation (a price review) and the decision to actually change the price. Micro price data cannot distinguish between a situation whereby a firm does not consider a price change and a situation when a price change is considered but rejected. Survey data allow asking what prompts a review, and under what circumstances a review leads to price adjustment.

Information obtained from surveys allows analyzing potential asymmetries in price adjustment. Does a firm react faster to a cost increase than to a cost decreases? Does the reaction to demand changes differ? In general, the analysis of price data cannot answer such questions as information on demand and cost changes is not available. But the understanding of the responses of firms' prices to these asymmetries is important for considerations of the reaction of the economy to aggregate changes.

Asking questions about motives for changing and not changing prices can shed light on the validity of various nominal rigidity theories popular in economics. These theories imply infrequent adjustment of individual prices, but it is difficult, if impossible, to distinguish between them on the basis of price data. Surveys allow asking firms to evaluate the importance of various theories for their pricing strategies directly.

The main disadvantage of surveys is that it is not clear how reliable the answers are. As respondents are not obliged to answer questions, the sample is not representative. In case of ad-hoc, one-time surveys, the person answering the questionnaire may not be familiar with some aspects of the issues being studied or may not have all available information. Questions may be difficult to understand, or misunderstood, as it is often challenging to phrase economic issues in layman terms. One way to avoid this problem is to conduct a repeated survey; this would allow the responder to familiarize themselves with the issues being studied as well as improve the understanding of questions. Furthermore, the validity of answers may then be checked using various econometric techniques. But repeated surveys are expensive and take a long time.

Another source of problems is the fact that it is, in general, difficult to categorize all answer possibilities into a limited number of boxes and so questionnaires may lead to misleading results. This problem is avoided in face-to-face interviews, but those are expensive and so can only be done on a limited number of firms. Survey designers then

have a dilemma: obtain somewhat less reliable answers for a large number of firms, through a mailed questionnaire, or put a limited number of more reliable answers through face-to-face interviews. In addition, the analysis of face-to-face interviews is difficult since the presence of different interviewers may introduce additional heterogeneity into answers.

An early example of using surveys to study pricing behaviour of firms is Hall and Hitch (1939). Modern analysis was pioneered by Blinder (1991) and his co-authors (Blinder *et al.*, 1998) for the United States. Similar surveys were then conducted by Köhler (1996) in Germany, Hall *et al.* (1997, 2000) in the United Kingdom, Apel *et al.* (2005) in Sweden and Amirault *et al.* (2004) in Canada.

Following this line of work the IPN conducted surveys in nine Euro-area countries in 2003 and 2004: Kwapil *et al.* (2005) for Austria (AT), Aucremanne and Druant (2005) for Belgium (BE), Loupias and Ricart (2004) for France (FR), Stahl (2005) for Germany (DE), Fabiani *et al.* (2004) for Italy (IT), Lünnemann and Mathä (2005) for Luxembourg (LU), Hoeberichts and Stokman (2005) for the Netherlands (NL), Martins (2005) for Portugal (PT), and Álvarez and Hernando (2005) for Spain (ES). These countries cover 94% of Euro-area GDP. The studies were conducted by phone, internet or mail; there were few face-to-face interviews. A large number of firms were interviewed in each country (between 333 and 2008). Each central bank conducted the interviews separately, but the questionnaires were similar. In the end, several characteristics of the price-setting process were discovered, and these characteristics were common to all countries. This suggests that the decentralized approach to conducting surveys and analyzing data did not affect the results and that they are robust.

The questionnaires were divided into four main parts. In the first part, firms were asked general questions about the product and market in which they operate. Questions were referred to prices of the firm's main product. Firms were asked what proportion of total turnover they obtain from the sales of the main product and whether the main market for the product was domestic or foreign. A number of questions dealt with the structure of the market. Firms' market share and the number of competitors provided an indication of the competitiveness of the market. Firms were asked whether the relationship with customers was transitory or long-term. Additional questions were asked in some countries. In Austria, France and Italy, firms were asked how their variable costs vary when they change the size of production; this allows to asses their incentives to change price following demand shocks. In Belgium, Luxembourg and Portugal, questions were aimed at providing additional information related to the competitiveness of the firm. Firms were asked whether their competitiveness depended on the price of their product, quality, delivery period, differentiations from competitors, after sales service etc. They were also asked whether they set the price independently of what competitors do.

The second part of the questionnaire asked several questions about how the price is set. Firms were asked whether they have price setting autonomy. They were then asked if they

use mark-up rules or whether prices are determined by the market (or regulated). Another question dealt with price discrimination and whether firms offered their customers quantity discounts. In Italy, Luxembourg and in the Netherlands, firms were asked whether their prices would be different if they did not have competitors in the market. In several countries, firms were asked to assess the price elasticity of demand for their main product.

The third part concentrated on how prices are changed. Questions aimed at determining, separately, the frequency of price reviews and the frequency of price adjustments. Another question investigated whether pricing policies are time or state contingent. Firms were asked whether their price reviews were done on a regular basis (i.e. at predetermined time intervals), in reaction to specific events, such as an increase in production costs or demand, or whether they took place both on a regular basis and in reaction to specific events. Firms were then asked about the information they take into account in price reviews: whether they use simple rules of thumb (for example indexation) or consider a range of information relevant to profit maximization and whether this information is backward or forward looking. Firms were also asked to rank the importance of various theories as reasons to delay a price change when a review indicates it should take place.

The last part of the questionnaire investigated asymmetries in price adjustment. Firms were asked how they react to demand versus cost changes, whether their reaction was different to an increase than to a decrease, and whether the reaction depended on the size of the shock.

Overall, over 11,000 of firms were surveyed. Of those, 62% were in the industrial sector, 13% in trade, 21% in other services and 4% in construction. Sector coverage differed across countries; industry constituted between 20% of firms in Luxembourg and 100% in France and Germany. The largest percentage of firms was in industry in all countries except Luxembourg, where 60% of firms were in services. Table 2.6 shows several characteristics and market structure of surveyed firms.

About half of firms surveyed are small (fewer than 50 employees). Small firms dominate the sample in Belgium and the Netherlands; they are least common in France and in Germany. The samples in the large countries (Germany, Spain, France and especially Italy) included the largest proportion of large firms.

The main product surveyed firms produce is sold mostly in the domestic market. Only 27% of firms report the main market is the foreign market. For those firms, the foreign market is often another Euro area country. The proportion of firms selling mostly abroad varies greatly across countries. Not surprisingly, it is high for the most open Euro-area economies - Belgium and Luxemburg - and low for the large economies - Spain and Germany - but the proportion does not always represent the degree of openness; for example a larger proportion of French than Dutch firms report their main market is the foreign market.

Table 2.6: Firm Characteristics and Market Structure

	BEL	GER	SPA	FRA	ITA	LUX	NED [1]	AUS	POR	Euro Area
1. Number of employees										
1-49	75	29	42	18	-	46	81	53	39	47
50-199	17	35	23	43	39	43	19	28	38	29
>=200	8	36	35	39	61	11	-	19	23	24
2. Main market for the main product [2]										
domestic	55	78	85	64	73	58	72	69	67	73
foreign	45	22	15	36	27	42	28	31	33	27
3. Main customer										
other firms	56	89	58	66	73	-	-	84	84	75
consumers	40	7	39	30	25	-	-	9	13	21
public sector	4	4	3	4	2	-	-	7	3	3
4. Firm-customer relationships [3]										
long-term	78	57	86	54	98	85	-	81	83	70
occasional	22	43	14	46	2	15	-	19	17	30
5. Perceived competition [4]										
very low	18	19	27	19	10	15	5	20	8	17
low	22	23	19	17	25	17	25	18	21	21
high	30	34	24	38	37	37	49	30	39	35
very high	30	24	30	25	29	31	22	32	32	26

Notes: [1]. For the Netherlands, the size classes are 1-49 and ≥50;
[2]. The data are for industry only;
[3]. In case of Belgium, France and Italy, this refers to the relationship with other firms;
[4]. Measured by the importance of competitors' prices when considering cutting its own prices.

Source : Fabiani *et al.* (2005)

Three quarters of firms sell mostly to other firms. Only about one firm in five sells mostly to consumers; the public sector is the main customer for only few firms. The data therefore represent producer prices rather than consumer prices. This is further reflected by the fact that firms report their relationship with customers is predominantly long term (with the potential exception of Germany).

Finally, the answers to the question about perceived competition indicate that, in all countries, firms operate in an environment they perceive as being competitive. The proportion of firms reporting perceived competition as high or very high varies between 54% in Spain and 71% in Portugal and the Netherlands.

The data in Table 2.6 indicate a large degree of heterogeneity across countries with respect to the size of firms and market characteristics. Furthermore, while surveys are fairly uniform across countries, there are some differences both in terms of questions asked and survey procedures. This indicates that comparisons across countries have to be made with care.

2.4.1. State versus Time Dependent Rules.

Surveys allow asking direct questions about the nature of the price-review policy. Under time-dependent rules, price reviews take place at predetermined intervals. The timing of the review does not depend on the state of the economy or on firms' situation. This is a common assumption in macroeconomic models based on price rigidities, as it makes the models easier to solve. In general, time- dependent rules are not optimal as reaction to changes is delayed by the timing of reviews (for example if a shock takes place in November and the review is planned for January). On the other hand, time dependent rules reduce the cost of the pricing policy and may be preferred under multitasking. This is a situation when the pricing manager does not focus exclusively on setting prices. Conducting price reviews on a regular basis permits better planning of manager's activities and may reduce total costs of adjustment. In contrast, under state-dependent rules, the firm observes its current situation continuously and adjusts the price whenever the benefit of adjustment exceeds the cost. For example, under general inflation the real price is continuously eroded; adjustment takes place whenever the real price falls below a predetermined threshold (Sheshinski and Weiss, 1977).

The nature of price review policy is important for macroeconomic consequences of nominal rigidities. The response of the price level is slower under time-dependent than under state- dependent rules. There are two reasons for the slow response of the price level. Individual price adjustments are delayed when a shock occurs at a time when no price review is scheduled. Furthermore, when price changes are staggered over time (as they usually are under time-dependent rules) a firm changing its price takes other firms' prices into consideration. Since other prices are fixed and not equal to the optimal values, the firm will adjust its price only part way towards its own optimal level. Adjustment is then only partial. Under state-dependent rules a large shock leads to synchronization of price changes, speeding up adjustment.

The question in the survey about the timing of price reviews differed somewhat from the theoretical considerations. Firms were asked (a) whether they changed prices at specific time intervals (for example in the Belgian survey), sometimes with examples of intervals provided (for instance every 3 months, once a year, etc.), (b) mainly at predetermined time intervals but also in reaction to specific events, with a substantial increase in costs being the usual example or (c) in reaction to specific events. This means that the standard for declaring a policy state-contingent in the survey was strict: adjustment of the real price that was eroded by inflation may not have been classified by firms as state-dependent.

Despite this strict definition, a majority of firms follow a mixture of time-dependent and state-dependent rules, as can be seen from Table 2.7:

Table 2.7: Price Changing Rules

Price changing rules:	BEL	FRA	GER	SPA	ITA	LUX	NED	AUS	POR	Euro Area
Mainly time-dependent	26	39	26	33	40	18	36	41	35	34
Both time and state dependent	40	55	55	28	46	32	18	32	19	46
Mainly state dependent	34	6	19	39	14	50	46	27	46	20

Source : Fabiani *et al.* (2005)

At the level of the Euro area, almost half of the firms use a mixture of time and state dependent policies, and a fifth uses mainly state-dependent policies. Policies differ across countries. Almost half of firms report using mainly state dependent policies in Luxembourg, the Netherlands and Portugal; such an approach is rare in France, Italy and Germany. Interestingly, following both time and state-dependent policies, which could be expected to be the most popular approach (especially given the way the question was formulated), is the most common answer in only four out of the nine countries (Belgium, France, Germany and Italy); mainly state-dependent policies are the most commonly used in four countries (Spain, Luxembourg, The Netherlands and Portugal) while mainly time-dependent policies are the most popular only in Austria.

Mainly time dependent policies, which potentially lead to largest price rigidity, are used by 30-40% of firms in six out of the nine countries, and by 18%-26% of firms in three (Luxembourg, Belgium and Germany). These numbers are in the same range as those obtained by Blinder *et al.* (1998) for the US (around 40%) and Apel *et al.* (2005) for Sweden (23%); for England, however, Hall *et al.* (2000) report a vast majority of firms (79%) follow time-dependent pricing rules.

The relationship between the type of policies and firm size as well as market characteristics is quite weak. Time-dependent policies are more common for larger firms, but the differences are quite small (less than 5%) and there are several exceptions. Except for Luxembourg, time dependent rules are more common for services than for industrial goods; they are also slightly more common for services than for trade and for trade than for industrial goods. The effects of perceived competition are mixed. In four countries (Belgium, Spain, Austria and Portugal), the higher the degree of perceived competition the less popular are mainly time-dependent rules, but in other countries this does not hold: the relationship is almost reversed for Germany while in the Netherlands the degree of competition has little effect. The effects of competition on the incidence of mixed policies and of mainly state-contingent policies are also mixed.

Overall, this analysis implies that both time- and state-dependent policies are used by firms. About a third uses mainly time-dependent policies while the remaining two thirds use policies with elements of state-dependence.

2.4.2. Information Set Used in Price Reviews.

Economic theory implies that, in setting prices, firms should be forward looking. In other words, pricing policies should depend on current and expected future outcomes, and not on past outcomes. Past economic conditions and prices are relevant only so far as they affect current and expected future conditions but, under rational expectations, they do not play an independent role in the determination of prices. This modern New-Keynesian Phillips Curve (NKPC), however, has problems generating the slow adjustment of the price level that is found in the data. This has led researchers to propose a hybrid version of the NKPC which includes backward looking behaviour or simple rules of thumb that are not optimal under rational expectations. These models seem to generate a behaviour that is closer to the observed price movements.

In six countries, questions were asked about the information being taken into account in price setting. Table 2.8 below summarizes this information.

In Belgium and Spain, a similar proportion of firms uses each of the strategies: rule of thumb (for example indexing to the price level or changing the price by a predetermined percentage), using a wider set of information based on the past and present context, and using a wider set of information based on the present and future context. Firms are more forward looking in Italy, Luxembourg and Portugal than in Belgium and Spain; for Austria (not shown in the table), 51% of firms report using past, present and future information.

Table 2.8: Information Used by Firms in Pricing Decisions

Information basis for pricing decisions	BEL	SPA	ITA	LUX	POR	AUS	Euro area
Rule of thumb	37	33	n.a.	30	25	n.a.	
Past/present context	29	39	32	26	33	37	34
Present/future context	34	28	68	44	42	12	48

Source : Fabiani *et al.* (2005)

Generally speaking, a surprisingly large proportion of firms make decisions in a way economists consider not rational or, more fundamentally, not profit maximizing. A rule of thumb is usually based on past experience. It may have been developed for simplicity, not using the full set of available information, and is typically unresponsive to economic conditions, thus leading to suboptimal adjustment. A pricing decision based on the past and present context does not take into account expectations about the future; these are particularly important as the price is expected to remain constant for an extended period of time. The fact that firms make decisions on the basis of suboptimal rules provides an

explanation while rational macro models, for example the NKPC, have problems generating the level of price rigidity observed in the data.

2.4.3. Frequency of Price Reviews

As already mentioned, the benefit of a survey is that firms can be asked separately about price reviews and price changes. In general price reviews are more frequent. Price data, which provide information on price changes only, underestimate the ability of firms to respond to shocks.

Perhaps more importantly, the comparison of the frequency of price reviews with the frequency of price adjustment can provide important information on the reasons for nominal price rigidities. If the frequencies are similar, i.e. if price changes take place following almost all price reviews, then price rigidity is of intrinsic nature. Because of costs of changing prices, collecting information, etc., price changes are infrequent. On the other hand, if price reviews are much more numerous than price changes, this indicates price rigidity is of extrinsic nature. Because of a stable environment, including stable costs and demand, the firm does not need to change the price even if it is prepared to do so.

The distinction between intrinsic and extrinsic rigidity is of fundamental importance to policy implications of the present project. If prices are intrinsically rigid then policy may be advisable to remove obstacles to price adjustment. If rigidity is extrinsic, price behaviour is optimal in the presence of a stable environment and there is little scope, or need, to undertake policy actions aimed at increasing price flexibility.

The questions in national surveys dealing with the frequency of price reviews differed across countries. Respondents were given a choice of daily, weekly, monthly etc. In Belgium, Luxembourg and Spain they were asked whether price reviews take place once a year, more often or less often and they were asked to specify then the exact number of times. Table 2.9 shows the results, dividing the responses into three categories: at least 12 times a year, at most 3 times per year, and between 4 and 11 times per year.

A majority of firms conducts price reviews no more than 3 times per year. The proportion of such firms for the Euro area is 57%. For six out of 9 countries the proportion is lower; for Belgium, Spain and Portugal it is much higher. Recall that questions asked in Belgium and Spain (as well as in Luxembourg) were different; so it may be the case that the formulation of the question affects results.

Table 2.9: The Frequency of Price Reviews

Frequency of price reviews	BEL	GER	SPA	FRA	ITA	LUX	NED	AUS	POR	Euro area
≥12	4	30	7	31	28	26	37	29	5	26
4-11	8	17	7	22	14	20	19	25	26	17
≤3	88	53	86	47	57	54	44	46	69	57
median	1	3	1	4	1	2	4	4	2	

Source : Fabiani *et al.* (2005)

Table 2.9 illustrates large differences across firms in the frequency of price reviews. At the Euro area level, over half of firms review their prices rarely while a quarter of firms conduct very frequent reviews – at least once a month. On average, reviews in Belgium, Spain and Portugal are less frequent than in other countries. The data allows determining the median number of reviews. In Belgium, Spain and Italy the median is once a year. At the other end of the spectrum, the median number of reviews is four (i.e. quarterly) in France, the Netherlands and in Austria; in Germany, Luxembourg and Portugal the median number of reviews is two or three.

The frequency of price reviews depends on firm size and market characteristics. The distribution of price reviews can be compared across characteristics using the Chi-square test. In Spain, Luxembourg, the Netherlands and Austria, price changes are more frequent in large firms (the reverse result is obtained for France). This is similar to the results in Amirault *et al.* (2004) for Canada. The effect is intuitive. Large firms sell more units; hence overall benefit from adjusting prices to the optimal value (which is presumably constant per unit) is larger. As long as there are returns to scale in price setting, for large firms, the trade-off between benefit and cost of adjustment is more favourable. As argued by Zbaracki *et al.* (2004), the major part of the cost of adjustment in industrial firms involves decision costs and communication costs; these costs exhibit increasing returns to scale.

Market competition is positively related to the frequency of price reviews. Firms that indicate competitors' prices matter, hold price reviews more often than other firms.[48] It is important to note that both phenomena are strongly logically related. If a firm's optimal price depends on what other firms do, then it needs to check prices of other firms frequently; hence the positive association.

There are also significant differences in the frequency of reviews across sectors. Firms in the service sector tend to have less frequent reviews; also, in several countries reviews in the trade sector are more frequent than in industrial firms.

[48] Except for Austria and Belgium where there is no effect of competitiveness on the frequency of reviews.

Overall, the analysis of survey data indicates that the number of price reviews is between 1 and 4 times per year. Reviews tend to be more frequent for large firms and for firms facing stronger competitive pressures.

2.4.4. Price-Setting Policies

Several survey questions dealt with firm price-setting policies. Firms were usually asked whether they conduct their own independent pricing policy, or whether their prices are regulated or set by the head office. Firms that described their pricing policy as independent were then asked whether their price is set as a mark-up over marginal costs, depends on their competitors' prices or is set in another way. Generally speaking, mark-up pricing is adopted by firms that have market power, while in competitive markets prices are set at the common market-clearing level. In the Euro area over half of firms used mark-up pricing; this is similar to findings in the US and in the UK. The proportion varied between 73% in Germany and 40% in France. In three countries (Belgium, Germany and the Netherlands) firms were asked whether the mark-up is constant or variable; a majority of firms in each country use variable mark-ups, especially in Germany where constant mark-ups are uncommon. About 30% of firms set prices on the basis of their competitors' prices. Not surprisingly, there is a negative correlation between the share of firms using mark-up pricing and competition. In every country, the percentage of firms following a mark-up rule was lower for firms that operated in markets with very low and low perceived competition than for firms operating in markets with high or very high competition. As can be expected, in competitive markets, firms' power to set prices (by setting a mark-up) is limited.

Several surveys asked questions about price discrimination – a procedure of charging different prices to different customers. Between 65% of firms (Spain) and 92% (Germany) use price discrimination. Out of the firms that price discriminate, about half do it on the basis of quantity sold, as opposed to a case by case approach. The Belgian, Spanish and Luxembourg surveys asked whether the price is the same in export markets. About half of firms charge different prices depending on the country the good is sold. The differences are mostly due to market conditions, competitors' prices and transportation costs.

2.4.5. Frequency of Price Changes

In every country except for Germany, firms were asked how frequently they change prices for their main product. Table 2.10 shows the results:

About 40% of firms report changing prices once a year. Except for Germany (where data are not comparable) and Luxembourg, around 70% of firms change prices no more than once a year (of course one has to take into account the possibility that a firm changing prices once every 3 quarters reports one change a year rather than 2-3 changes). Price

changes are quite infrequent. The median frequency of price changes is once a year in all countries except for Luxembourg.

Table 2.10: The Frequency of Price Changes

Frequency of price changes	BEL	GER	SPA	FRA	ITA	LUX	NED	AUS	POR	Euro area
≥4	8	21	14	9	11	27	11	11	12	14
2-3	18	21	15	24	19	27	19	15	14	20
1	55	14	57	46	50	31	60	51	51	39
<1	18	44	14	21	20	15	10	24	24	27
median	1	1	1	1	1	2	1	1	1	

Source : Fabiani *et al.* (2005)

It is difficult to compare these numbers to those obtained directly from CPI and PPI data. Recall that, for the Euro area, the frequency of price changes was 15% per year in CPI data and 21% per year in PPI data. Most firms in the sample are industrial firms (selling to other firms); frequency reported in surveys appears lower than the frequency for producer prices. But there are large sectoral differences in the frequency of price changes for PPI data; in particular, for non-food products and capital goods the frequency is 10%. More precise information on surveyed firms is not available, making it impossible to draw definite conclusions on the comparison of survey and price data.

Comparison of the frequency of price changes across types of goods reveals a common pattern in all countries. Price changes are most frequent in the trade sector, where 55% of firms change prices no more than once a year, followed by the goods sector (67%) and are the least frequent in the service sector, where 84% of prices are changed no more often than once a year. This pattern is consistent with results from CPI and PPI data which show that service prices are changed least often.

Competition has a positive effect on the frequency of price changes. Except for Austria and Portugal, firms that face strong competition in their markets change prices more often than those in less competitive markets. The positive relationship between competition and the frequency of price changes is consistent with the partial results obtained from CPI and PPI data sets.

It is clear from the data that price changes are less frequent than price reviews. Tables 2.9 and 2.10 allow the comparison of the proportion of firms that change prices no more than three times a year. Except for Belgium and Spain, this proportion is much higher for price changes. Furthermore, in several countries the median number of price reviews is larger than the median number of price changes.

This is an important finding for the purpose of the current study. The fact that a firm undertakes a price review but decides not to change its price may often mean that the firm operates in a stable environment and the cause of infrequent price adjustment is extrinsic rigidity. This has important policy implications. If the main reason for prices not to adjust is the stability of the economic environment, the case for policy aimed at making prices more flexible is weakened. But of course there may be other reasons than a stable environment to keep prices constant. These alternative reasons will now be discussed.

2.4.6. Firms' Reasons for Keeping Prices Constant

The modern survey literature started with the path breaking study by Blinder (1991). The goal of that study was to check which of the numerous economic theories of price rigidity matter for firms. Blinder's questions are incorporated in virtually all surveys, including the IPN surveys. Before discussing results, we summarize the theories considered in surveys.

Explicit contracts. Firms do not change prices as they have a contractual arrangement to deliver the product at a constant price for an extended period of time. This is quite common in the case of wages; most wages and salaries are constant for extended periods. Such arrangements allow to build long-term customer relationships for the seller, and provide both sides with a stable environment. In effect, both sides provide insurance: the seller, against costs variations, and the buyer, against demand variations.

Implicit contracts. Firms may keep prices constant in order to build a long-term customer relationship even in the absence of explicit agreements. This is often the case for consumer products. A firm builds a reputation for not taking advantage of temporary demand shifts (not raising the price of snow shovels when a snowstorm approaches). This is one example of a view that frequent price changes upset customers.

Prices based on costs. If firms have a policy of constant mark-ups, they will not change prices as long as costs do not change. Cost stability then gets transformed into prices that appear rigid.

Coordination failures. In markets which are not perfectly competitive, one firms' optimal price depends on what other firms are charging. Following a shock, the desire to change the price depends on what other firms are doing. A nominal price increase does not change the firm's real price when other firms increase prices by the same amount. But if other firms keep their prices constant, an increase in the nominal price is equivalent to an increase in the real price and may lead to a loss of customers and a big drop in market share. On the other hand, a decrease in the price that is not matched by other firms may not raise market share much as only the firms' customers know the price has been cut. Hence if a firm thinks other firms will keep their prices constant, it will not change its own price.

Costs of price adjustment and costly information. The most popular, among economists, reason why firms keep prices constant is that changing prices is costly. The costs, often called menu costs, include the physical costs of changing labels etc, as well as costs of informing salesmen and customers and, for industrial products, negotiating with customers. Similarly, there are costs to the firm of getting informed about current economic conditions and shocks.

Temporary shocks. If the firm perceives a shock as temporary, a price change in response to it will have to be followed by a price reversal when the shock passes. As the firm perceives customers do not like frequent price changes, it may refrain from changing the price for a short period and instead will keep it constant until the shock effects disappear.

Adjusting non-price factors. Rather than changing the price, a firm may adjust delivery lags, quality, after sale service etc. It may resort to these adjustments if it does not want to change prices.

Price as signal of quality. In some theories, customers infer good quality from its price. This may make firms unwilling to reduce prices. Consider a firm that is facing declining demand. If it lowers the price, hoping to maintain market share, customers may perceive the change as a signal of lowered quality and refrain from buying the firms' products.

Pricing points. There is plenty of evidence that firms have a preference for setting some value of prices over others: attractive prices (i.e. 9.99 instead of 10.02) or round prices (10.00 instead of 10.02). There are various explanations of such behaviour; they mostly apply to goods sold to customers.[49] Firms which prefer such prices refrain from small price changes (from, say, 9.99 to 10.06) but rather wait until a switch to another pricing point will be justified.

Following Blinder (1991) and others, IPN researchers asked firms to evaluate the importance of these explanations of price stickiness by choosing an assessment from four possibilities: unimportant, of minor importance, important and very important; these answers were scored by attaching values one through four, with one being unimportant. The average scores are given in Table 2.11.

On the basis of the numbers for the Euro area (which are unweighted averages of country scores), the responses may be divided roughly into two groups. The first group, which contains theories firms find important, consists of the top four categories: implicit and

[49] A popular argument says that people have limited capability to remember numbers and to reduce information processing costs ignore the last digit. This is presumably not the case for industrial transactions that are larger and where professionals deal with prices. Pricing managers can be expected to pay attention to every digit, especially if the volume of transaction is large.

explicit contracts, cost-based pricing and coordination failure. The second group consists of the remaining theories, where the scores are lower. In the first group, the average score in the Euro area is significantly higher than 2. This division applies in individual countries, despite some differences in responses across countries. In each country the scores in the top group are higher than in the second group, with few exceptions (two theories for the Netherlands and one theory for Luxembourg). Using the same logic, the second group may be divided into the theories with an average score around 2 (judging quality by price and temporary shocks) and the remaining four theories, considered by firms to be the least important. The results summarized in Table 2.11 are remarkably similar across countries. This is important as surveys differed quite a bit across countries, both in terms of the formulation of questions as well as in the order theories were placed.

Table 2.11: Assessment of the Relevance of Sticky Price Theories by Firms.

	BEL	**GER**	**SPA**	**FRA**	**ITA**	**LUX**	**NED**	**AUS**	**POR**	**Euro area**	**US**	**SWE**	**UK**	**CAN**
Implicit contracts	2.5		2.6	2.2		2.7	2.7	3.0	3.1	**2.7**	4	1	5	2/7
Explicit contracts	2.4	2.4	2.3	2.7	2.6	2.8	2.5	3.0	2.6	**2.6**	5	3	1	3
Cost-based pricing	2.4			2.5		2.7		2.6	2.7	**2.6**	2	2	2	1
Coordination failure	2.2	2.2	2.4	3.0	2.6	2.1	2.2	2.3	2.8	**2.4**	1	4	3	5/8
Judging quality by price	1.9		1.8			2.2	2.4	1.9	2.3	**2.1**	12		10	
Temporary shocks	1.8	1.9	1.8	2.1	2.0	1.7	2.4	1.5	2.5	**2.0**				
Change in non-price factors	1.7		1.3			1.9	1.9	1.7		**1.7**	3		8	4
Menu costs	1.5	1.4	1.4	1.4	1.6	1.8	1.7	1.5	1.9	**1.6**	6	11	11	10
Costly information	1.6		1.3			1.8		1.6	1.7	**1.6**		13		10
Pricing thresholds	1.7		1.5	1.6	1.4	1.8	1.8	1.3	1.8	**1.6**	8	7	4	

Source : Fabiani *et al.* (2005)

There are few differences across sectors. For goods and services, the rankings are very similar. For trade, explicit contracts are less important while pricing thresholds are more important than for goods and services.

The results are similar to those obtained in other countries: US, Sweden, UK and Canada.[50] The table provides ranks, in the order of importance, for the theories; the lower the number, the more important is the theory. In general, theories which are most important for European firms are also most important for firms in other countries, with few exceptions (changing no-price factors is important in the US and in Canada while pricing thresholds are important in UK).

The results of the surveys differ quite a bit from theoretical approaches to modelling price rigidity. In formal modelling of price rigidities, the most popular approaches are menu

[50] In the Canadian survey two questions addressed the importance of implicit contracts and of coordination failures; hence two numbers are provided.

costs and, recently, information costs. Macroeconomists also stress that adjustment may be skipped for changes perceived as temporary, and that rigidity of nominal prices does not mean effective rigidity since the conditions of the contract can be adjusted to a shock by changing non-price elements of the buyer-seller relationship. These theories are, however, not considered very important by reporting firms.

There are three basic reasons for the difference between the theoretical literature and survey results. In the theoretical literature, the ability to solve, or at least to calibrate the model, is of paramount importance. Authors use the menu cost assumption or, simpler still, the Calvo assumption of time-contingent adjustment because such models can be solved. On the other hand, models with repeated shocks and repeated co-ordination failures are complex. The same is true in case of implicit contracts. Rotemberg (2005) has recently proposed a theory of fair pricing, but such a model is very hard to incorporate into a dynamic macroeconomic framework.

The second reason for the difference is that the theoretical literature concentrates on retail pricing while the survey results apply mostly to wholesale relationships or producer prices. Such relationships are often long term (70% of all firms in the Euro area, see Table 2.6) and firm-to-firm relationships are very important. Not surprisingly, firms sign explicit long-term contracts specifying the (constant) price per unit, with perhaps some escape clauses in case of extraordinary events and prices stay fixed for an extended period of time. Long term relationships also give rise to implicit contracts; these establish the reputation of the supplier as a solid firm that does not take advantage of temporary demand shifts.

Finally, one may speculate that there are limits to the quality of information obtained from surveys. As mentioned at the beginning of this section, the person filling out the information may not be the best informed employee in the firm. Some questions may be misunderstood; this is in particular the case when specific concepts used by economists (but not necessarily by firm managers) are investigated. As an example, consider pricing points. Survey responses rank them last in terms of importance for not adjusting prices. Yet, empirical evidence (Baumgartner et al, 2005, Konieczny and Rumler, 2006) shows that the probability of a price change is lower when the previous price is equal to a pricing point than when it is not. Clearly, pricing points matter in the data but are considered unimportant by firms.[51]

The difference between survey results and the typical theories of price rigidity are essential for the purpose of this project. While theory is important, the direct answers provided by firms add important information that, in our view, should not be neglected. A policy aimed at making prices more flexible should address issues firms themselves specify as obstacles to price adjustment. Hence, recommendations of this project aiming to

[51] One reason for the difference may be that the evidence cited is from the CPI prices, while surveys deal mostly with producer prices.

increase the flexibility of prices in Euro-area countries should take into account the perceived importance of contracts and coordination failures, as well as the fact that cost-based pricing suggests infrequent adjustment is due to the stability of the economic environment.

2.4.7. Asymmetries in Price Adjustment

The last part of the surveys dealt with questions about differences in the reaction of firms to various shocks. Such questions are difficult to investigate using other approaches as data on the nature of shocks in individual markets do not exist. The picture provided by survey results is clear-cut: there are important asymmetries in the response to demand and cost shocks in terms of both direction and speed of price changes. Firms are more likely to increase prices when costs rise than when demand or competitors' prices increase; they are less likely to lower prices when costs fall than when demand or competitors' prices fall.

Firms were asked about factors influencing their decisions to increase prices and, separately, to decrease prices. The factors included labour, raw material and financial costs, demand shocks and prices charged by competitors. Firms ranked each factor on a scale from one (completely unimportant) to four (very important). The average responses are shown in Table 2.12, separately for price increases and for price decreases. In addition, the bottom part of Table 2.12 shows the difference between the reported importance for price increases and for price decreases.

For price increases, firms attach the highest weight to labour and raw material costs. This is true for the Euro area as a whole and for each country. In every country, labour and raw material costs are the top-ranked reasons for price increases. For most countries, changes in material costs are more important than changes in labour costs; the only exceptions are Austria, where labour costs matter more and Belgium, where both factors are of the same importance. Furthermore, these two factors are much more important than the remaining three: financial costs, demand and prices charged by competitors.

The essential distinction between these factors is as follows. Keeping prices constant when raw materials and labour costs increase lowers profits. On the other hand, when demand or competitors' prices rise, the firm's profits increase when it keeps its prices constant. By adjusting its prices, the firm may realize even higher profits, but not adjusting does not have a negative effect on the bottom line.

Table 2.12: Importance Of Demand And Cost Factors For Price Increases And Decreases.

	BEL	GER	SPA	FRA	ITA	LUX	NED	AUS	POR	Euro area
	Importance for price increases									
Labour costs	2.9	2.7	2.7	2.5	2.9	3.5	2.7	3.4	3.3	3.0
Raw material costs	2.9	3.4	3.1	3.0	3.3	-	2.5	3.1	3.6	3.1
Financial costs	2.2	1.9	1.8	-	2.3	3.0	2.1	1.9	2.5	2.2
Demand	2.2	2.2	2.4	2.0	2.4	2.3	2.3	1.9	2.5	2.2
Competitors' price	2.5	2.1	2.5	2.3	2.6	2.4	2.5	2.0	2.7	2.4
	Importance for price decreases									
Labour costs	2.1	1.9	2.0	1.9	2.4	2.6	2.1	1.3	3.0	2.1
Raw material costs	2.3	2.8	2.6	2.6	2.9	-	2.0	2.2	3.3	2.6
Financial costs	1.8	1.6	1.5	-	2.1	2.5	1.8	1.6	2.3	1.9
Demand	2.5	2.4	2.4	2.3	2.8	2.7	2.5	2.0	3.0	2.5
Competitors' price	2.9	2.6	2.7	2.8	2.8	2.8	2.7	2.6	2.9	2.8
	Importance for price increases minus importance for price decreases									
Labour costs	0.8	0.8	0.7	0.6	0.5	0.9	0.6	2.1	0.3	0.9
Raw material costs	0.6	0.6	0.5	0.4	0.4	-	0.5	0.9	0.3	0.5
Financial costs	0.4	0.3	0.3	-	0.2	0.5	0.3	0.3	0.2	0.3
Demand	-0.3	-0.2	0.0	-0.3	-0.4	-0.4	-0.2	-0.1	-0.5	-0.3
Competitors' price	-0.4	-0.5	-0.2	-0.5	-0.2	-0.4	-0.2	-0.6	-0.2	-0.4

Source : Fabiani *et al.* (2005)

The picture for price decreases is quite different. The factors that matter most are competitors' prices, changes in demand and raw material costs. The remaining two factors: financial and labour costs less important. Hence, apart from changes in raw-material prices, which are important for both, factors leading to price increases are different from factors leading to price decreases.

To disentangle the effect of the five factors on price increases and decreases, the bottom part of Table 2.12 shows the difference between the reported importance for price increases and for price decreases. The picture is clear-cut. Raw material, labour and financial costs are more important for price increases. In every country, the ranking of raw material costs for price increases is higher than the ranking for price decreases; for example for Belgium the rankings are 2.9 for price increases and 2.3 for price decreases. Changes in demand and competitors' prices are more important for price decreases (as shown by the negative numbers in the bottom part of the table).

This picture suggests that decisions whether to raise or lower prices depend on the effects of exogenous changes on profits. Firms are more likely to change prices if not doing so leads to a drop in profits. When costs rise, firms increase prices to protect profits; while firms are less eager to lower prices when costs fall. An increase in demand or in competitors' prices raises profits of a firm that keeps its prices constant and so firms are less likely to raise prices. On the other hand, a reduction in demand or a reduction in prices charged by competitors endangers profits and prompts firms to lower prices.

As discussed before, survey results show that the greater is the degree of competition in the market, the more frequent are price changes. This is also the case for the response to shocks. Firms reporting a high degree of competition are more likely to respond to a change in the underlying factors, especially to a change in demand, than firms reporting a low degree of competition. The only exception is labour costs, where the response does not depend on perceived competition.

In five countries (Spain, France, Austria, Luxembourg and Portugal), firms were asked how fast they changed prices in response to a shock. Answers provide weak evidence that the response is a bit faster when demand falls than when costs fall and when costs increase than when costs fall, as in Peltzman (2000). There is little difference in the speed of reaction to demand versus cost increases and to demand increase versus demand decreases.

2.5. Recent Evidence about Wage Rigidity in the Euro Area.

Research about wage rigidities has put a lot of emphasis on individuals' wage dynamics, highlighting both nominal and real rigidities. However, what is important for the macroeconomic adjustment after a shock is the link between wages and firms' pricing decisions and ultimately inflation. The flexibility of labour costs is an important element in the pricing decision of firms. Adjustment of labour costs could occur either through the adjustment of wages or through the adjustment of employment. Therefore, it is not sufficient for assessing the adjustment capability of the labour market to look only at wages rather than also taking into account employment.

Considering wage rigidity first, it is a well established fact that nominal base wages of individual workers are very rarely cut. A survey conducted among 17,000 European firms by the WDN (Wage Dynamic Network) delivers new evidence on nominal and real downward wage rigidities (hereafter DNWR and DRWR) as well as on alternative ways of adjusting the wage bill at the firm level (see Babecky *et al.,* 2008). Overall, 14.2% of all surveyed firms in 15 EU countries display DRWR and 10.4% display DNWR (see Table 2.13), which for both is only a small fraction of all firms. A firm is classified as displaying DNWR if the respondent states that base wages have never been cut in the last 5 years and

as displaying DRWR if they ever linked base wages to inflation in the last 5 year. DNWR appears to be strongest in the Czech Republic, Estonia and the Netherlands and considerably smaller in Spain, France, Italy and Slovenia, while DRWR is especially prevalent in Spain and Slovenia and less so in Italy, Estonia and Poland.[52] The breakdown by sector and firm size shows that DNWR is more prevalent in large firms and in the business service sector, while DRWR is more common for smaller firms and for firms in construction and trade. Moreover, DRWR is found to be stronger for firms covered by a collective wage bargaining agreement (as opposed to bargaining at the firm level) and for firms with a less qualified workforce (more blue-collar workers).

Table 2.13: Downward Nominal and Real Wage Rigidity across Country
(Proportion of Firms by Country)

	Downward nominal wage rigidity	**Downward real wage rigidity**
Austria	0.089	0.119
Belgium	0.058	NA
Czech Republic	0.259	0.113
Estonia	0.211	0.047
Spain	0.021	0.544
France	0.026	0.096
Greece	0.115	0.199
Hungary	0.064	0.117
Ireland	0.079	0.087
Italy	0.038	0.017
Netherlands	0.211	NA
Poland	0.096	0.067
Portugal	0.151	0.083
Slovenia	0.033	0.215
Total	0.142	0.104

Notes: The numbers for downward nominal wage rigidity refer to the proportion of firms which declare that they never cut their base wages during the last 5 years and the numbers for downward real wage rigidity refer to the proportion of firms which linked base wages to inflation at least once in the last 5 years

Source : Babecky *et al.* (2008)

The surveys also include questions on non-wage labour costs which play a role at least as important as base wages for the flexibility of total labour costs at the firm level. These include: bonus payments, fringe benefits, promotions, lower wage for new hires and early retirements. Analyzing the responses of firms on their preferred strategies of non-wage labour cost adjustment, cheap hires to replace workers who leave the firm and the adjustment of bonus payments are found to be the preferred strategies to adjust the wage

[52] No question about DRWR was asked in the Belgian survey, as the institutional setting implies a compulsory link between base wages and inflation.

bill. The choice of alternative ways of adjustment is found to be influenced by the firm characteristics, where firms operating in more competitive environments or in sectors with firm-level bargaining use the non-wage margins of adjustment more intensively. Furthermore, firms whose wages are subject to DNWR are more likely to use any of these strategies to reduce non-wage labour costs, suggesting that adjustment of non-wage labour costs could be a strategy to compensate DNWR and that overall labour costs are actually not as rigid as evidence on individual base wages might suggest.

The fact that the survey also includes questions on the price setting of firms allows an additional analysis of the link between wage and price setting at the firm level, an issue which is particularly relevant for this project. According to Druant *et al.* (2008), 40% of firms confirm the existence of a link between wage and price changes. A strong seasonal pattern in, both, price and wage adjustments is found in the data as changes appear to be highly synchronized, predominantly occurring in January. An econometric investigation of this link presented in this paper shows that firms with a comparatively lower labour share in total costs and firms that display a high frequency of wage adjustments tend to change their prices more frequently than others. This implies that, indeed, the share of wage costs in total production costs and the frequency of wage changes (although lower on average than the frequency of price changes) are important determinants - among other factors - of price adjustment and ultimately inflation. The paper also shows that the link between wage and price changes itself varies across firms and is stronger for firms for which the share of labour costs is high, competition in products markets is weak, there is no collective wage bargaining and if the technology of the firms is less advanced.

Another paper within the WDN which uses survey results for its empirical analysis deals with the reaction of firms to macroeconomic shocks. Bertola *et al.* (2008) find that the way firms react to cost-push and demand shocks, i.e. if they either adjust their wages or their employment, depends on the institutional characteristics and other conditions under which the firms operate. Specifically, in the case of a demand shock, firms are more likely to adjust their employment than their wages when they are exposed to foreign competition and when their wages are subject to a collective wage agreement, while they are more likely to adjust their wages in response to a demand shock when the degree of employment protection on the labour market is high. In the case of a cost-push shock, we see a stronger reaction of employment for firms with a higher labour share in total costs as well as for firms that are exposed to stronger competition on their operating market, while the adjustment through wages is more likely if, again, the degree of employment protection is high. Overall, the results reveal that wage and employment adjustments depend on the product market structure, international conditions and the existing labour market institutions, but strong heterogeneity is observed across countries. All these findings are consistent with existing theories on the transmission of macroeconomic shocks to the labour market.

The paper by Knell and Stiglbauer (2008) analyzes the influence of reference norms in wage setting to explain why and to what extent prices adjust sluggishly. The authors show

in a simple dynamic model of staggered wage setting that reference norms can be responsible for inflation persistence beyond the fact that prices are assumed to be sticky. They then test empirically which form of reference norm (external reference norms, sectoral leadership, habits and aggregate reference norms) explains best the degree of observed inflation persistence in Austrian data. The results suggest that the sectoral leadership norm, where wages are set according to wage changes in a "leading" sector, is most consistent with the data, followed by the external reference norm, where wage changes are set according to the average wage increase since the last wage change by the particular wage-setting unit.

The effect of DNWR and DRWR on optimal monetary policy in a monetary union is analyzed in the framework of a sticky price DSGE model in Fahr and Smets (2008). The presence of downward wage rigidity implies a strictly positive optimal rate of inflation and requires a more responsive monetary policy in response to an inflationary (negative productivity) shock, but a weaker reaction in response to a deflationary shock. Because price adjustment in this model inherits some of the upward bias of wage adjustment, optimal monetary policy has to react asymmetrically to positive and negate shocks as compared to the reference case without downward wage rigidity.

On the whole, these results tend to suggest that at the firm level, the link between prices and wages is not necessarily as strong as it appears to be at the macroeconomic level. This does not necessarily come as a surprise when we consider the - for many products low - share of labour costs in total production costs. Moreover, when they are facing a negative shock, firms tend to use a variety of channels to adjust their wage bill: given that downward (nominal and real) wage rigidity seems to be a stylized fact in most countries, employment and non-wage labour costs adjustment appear to be quite often used as a way to reduce total labour costs.

2.6. Conclusions.

This survey looked at the evidence on infrequent price changes at the level of individual firms. We reviewed evidence from consumer data, producer data and firm surveys. The picture showed by the data is quite consistent. Prices of most goods and services change infrequently. In Europe, consumer prices are changed about once a year. In the US price changes are more frequent, but it appears that frequent sales are responsible for much of the difference between price flexibility in Europe and in the US. Producer prices in Europe change more often than consumer prices; on the other hand, in the US the frequencies of adjustment of producer and consumer prices are similar. The behaviour of prices differs across countries and sectors in the economy, but differences across countries appear smaller. The differences in the frequency of adjustment across sectors are remarkably similar in all countries. For consumer goods, prices of energy are the most flexible, followed by prices of perishable foods, durable foods, manufactured products and services. For producer goods, prices of energy and food are the most flexible, and prices

of non-food products and investment goods are the stickiest. These sectoral differences hold essentially in every country. Overall, it appears that the differences across countries are of secondary importance.

Several empirical facts are of particular importance for the purpose of this report. Price changes are more frequent in competitive markets and in large stores. Price regulation increases price rigidity. As prices often decrease, this suggests that downward price stickiness might not be a problem in a low inflation environment. Price reviews are significantly more frequent than price changes, indicating at least that part of price rigidities is due to stable environment, rather than particular obstacles to price changing. Firms react to unusual events by raising the frequency of price adjustment.

These observations suggest that the focus of policy should be on the promotion of competition and reducing price regulation. Such changes would promote price flexibility and speed up adjustment of prices to shocks.

Wage Dynamics Network, recently set up by the European Central Bank and National Central Banks has conducted an extensive survey of wage determination in European firms. It distinguishes between downward nominal wage rigidity, when base nominal wages are never (in the previous 5 years) cut and downward real wage rigidity, when base wages are linked to inflation. Nominal rigidities are present in 14% of firms in the 15 European countries covered by the survey while real rigidities are present in 10%. Firms that face nominal rigidities tend to be more likely to use non-wage strategies to reduce labour costs indicating that nominal rigidities are a constraint on firms' ability to adjust to shocks.

In general wages are more rigid than prices: 75% of firms change wages once a year or less frequently (for prices the corresponding number is 50%). The relationship between price and wage changes is weaker in sectors with lower labour share in total costs, sectors with more competitive pressures, in firms with firm-level collective agreements, large firms and those with more flexible technology.

III. ASSESSING PRICE RIGIDITY: THREE INDICATORS

Using quantitative micro consumer prices for Belgium and for France and considering the theoretical framework derived in Dixit (1991), Dhyne *et al.* (2008) directly estimate the relative importance of intrinsic and extrinsic price rigidities for Belgium and France, using a state dependent model similar to Equation (2) below. We cannot use their approach here as, first, they require micro CPI data for (all) euro area countries which are not available and, second, their estimation method requires extremely lengthy computations and so is impractical. To obtain results for a wide sample of countries, in this section we develop three indicators of price rigidity. They differ in terms of the underlying assumptions as well as, due to data limitations, in terms of sector and country coverage. The results obtained with the use of these indicators are then compared, in section IV, with the results of Dhyne *et al.* (2008) The three indicators are presented and discussed below.

3.1. First Indicator: Comparing the Frequency and Magnitude of Changes for Prices and Costs.

Consider a situation when prices are fully flexible. Then they fully and immediately adjust to changes in the optimal frictionless price. This means that both the frequency and the size of changes in the actual price are the same as the frequency and the size of changes in the optimal price. Thus:

$$freq(\Delta p) = freq(\Delta p^*) \text{ and } \left|\Delta p\right| = \left|\Delta p^*\right| \quad (1)$$

Where p denotes the price, p^* denotes the (unobserved) optimal frictionless price and $\Delta\underline{x}$ is the first difference $x_t - x_{t\text{-}1}$.

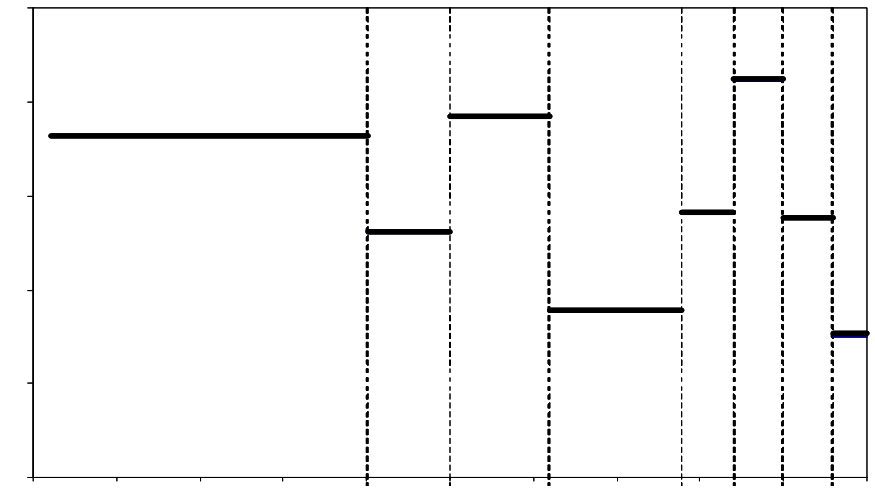
However, the number of markets where prices are fully flexible is quite limited. In most markets, price adjustment is costly. From the discussion above, it follows that a natural way to measure price rigidity is to compare the frequency and magnitude of price changes with those of the underlying costs and/or mark-ups as measured by p^*.

The literature about adjustment costs focuses on two polar cases: fixed costs and quadratic costs. In the former case, prices (p) change less often than the optimal (frictionless) price p^*. The standard representation of this behaviour is the (S,s) model where the price of a specific product i is changed to its optimal value when its price in period t-1, $p_{i,t\text{-}1}$, deviates from the optimal (frictionless) price level, p^*_{it}, by an amount larger than an inaction band s_{it}. The inaction band depends in particular on the costs incurred by adjusting prices, on those induced by *not* adjusting prices but also on the "usual" magnitude of shocks (e.g. see Dixit, 1991):

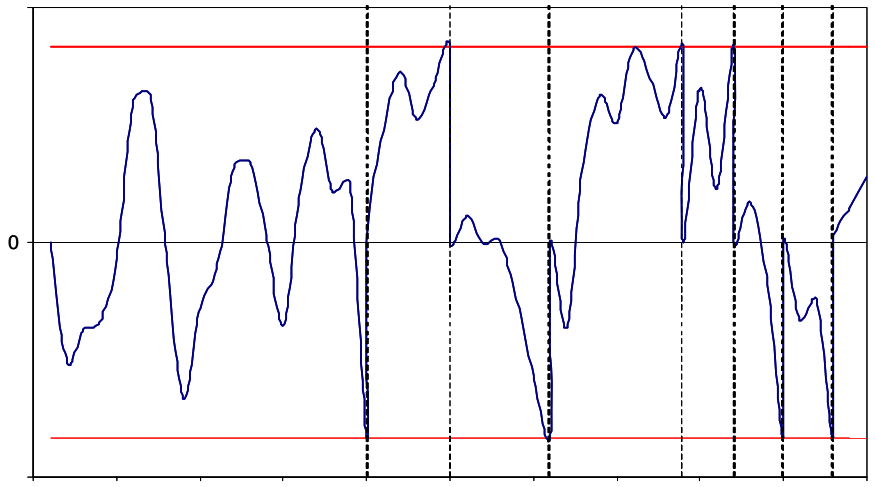
$$p_{it} = \begin{cases} p_{i,t-1} & \text{if } \left| p_{i,t-1} - p_{it}^{*} \right| < s_{it} \\ p_{it}^{*} & \text{otherwise} \end{cases} . \qquad (2)$$

Given a constant inaction band, s, such price-setting behaviour implies periods of price inaction, as described in Figure 3.1.

Figure 3.1: The (S,s) Price Setting Model



a. Actual price



b. Deviations from optimal price

As can be seen in Figure 3.1, such a model generates periods of price inaction during which the price is kept constant for different periods of time, depending on the evolution

of the optimal price and whether or not the discrepancy between this optimal price and the current price is larger or smaller than s_i. When prices are changed, the magnitude of the change is larger than the current change in p^*. Therefore, for the fixed cost case, the frequency of changes of the nominal price is smaller, and the size is larger, than the frequency and size of changes of the optimal price:

$$\text{Fixed costs}: freq(\Delta p) < freq(\Delta p^*) \text{ and } |\Delta p| > |\Delta p^*|. \quad (3)$$

The other often used form of adjustment costs is a quadratic cost, where the cost is increasing in the size of adjustment. This means that the total cost of two small changes is less than the cost of one large change.[53] In this case, after a shock to costs or demand, firms may find it too costly to make a full adjustment to the new optimal price and instead proceed to undertake several small changes. Therefore, in the quadratic cost case, the frequency of changes of the nominal price is larger, and the size is smaller, than the frequency and size of the changes of the optimal price:

$$\text{Quadratic costs}: freq(\Delta p) > freq(\Delta p^*) \text{ and } |\Delta p| < |\Delta p^*|. \quad (4)$$

Following these considerations, we define the first indicator of price rigidity as:

$$RigidA1 = (\ freq(\Delta p) - freq(\Delta p^*))^2 + (\ |\Delta p| - |\Delta p^*|)^2. \quad (5)$$

Products/sectors with flexible prices would have low values of this indicator while products with rigid prices should have high values of this indicator, regardless of the nature of underlying rigidity.

Given the difference in the size of the frequencies and magnitude of price changes, these measures can be standardized by dividing the differences by the averages:

$$RigidA2 = \left[\frac{freq(\Delta p) - freq(\Delta p^*)}{\frac{1}{2}(freq(\Delta p) + freq(\Delta p^*))}\right]^2 + \left[\frac{|\Delta p| - |\Delta p^*|}{\frac{1}{2}(|\Delta p| + |\Delta p^*|)}\right]^2 \quad (6)$$

[53] Although this is not the most frequently observed pattern of price changes, at least at the consumer level, its relevance may nevertheless be explored for some products. For example, an agreement has been signed in France between oil companies and the government to smooth the impact of crude oil price rises by staggering price increases over time. Even though prices are changed frequently, this situation is characterized by rigidity since oil companies are constrained in their ability to adjust prices to changes on the crude oil market. However, consumers often consider than, at the opposite, price increases are fully and rapidly transmitted to prices while crude oil decreases are staggered over time. Then, despite the numerous price increases and decreases we observe, it is not certain that gas prices are as flexible as we might think by just looking at the frequencies.

A simple modification of the second indicator allows the identification of the type of adjustment costs underlying the price rigidity. This is obtained by computing the following indicator:

$$RigidA3 = \left[\frac{freq(\Delta p) - freq(\Delta p^*)}{\frac{1}{2}(freq(\Delta p) + freq(\Delta p^*))} \right] + \left[\frac{\left|\Delta p^*\right| - \left|\Delta p\right|}{\frac{1}{2}(\left|\Delta p\right| + \left|\Delta p^*\right|)} \right] \quad (7)$$

If the rigidity is mostly due to fixed costs, we should obtain $RIGID_{A3} < 0$ since $freq(\Delta p) < freq(\Delta p^*)$ and $|\Delta p| > |\Delta p^*|$. On the other hand, a positive value for $RIGID_{A3}$ would correspond to quadratic costs as, in this case, $freq(\Delta p) > freq(\Delta p^*)$ and $|\Delta p| < |\Delta p^*|$.

In order to implement these indicators, we need to measure changes in the optimal price, p^*. For consumer prices, we assume that a proxy for the optimal price of a given product is obtained from its manufacturing production cost. The frequency and magnitude of producer price changes as compared to those observed at the retail level determine the relative rigidity rankings across products. In other words, we assume that other retailer costs (wages, rents, transportation costs) affect consumer prices of all final products in roughly the same proportion and thus do not affect the rankings obtained with the producer price changes.

The conversion table between the consumer goods and services categories (the COICOP grouping) and the producer goods categories for which the necessary information about price changes is available (the NACE 2 digit) is given in appendix A. The construction of the conversion table requires a few assumptions and simplifications. As a (simple) example, the COICOP category 'Food products and non-alcoholic beverages' is linked with NACE 15, 'Manufacture of food products and beverages' despite the fact that the latter also includes alcoholic beverages.

Due to data limitations, it is more difficult to assess the degree of rigidity of producer prices themselves. Indeed, for the set of countries and sectors for which the PPI analyses have been made, we do not have much information about the variations of costs and demand underlying the variations in the optimal (unobserved) producer prices. However, it is possible to make use of the input-output tables in order to determine the influence of price changes of important inputs on the frequency of price changes (see section 6.4.)

Availability of data on producer price changes required by $Rigid_{A2}$ and $Rigid_{A3}$ indicators (i.e. their frequency and magnitude), allows computing these indicators for only four countries: Belgium, France, Germany and Spain. The analysis concentrates on prices of goods as the information on cost changes is not available for services.

3.2. Second Indicator: Comparing the Persistence of Inflation Rates for CPI and PPI

The second indicator compares the persistence of the CPI and PPI sectoral inflation rates. The idea behind this indicator is that, if the costs of CPI goods can be approximated with the corresponding PPI sub-index, prices are rigid when the inflation persistence of the CPI sub-index is larger than the PPI sub-index. Since the CPI and PPI sub-indices are available for most euro area countries from Eurostat, the coverage of countries and sectors with this indicator is larger than for the other indicators which rely on micro data observations.

As for the previous indicator, we assume that the part of costs of retailers that varies across products is the production cost of the product while changes in the remaining trading cost components (wages, transportation costs, rents, energy costs) as well as in mark-ups[54] are assumed to be common to all products and can therefore be neglected in a cross-sectional analysis. Thus, we approximate the costs of the final product with its corresponding producer price index (PPI). To match CPI and PPI sub-indices we use the same conversion table as for the previous indicator, given in appendix A.

A simple way of measuring inflation persistence of a CPI/PPI sub-index is to compute serial correlation. Since most CPI and PPI sub-indices as well as their monthly inflation rates display seasonality, we calculate the serial correlation of the monthly inflation rates at the 12th lag. Thus, the second price rigidity indicator is defined as the difference between inflation persistence of the CPI and the corresponding PPI sub-index:[55]

$$RigidB = cor\left(\Delta CPI_t, \Delta CPI_{t-12}\right) - cor\left(\Delta PPI_t, \Delta PPI_{t-12}\right) \tag{8}$$

It should be mentioned that comparing the serial correlations of CPI and PPI indices represents an indirect way of assessing the persistence of inflation at the consumer and producer level. A direct approach would be to estimate the inflation persistence coefficients (the sum of the AR terms in an autoregression) of both the CPI and PPI indices and compare those. But this approach raises a number of methodological issues which potentially affect the reliability of the results. For instance, the estimated inflation persistence coefficient crucially depends on the assumption on the unconditional mean of the process (fixed vs. time-varying unconditional mean) and results might differ considerably according to the assumption adopted.

[54] The assumption of homogeneity of mark-up movements across products is more debatable than for the remaining cost components, at least at the individual product level. But given that we compute the indicator at the sectoral level, the assumption that mark-ups within any industry move in the same direction seems to be more justified.

[55] An alternative way of removing the seasonality would be to calculate the first-order serial correlation of yearly instead of monthly inflation rates. To check the robustness of our results we also calculated this second price rigidity indicator for yearly inflation rates. This produced a quite similar ranking of sectors in terms of price rigidity.

CPI inflation is usually found to be more persistent than PPI inflation. So, we expect this indicator to be positive most of the time. A potential problem for the interpretation of this indicator is a situation when material and other input costs move in opposite directions. In that case the inflation persistence of the CPI sub-index might be smaller than the persistence of the cost movement of the material input considered. Low inflation persistence at the retail level would then be the result of compensating cost movements rather than an indication of price flexibility. However, with the assumption that the production cost of the product captures the major part of the total costs, movements in the other cost components would have to be rather large in order to compensate changes in the production cost, which is quite unlikely. Thus, proxying costs with the PPI should not distort the ranking of products according to their price rigidity as measured by this indicator.

Another problem is that the value of the indicator may be negative in a situation when prices are changed very frequently at the CPI level due to a marketing strategy commonly employed by retailers (Hi-Lo pricing). In that case the sector may be characterized by low persistence of consumer prices even when producer prices are persistent. Therefore, the values of the indicator should not be interpreted in absolute terms but only relative to the other sectors.

3.3. Third Indicator: Intrinsic Price Rigidity

The previous two indicators are subject to data constraints as they rely on the matching of information about consumer and producer prices. This limits the set of countries and sectors we consider for the first indicator and leads to some statistical difficulties for the second indicator.

The analysis in Dhyne *et al.* (2008) provides the basis for an alternative approach. Using the discussion in section 3.1, their model can be written as

$$p_{it} = \begin{cases} p_{i,t-1} & \text{if } \left| p_{i,t-1} - p_{it}^{*} \right| < s_{it} \\ p_{it}^{*} & \text{otherwise} \end{cases} \tag{9}$$

This model illustrates the two sources of price stickiness discussed above. The current price, p_{it}, may remain unchanged if the difference between the current optimal price and previous periods price ($|p_{i,t-1} - p^{*}_{it}|$) is small, or if the range of inaction (s_{it}) is large. In the first case the lack of price adjustment is due to extrinsic rigidity, in the second, it is due to intrinsic rigidity.

The separation of sources of rigidity into extrinsic and intrinsic is, in general, very complex. Dhyne *et al.* (2008) use the mathematical expression of the range of inaction

proposed by Dixit (1991) to properly distinguish the two sources of price stickiness. Their methodology provides policy-relevant results by disentangling extrinsic and intrinsic rigidity. Unfortunately, their approach cannot be easily extended to analyze the situation observed in the other euro area countries as it requires the use of very detailed micro data which are not publicly available[56]. We therefore developed an alternative way of disentangling the two dimensions of price rigidity. Our third indicator is:

$$RigidC = \left|\Delta P\right| / \sigma_{PI} \qquad (10)$$

This decomposition is based on two main arguments. First, as can be seen in Figure 3.1, under the assumption of constant range of price inaction, a simple estimate of the range of inaction, *s*, will be provided by the average absolute size of price adjustments, $|\Delta P|$[57]. Dhyne *et al.* (2008) show that there is a strong correlation between $|\Delta P|$ and the estimated range of inaction that incorporates intrinsic rigidity.

Second, extrinsic rigidity corresponds to the variance of shocks: common (sectoral) and idiosyncratic (store level). Dhyne *et al.* (2008) determine the variability of the optimal price using individual price data allowing to identify the relative contribution of common and idiosyncratic shocks to price volatility. As we do not have access to such detailed dataset, we have rely on sectoral price indices only to try to approximate at least the magnitude of the common shocks that affect prices. The sectoral prices are publicly available at Eurostat. To proxy the size of the common shocks, we use the standard deviation of the log of the monthly price index over a given period of time[58], σ_{PI}. This indicator is considered as a proxy of the degree of extrinsic rigidity. This argument is supported by the results presented in Dhyne *et al.* (2008) showing that the price index of a given product category is highly correlated with the unobserved common factor of the optimal price.

A large value of the third indicator means that, relative to the size of the common shocks captured by σ_{PI}, firms tend to change their price by large amounts. This would be a signal of strong price rigidities, as large price changes would proxy large range of inactions or price adjustment costs. Based on the statistical information presented in appendices A and B, this indicator can be computed for 10 euro area countries for consumer prices at the

[56] The main results of this article, based on a subset of the French and Belgian CPI basket, are presented in Section 5.1.

[57] Statistical information on the average size of price changes by COICOP category can be found for nine euro area countries in Glatzer, Rumler (2007), Dhyne, Konieczny (2007), Hoffmann, Kurz-Kim (2006), Baudry *et al.* (2006), Veronese *et al.* (2005), Lünneman, Mathä (2005), Jonker *et al.* (2005), Dias, Dias, Neves (2004), Alvarez, Hernando (2004)

[58] We use the same observation period for the computation of the volatility of the price index for a given product as the one used for the computation of the average size of price changes for that product. See the different national papers for the definition of the sample period used for each type of product in the different countries.

COICOP 2 digit level and for 6 euro area countries for producer prices at the NACE 2 digit level.

This third indicator provides an interesting alternative to the measure of the frequency of price changes but it has some drawbacks, especially for consumer prices.

First, the proposed measure of extrinsic rigidity is based only on sectoral price indices and so it only captures the common shocks that are affecting one particular product category. This means that it misses the idiosyncratic dimension of price adjustment. As shown in Dhyne *et al.* (2008) or Golosov and Lucas (2007), this idiosyncratic dimension is important, especially for consumer prices for which temporary promotions are common (especially in supermarkets that follow Hi-Lo pricing strategy). This means that our approach probably underestimates the volatility of the shocks that are affecting optimal prices and therefore our third indicator may be overestimated.

Second, our third rigidity indicator is affected by the occurrence of end-of-season sales, especially for COICOP categories 3 and 9, which involve large price changes and increase its value. Contrary to the occurrences of temporary promotions which are firm-specific price changes, the occurrences of end-of-season sales are common across stores. Therefore, they can be considered as a common shock. However, during most of the observation period, end-of season sales were not included in the price indices and in the average size of price changes, except in three countries (Austria, Germany and France) where the average size of price changes includes end-of-season sales. As end-of-season sales involve larger price changes than usual, this increases the average size of the price changes and therefore the value of our indicator in these countries, for COICOP 3 and 9.

To summarize, each of these three indicators have its own advantages and drawbacks:

The first indicator is probably the most intuitive as it directly reflects the differences between the frequency and magnitude of price changes at the consumer and producer levels. Such differences may indeed be considered to characterize the degree and nature of price rigidity *at the consumer level*. This indicator is then informative about the contribution of the retail and wholesale trade sector to consumer price rigidity. Unfortunately, this indicator is quite demanding in terms of information. Moreover, this information cannot be updated as it is based on computations made using the raw data on price changes at the micro-level which are not publicly available. This induces a limitation in the coverage of countries and sectors for which it could be computed.

The second indicator aims, in a way, at mimicking the first one by comparing the characteristics of price changes at the consumer and producer levels using price indices rather than "raw characteristics" (frequency, magnitude) of price changes. This is done by comparing the statistical properties of consumer and producer price inflation at the disaggregate level, which can be done for a larger set of sectors and countries than feasible for the first indicator. This is a clear advantage of this second indicator over the first one.

However, both the first and second indicators require comparing consumer and producer prices and thus could only be computed for assessing price rigidity at the consumer level.

The third indicator does not have this drawback. Its definition entails the comparison of a measure of intrinsic rigidity with a measure of extrinsic rigidity either at the consumer, or producer, level. Under the assumption of lumpy price adjustment costs, intrinsic rigidity can reasonably be approximated by the average size of price changes while extrinsic rigidity is approached through the variability of the sectoral price index. This indicator can thus be computed for assessing both consumer and producer price rigidity and this can be done for a large set of sectors and countries.

IV. CONSUMER PRICE RIGIDITY IN THE EURO AREA.

4.1 Assessing the Degree of Consumer Price Rigidity across Sectors and Countries.

We now apply the three indicators to analyze consumer price rigidity in the Euro area. We have computed the indicators for as many countries and sectors as possible, given limited data availability. As previously mentioned, the first indicator is the most demanding in terms of data as it requires data on the frequency and magnitude of price changes of both consumer and producer prices. Available data allow the computation of the first indicator for 8 of the 12 COICOP categories. In particular, it is not possible to compute it for services (e.g. hotels and restaurants or education) as there is no corresponding producer price information. As the COICOP classification is the most natural one for considering consumer prices, our indicators and the subsequent analysis will focus on this classification. We have nevertheless also tried, as much as possible, to conduct the same analysis using the NACE classification but this proved to be more difficult and less reliable due to the complexity in the matching of the two classifications.[59] We computed the first two indicators for 15 categories using the NACE classification. As will be seen below, the conclusions of the two analyses (based respectively on the COICOP and NACE classifications of products) are similar for our first indicator.

The first indicator, which requires data on the frequency and size of producer price changes, can be computed for four countries: Belgium, France, Germany and Spain. The data requirements of the second and third indicators are more modest and they can be computed for nine countries each: the four above plus Austria, Finland, Italy, Luxembourg and the Netherlands for the second indicator and Austria, Italy, Luxembourg, the Netherlands and Portugal for the third indicator. We have also computed the mean value of the indicators using weights given to each country in the computation of the CPI for the Euro area.[60] The values of the indicators are in Tables 4.1 - 4.3 and 4.6 - 4.8 below.

The three indicators, computed for several countries and different classifications, provide a large amount of data. Rather than discussing in detail all these estimates and repeating the discussion for each indicator, we summarize below the conclusions that appear robust across countries and across our three indicators. These conclusions are as follows:

[59] It is much easier to go from a more detailed (NACE) classification to a more aggregate (COICOP) one than the other way round, where more arbitrary choices have to be made for imputing available information.

[60] These weights are the same for the different COICOP categories. See Appendix A2

4.1.1. The Differences in Rigidity are Greater between Sectors than between Countries

As pointed out in the IPN surveys, there is much more heterogeneity across sectors than across countries. We computed the correlations between each country values of the first indicator with those of the Euro area average. These values are quite highly correlated, except for Spain. The correlations range from 0.72 for Belgium to 0.90 for Germany.[61] Moreover, all correlations between country pairs are significantly positive and take values larger than 0.4 except for the Spain -France and Spain-Germany pairs. This indicates that differences across countries are not predominant. The first indicator suggests that prices in Spain are more flexible than in the three other countries.

Table 4.1: $Rigid_{A2}$ Indicator of Consumer Price Rigidity by COICOP 2 Digit Groupings.

COICOP	BEL	GER	FRA	SPA	Average
01. Food and non alcoholic beverages	1.06	1.50	1.73	0.58	1.42
02. Alcoholic beverages, tobacco and drugs	0.18	-	0.00	0.23	0.08
03. Clothing and footwear	0.71	1.87	2.06	0.49	1.68
04. Housing, water, electricity, gas and other fuels	0.60	-	0.26	-	0.31
05. Furnishing, household equipment and maintenance	0.16	0.74	0.86	0.09	0.66
06. Health	1.96	-	1.00	2.82	1.60
07. Transport	0.06	0.78	0.09	2.06	0.70
08. Communications	-	-	-	-	-
09. Recreation and culture	0.81	1.62	0.51	0.18	1.04
10. Education	-	-	-	-	-
11. Restaurants and hotels	-	-	-	-	-
12. Miscellaneous goods and services	1.40	1.77	0.65	1.10	1.32
Correlation with the average	0.72	0.90	0.80	0.33	
Rank correlation with the average	0.67	0.83	0.85	0.48	

Source : Own computation

[61] The correlation between ranks provides the same picture. The rank correlation between Spain and the four country average is significantly higher than that based on the indicator values, although it remains lower than that obtained for other countries.

Table 4.2: $Rigid_{A2}$ Indicator of Consumer Price Rigidity by NACE 2 Digit Groupings.

NACE	BEL	GER	FRA	SPA	Average
15. Manuf. of food products and beverages	0.97	1.49	1.62	0.51	1.37
16. Manuf. of tobacco products	0.32	-	0.17	0.24	0.21
18. Manuf. of wearing apparel, dressing, dyeing of fur	0.81	1.85	2.05	0.42	1.66
19. Tanning & dressing of leather, manuf. of luggage, etc	0.64	1.97	2.14	0.82	1.79
21. Manuf. of paper & paper products	0.14	0.37	0.19	1.98	0.51
22. Publishing, printing & reproduction of recorded media	2.17	2.08	0.61	0.23	1.39
23. Manuf. of coke, refined petroleum products, nuclear fuel	0.51	1.23	0.74	2.82	1.25
24. Manuf. of chemicals & chemical products	1.90	2.30	0.87	1.98	1.80
29. Manuf. of machinery & equipment n.e.c	0.07	0.80	1.13	0.21	0.78
32. Manuf. of radio, TV, communication equipment	0.46	1.33	0.37	0.23	0.84
33. Manuf. of medical, precision & optical instruments, watches	1.09	0.68	0.66	0.20	0.64
34. Manuf. of motor vehicles, trailers & semi-trailers	0.66	2.66	1.20	0.53	1.82
36. Manuf. of furniture; manufacturing n.e.c.	0.36	0.93	0.75	0.10	0.73
40. Electricity, gas, steam and hot water supply	1.29	-	0.07	0.70	0.38
41. Collection, purification, distribution of water	0.54	-	1.59	-	1.42

Note. n.e.c. = Not elsewhere classified.

Source : Own computation

4.1.2. Differences in Rigidity across Sectors.

The three indicators provide a consistent picture. The most rigid sectors are clothing (COICOP 3, NACE 18 and 19), cultural products (COICOP 9, NACE 22) and food products (COICOP 1, NACE 15) as well as healthcare products (COICOP 6, NACE 24), except for France.[62] It is worth noting that food products appear to have quite rigid prices despite their high frequency of price changes.[63] This means that, given the high frequency of price changes at the producer level, prices of food products should change more often than they do. This finding provides a justification of the approach we use. A simple look at the frequency of price changes suggests food prices are very flexible but, in fact, they are rather rigid. The apparent (and misleading) flexibility that would be assessed from looking only at the frequency of consumer prices is the result of even more frequent changes of producer prices.

The two other product categories are less of a surprise. Prices of clothing are often changed subject to a seasonal pattern with products having a fixed price for the season until the possible end of season sale and then disappearing from outlets and being replaced by other seasonal items. For cultural products, their specific nature and their once-and-for-

[62] The third indicator also implies rigid healthcare products prices in France.

[63] See Table 4.8 and Appendix A2for the frequencies of consumer and producer price changes.

all production costs might be the explanation of their price rigidity. Finally, the rigidity found for healthcare products may be due to regulation of their prices.

At the opposite end of the spectrum, we find that products with the most flexible prices are housing products (COICOP 4) as well as transport (COICOP 7). The most likely explanation for this result is the large role of energy prices in these two groups. The frequent price changes of energy raise the frequency of price changes in the categories where they are an important component. Alcoholic beverages and tobacco products (COICOP 2 and NACE 16) also appear to have rather flexible prices. This might be surprising given that the price of tobacco products is regulated in several countries. But at the producer level, the frequency of price changes is even lower than that observed at the consumer level and this explains the result. Finally, durable manufactured goods (COICOP 5, NACE 32, 33 and 36) also appear to have rather flexible prices, though to a lower degree. In the last two cases, judgments based on the frequency of price changes would indicate high rigidity and so would be misleading.

The results are broadly consistent with those of Dhyne *et al.* (2008) who find low degree of price rigidity for energy products, moderate amount for services, despite their low frequency of price changes and moderate amount for food, despite their high frequency of price changes. Using the theoretical framework derived by Dixit (1991) they directly estimate the relative importance of intrinsic and extrinsic price rigidities for Belgium and France, using a state dependent model described in equation (9). As already mentioned we cannot use their approach here as, first, they require micro CPI data which are no longer available and, second, their estimation method requires extremely lengthy computations.

Dhyne *et al.* (2008) directly estimate the relative importance of intrinsic rigidity (represented in their paper by the parameter $\hat{c}$) and extrinsic price rigidity (the parameter $\hat{\sigma}$). The $\hat{c}$ parameter reflects the importance of price adjustment costs (the costs incurred by the firm when it changes its price) relative to the costs of price inaction (the costs associated with suboptimal pricing) while the $\hat{\sigma}$ parameter reflects the volatility of both common and idiosyncratic shocks that affects the firm optimal price. The averages of these parameters across broad product categories, as well as the frequency and size of price changes, are in Table 4.3.

As can be seen from the averages, the level of intrinsic rigidity is the lowest for oil products, indicating that the high frequency of price changes of oil products is the result of very low relative price adjustment costs in this sector. Indeed, for oil products, the cost of changing price is very low (the operator of the gas station only has to change a couple of posted numbers) and the cost of price inaction is very high because of the fierce competition in that sector (consider how frequently two gas stations are located in front of each other).

On the other hand, prices of services are seldom changed. This is partly the result of higher adjustment costs compared to those of energy or food products. However, the

estimated adjustment costs for services do not differ much from those obtained for durable and non- durables goods, for which prices change more often. What explains the very low frequency of price changes in services is the combination of high relative adjustment costs (high intrinsic rigidity) and low volatility of the optimal price (high extrinsic rigidity). Therefore, based on these results, the low frequency of price changes in services does not mean service prices are intrinsically rigid but the fact that firms do not need to change service prices often.

Intrinsic/nominal rigidities (as measured by the size of $\hat{c}$) seem to be the main determining factor of the observed differences in the frequencies of price changes across products, whilst the size of shocks ($\hat{\sigma}$) seems to largely explain the differences in the magnitude of price changes. Dhyne *et al.* (2008) argue that this could explain why, despite the fact that energy products and services exhibit strongly different degrees of nominal rigidities and frequencies of price changes, the sizes of observed price changes are relatively small for both products. These results are confirmed by the econometric estimation. As can be seen in Table 4.4, a lower level of intrinsic rigidity or of extrinsic rigidity raise the frequency of price changes (note that a large value of $\hat{\sigma}$ means that shocks affecting the optimal price are large and so extrinsic rigidity is low). Both effects are significant but dropping $\hat{c}$ from the estimated equation has much larger effect on R^2 than dropping $\hat{\sigma}$. For the size of price changes, the effect of $\hat{\sigma}$ is significant while that of $\hat{c}$ is not; furthermore, all the explanatory power of the regression can be attributed to $\hat{\sigma}$.

Table 4.3: Intrinsic and Extrinsic Price Rigidity by Broad Product Categories – CPI Weighted Averages

	Energy	Perishable food	Non-perishable food	Non-durable goods	Durable goods	Services
Belgium						
Intrinsic rigidity	0.002	0.401	0.479	0.947	1.540	1.245
Extrinsic rigidity	0.038	0.115	0.082	0.079	0.095	0.048
Frequency	0.723	0.315	0.127	0.145	0.056	0.041
Size of price changes	0.039	0.139	0.102	0.083	0.072	0.056
France						
Intrinsic rigidity	0.000	0.181	0.226	0.601	0.486	0.780
Extrinsic rigidity	0.029	0.107	0.076	0.112	0.081	0.057
Frequency	0.799	0.247	0.204	0.124	0.134	0.077
Size of price changes	0.022	0.119	0.064	0.166	0.083	0.047

Source: Dhyne *et al.* (2008)

Table 4.4: Cross Section Regressions of the Frequency and the Magnitude of Price Changes on Measures of Intrinsic ($\hat{c}$) and Extrinsic Rigidities ($\hat{\sigma}$)

	Frequency of price changes			**Size of price changes**		
Constant	-0.080	-2.525	-0.307	-0.017	-0.024	0.102
	(-0.23)	(-4.59)	(-1.06)	(-1.68)	(-3.94)	(9.37)
D_France	-0.393	-0.006	-0.388	0.002	0.005	0.015
	(-3.09)	(-0.02)	(-2.88)	(0.44)	(0.98)	(1.41)
$\hat{c}$	-3.471	--	-2.229	-0.011	--	-0.010
	(-6.84)		(-10.32)	(-0.93)		(-1.18)
$\hat{\sigma}$	7.677	9.136	--	1.391	1.437	--
	(2.93)	(1.99)		(16.15)	(23.08)	
$\hat{c} / \hat{\sigma}$	1.792	--	--	0.090	--	--
	(0.38)			(0.72)		
$\overline{R}^2$	0.72	0.13	0.63	0.76	0.76	0.02

Note : t-stat in brackets.

Source: Dhyne *et al.* (2008)

4.1.3. Nature of Adjustment Costs.

Table 4.3: $Rigid_{A3}$ Indicator of Consumer Price Rigidity by COICOP 2 Digit Groupings.

COICOP	**BEL**	**GER**	**FRA**	**SPA**
01. Food and non alcoholic beverages	-1.04	-1.56	-1.71	-0.55
02. Alcoholic beverages, tobacco and narcotics	-0.54	-	-0.07	-0.64
03. Clothing and footwear	-1.17	-1.57	-0.36	-0.74
04. Housing, water, electricity, gas and other fuels	-1.09	-	-0.35	-
05. Furnishing, household equipment and routine household maintenance	-0.53	-1.12	-0.33	-0.30
06. Health	-1.54	-	-0.75	-
07. Transport	-0.33	-1.14	-0.42	-1.61
08. Communications	-	-	-	-
09. Recreation and culture	-0.96	-1.80	-0.63	-0.49
10. Education	-	-	-	-
11. Restaurants and hotels	-	-	-	-
12. Miscellaneous goods and services	-1.48	-1.87	-1.09	-1.37

Source : Own computation

As mentioned in the previous section, one can also try to draw some information about the nature of price adjustment costs from the sign of the difference between the frequency and magnitude of consumer prices and those of producer prices. Fixed costs of adjustments (i.e. menu costs) should lead to less frequent and larger variation of consumer prices as compared to those of producer prices while quadratic adjustment costs should lead to the well-known partial adjustment process which induces more frequent but smaller consumer price variations. The sign of the $Rigid_{A3}$ indicator (see equation (7) in section 3.1) allows to identify the relevant mechanism behind observed price changes. As the results in table 4.5 show, this difference is always negative. In other words, consumer prices tend generally to vary less often and by a larger amount than producer prices do. This is an indication of the existence of fixed costs rather than quadratic costs.

At this point, it is worth mentioning that the above conclusions appear to be robust for both product classifications (See table 4.2 above). While the NACE classification is subject to a number of stringent assumptions to allow the matching between consumer and producer price data, this can be seen as a positive signal regarding the robustness of our classification of products on the basis of their price rigidity.

4.1.4. Results are Robust with Respect to the Choice of Indicators Used.

We now turn to the two other indicators. It should be noted here that both the usual Pearson correlation and the Spearman rank correlations of the Euro area average values of the first indicator with those of the second and third indicators are quite high. The Pearson correlations between the first and second indicators, as well as those between the second and third all equal 0.77 (and also 0.77 for the Spearman correlation) while the correlation between the first and third indicators equals 0.54 (0.58 for the Spearman correlation). In other words, the picture drawn above from our first indicator (computed for 4 countries), appear to be quite similar to that based upon the two other indicators.

Table 4.6: $Rigid_B$ Indicator of Consumer Price Rigidity by COICOP 2 Digit Groupings.

COICOP	AUS	BEL	GER	FRA	FIN	ITA	LUX	NED	SPA	Average
01. Food and non alcoholic beverages	0.51	0.14	0.49	0.14	0.33	0.51	0.15	0.07	0.22	0.36
02. Alcoholic beverages, tobacco and drugs	0.17	-	-0.06	0.00	-	-0.01	-	0.01	-0.12	-0.02
03. Clothing and footwear	0.65	1.00	0.68	0.74	0.53	0.22	-	1.22	0.77	0.65
04. Housing water, electricity, gas, other fuels	0.18	-0.26	0.28	0.01	-	0.10	-0.31	1.09	-0.26	0.19
05. Furnishing, household equipment and maintenance	0.16	0.90	-0.42	0.51	0.23	0.65	-	-0.29	0.12	0.12
06. Health care	0.36	0.54	0.12	0.39	0.44	0.04	-0.08	0.33	0.38	0.22
07. Transport	-0.06	0.25	0.01	0.10	-	0.22	-	0.19	0.09	0.10
08. Communications	-	-	-	-	-	-	-	-	-	-
09. Recreation and culture	0.59	0.53	0.79	0.35	0.44	0.38	0.22	0.01	0.53	0.52
10. Education	-	-	-	-	-	-	-	-	-	-
11. Restaurants and hotels	-	-	-	-	-	-	-	-	-	-
12. Miscellaneous goods and services	0.41	0.72	0.54	0.54	0.55	0.06	0.53	0.90	0.83	0.48

Source : Own computation

Table 4.7: $Rigid_C$ Indicator of Consumer Price Rigidity by COICOP 2 Digit Groupings.

COICOP	AUS	BEL	GER	FRA	ITA	LUX	NED	POR	SPA	Average
01. Food and non alcoholic beverages	3.96	2.65	5.32	2.67	1.27	2.29	3.22	3.37	1.80	3.48
02. Alcoholic beverages, tobacco and drugs	2.00	1.04	1.70	0.57	1.16	0.81	1.21	0.68	0.37	1.23
03. Clothing and footwear	11.12	2.83	18.20	12.65	1.27	2.84	3.08	1.51	0.99	10.91
04. Housing water, electricity, gas, other fuels	0.89	1.00	2.09	2.04	0.68	1.11	1.19	0.67	0.76	1.59
05. Furnishing, household equipment and maintenance	4.55	1.84	7.57	4.41	1.25	2.28	2.12	1.27	1.05	4.60
06. Health care	0.62	1.69	-	3.83	-	2.36	-	0.58	1.52	2.94
07. Transport	1.37	0.73	1.16	1.07	1.17	0.77	0.70	0.47	0.65	1.07
08. Communications	1.39	1.84	-	1.64	-	1.80	-	1.07	-	1.61
09. Recreation and culture	5.47	3.78	6.96	16.05	2.26	2.59	6.81	2.79	1.09	7.70
10. Education	0.21	-	-	1.08	-	1.74	-	0.28	0.47	0.90
11. Restaurants and hotels	1.01	1.04	2.11	1.19	1.27	1.01	1.37	1.66	0.95	1.56
12. Miscellaneous goods and services	1.42	1.50	2.68	2.51	1.23	1.55	1.62	0.62	0.81	2.11

Source : Own computation

This has two implications regarding the robustness of our previous conclusions:

1. The broad classification of products based upon their degree price rigidity as it is derived from our first indicator can be considered to be robust. Indeed, the overall assessment of products with rigid prices (resp. flexible prices) is almost independent of the specific way we are measuring rigidities. All three indicators indicate that food products, clothing and cultural products have the most rigid prices while alcohol and tobacco, house related services and transport products have the most flexible prices.

2. Since the last two indicators are available for a large number of countries, one can reasonably expect that the above conclusions are valid for a quite large set of countries. Indeed, would there exist strong differences across countries, the average computed from the four countries available for the computation of our first indicator would then probably differ from the average computed on a significantly larger set of countries. Our three Euro-area averages appear to be highly correlated to each other. As already mentioned the correlation between $Rigid_{A2}$ and $Rigid_B$ is 0.77; that between $Rigid_{A2}$ and $Rigid_C$ is 0.58 and that between $Rigid_B$ and $Rigid_C$ is 0.77. This can be interpreted as an indication of homogeneity across countries as the Euro-area averages of these three indicators have been computed on different sets of countries. This statement will be confirmed by the econometric exercise presented in the next section.

This conclusion about homogeneity is also reinforced by the fact that, as already mentioned for the first indicator the correlation between country rankings and the euro area weighted average ranking is high. For the second indicator, this correlation ranges from 0.60 for Finland to 0.92 and 0.93 for Austria and Germany respectively. The two main exceptions are Belgium and Italy (with correlations of 0.38 and 0.18). The correlations are even higher for the third indicator: these range from a minimum of 0.60 for Italy to a maximum of 0.97 for Germany, with values for most countries above 0.80.

Moreover the third indicator, which allows to evaluate the rigidity of service prices, confirms the conclusion that looking only at the frequency of price changes is misleading. While prices of services change less often than prices of goods, the third indicator shows prices of services are not the most rigid. The low frequency of price changes for services is the result of the stability of their costs, as measured by the price index in this sector.

It is worth comparing the picture presented by the three indicators with what is obtained using the frequency of price changes as an indicator of price rigidity. These frequencies, across countries and sectors, are in Table 4.8 below.

Table 4.8: Frequency of Consumer Price Changes by COICOP 2 Digit Groupings

COICOP	AUS[1]	BEL[2]	GER[3]	FRA[4]	FIN[5]	ITA[6]	LUX[7]	NED[8]	POR[9]	SPA[10]	Average
01. Food and non alcoholic beverages	18.0	20.4	18.4	19.0	20.4	14.6	19.0	23.2	36.3	32.2	18.8
02. Alcoholic beverages. tobacco and drugs	14.8	14.0	8.4	21.0	12.6	10.0	14.0	19.2	14.3	17.5	13.1
03. Clothing and footwear	12.7	3.8	6.7	17.0	19.8	5.4	20.0	20.5	28.6	5.1	10.3
04. Housing water. electricity. gas. other fuels	11.8	25.1	5.9	24.0	20.4	21.8	29.0	18.9	8.7	6.1	15.4
05. Furnishing. household equipment and maintenance	7.3	5.2	6.3	16.0	12.0	4.4	18.0	7.9	11.7	8.7	8.5
06. Health care	5.0	6.4	-	8.0	10.0	-	3.0	-	4.9	4.5	7.2
07. Transport	35.8	46.0	34.4	36.0	36.5	24.8	21.0	88.0	25.9	8.3	36.0
08. Communications	10.1	12.3	-	23.0	38.5	-	4.0	-	12.2	-	20.4
09. Recreation and culture	25.1	10.3	5.3	13.0	15.4	7.7	13.0	7.9	14.2	9.5	9.0
10. Education	5.0	-	-	6.0	2.6	-	5.0	-	7.7	7.9	5.9
11. Restaurants and hotels	9.2	3.3	4.7	8.0	10.2	5.8	5.0	7.8	14.7	4.2	6.2
12. Miscellaneous goods and services	7.7	6.7	7.0	12.0	11.0	4.3	11.0	10.4	11.3	7.4	8.0
CPI	15.8	15.3	10.8	19.0	17.8	10.0	17.0	16.5	21.8	14.4	

Sources : [1] Glatzer, Rumler (2007), [2] Dhyne, Konieczny (2007), [3] Hoffmann, Kurz-Kim (2006), [4] Baudry et al. (2006), [5] Laakonen, Vilmunen (2004), [6] Veronese et al. (2005), [7] Lünneman, Mathä (2005), [8] Jonker et al. (2005), [9] Dias, Dias, Neves (2004), [10] Alvarez, Hernando (2004)

Judging by the frequency of price changes, products with the most flexible prices are transport (because of the role of energy products) and food products, while the most rigid ones are, essentially, services. This ranking differs from the one obtained with our indicators, showing the importance of accounting for the intrinsic and extrinsic components of price rigidity. Indeed, the low frequency of price changes in services appears to be the result of strong extrinsic rigidity: production costs of services do not vary often and/or by large amounts. It is then rational for service providers not to change their prices very often. At the opposite, our indicators stress the rigidity of clothing prices as well as that of food products which exhibit intermediate (for clothes) and high (for food) frequencies of price changes.

Table 4.9: Rank Correlation between the Three Rigidity Indicators and the Frequency of Price Changes

	AUS	BEL	GER	FRA	FIN	ITA	LUX	NED	POR	SPA	Average
$Rigid_{A2}$	-	-0.29	-0.14	-0.50	-	-	-	-	-	-0.29	0.02
$Rigid_{B}$	0.05	-0.90	-0.33	-0.68	-0.31	0.00	-0.40	0.38	-	-0.25	-0.26
$Rigid_{C}$	0.50	-0.44	-0.33	-0.23	-	-0.28	-0.16	-0.23	0.62	0.01	-0.33

Source : Own computation

A summary of these differences is given in Table 4.9 above where the rank correlations between the frequencies and our indicators are given. These correlation are, as expected, most often negative, except for Austria and Portugal, but are not large.

These results demonstrate two things. First, the distinction between intrinsic and extrinsic rigidity is crucial. The average frequency of price changes is not the best indicator of nominal rigidities, as it fails to make this distinction. Second, and more important for the purpose of this study, the fact that service prices appear sticky should not be a source of concern as, in fact, service prices are not excessively rigid. The low frequency of price changes for services is caused by the stability of the cost of providing them, i.e. by extrinsic rigidity.

4.2 Are Consumer Prices More Rigid Downward?

In order to assess whether prices are more rigid downward than upward i.e. whether prices are "more easily" increased than decreased, we computed our first indicator for price increases and price decreases separately. The results are in Tables 4.10 and 4.11:

Table 4.10: $Rigid_{A2}$ Indicator of Price Rigidity - Increases.

COICOP	BEL	GER	FRA	SPA
01. Food and non alcoholic beverages	0.96	1.53	1.90	0.49
02. Alcoholic beverages, tobacco and narcotics	0.15	-	0.06	0.16
03. Clothing and footwear	0.25	2.00	1.96	0.19
04. Housing, water, electricity, gas and other fuels	0.96	-	0.22	-
05. Furnishing, household equipment and routine household maintenance	0.18	0.56	0.63	0.06
06. Health	1.12	-	0.83	2.15
07. Transport	0.23	0.38	0.04	1.36
08. Communications	-	-	-	-
09. Recreation and culture	0.79	1.67	0.69	0.11
10. Education	-	-	-	-
11. Restaurants and hotels	-	-	-	-
12. Miscellaneous goods and services	1.25	1.63	0.85	0.62

Source : Own computation

Table 4.11: $Rigid_{A2}$ Indicator of Price Rigidity - Decreases.

COICOP	BEL	GER	FRA	SPA
01. Food and non alcoholic beverages	1.17	1.48	1.27	0.69
02. Alcoholic beverages, tobacco and narcotics	0.28	-	0.30	0.50
03. Clothing and footwear	1.86	1.65	2.65	1.95
04. Housing, water, electricity, gas and other fuels	0.23	-	0.89	-
05. Furnishing, household equipment and routine household maintenance	0.12	1.12	1.59	0.24
06. Health	3.51	-	1.44	3.92
07. Transport	0.07	1.18	0.20	3.52
08. Communications	-	-	-	-
09. Recreation and culture	0.83	1.59	0.73	0.38
10. Education	-	-	-	-
11. Restaurants and hotels	-	-	-	-
12. Miscellaneous goods and services	2.04	2.37	0.64	2.76

Source : Own computation

Overall, these results indicate that, indeed, prices are more rigid downward than upward. The price rigidity indicator, accounting for the discrepancy between price variations at the producer level and those observed at the consumer level, is larger for price decreases than for price increases. The ratio of the two indicators is, in the vast majority of cases, larger than one and quite often significantly so.

Strong asymmetries are present even when prices are quite flexible. As an example, prices for the "Transport" COICOP 07 category, which mainly includes fuel products, seem to be subject to a significant asymmetry: the ratio of the indicator for decreases over that for increases takes values which are about 3 and above for three of the four countries (except Belgium). Strong asymmetries exist also for health products and clothing. For the latter products, one must keep in mind that sales are not necessarily recorded in price statistics in all countries (e.g. for Belgium). At the opposite end of the spectrum, food product prices do not appear to be subject to significant asymmetries.

The results for the third indicator, which can be computed for a significantly larger number of countries, confirm that downward price rigidity is stronger than the upward price rigidity. These results are shown in tables 4.12 and 4.13 below.

Table 4.12: $Rigid_C$ Indicator of Price Rigidity - Increases.

COICOP	AUS	BEL	GER	FRA	ITA	LUX	NED	POR	SPA
01. Food and non alcoholic beverages	3.79	2.49	5.35	3.22	1.27	2.05	2.90	3.85	1.73
02. Alcoholic beverages, tobacco and narcotics	1.96	0.99	1.67	0.56	1.17	0.71	1.01	0.77	0.35
03. Clothing and footwear	8.90	2.67	16.64	16.95	1.24	2.96	2.87	1.50	0.94
04. Housing, water, electricity, gas and other fuels	0.84	1.04	2.23	2.08	0.70	1.19	1.73	0.83	0.74
05. Furnishing, household equipment and routine household maintenance	3.80	1.82	6.44	4.21	1.26	2.28	2.07	1.40	0.99
06. Health	0.52	1.69		3.75		2.36		0.66	1.50
07. Transport	1.46	0.86	0.92	1.03	1.23	0.84	0.67	0.55	0.61
08. Communications	1.98	1.76		1.72		1.14		0.61	
09. Recreation and culture	5.22	3.52	6.69	15.73	2.14	2.71	5.51	3.30	0.94
10. Education	0.23			1.04		1.67		0.31	0.41
11. Restaurants and hotels	1.02	1.06	1.97	1.16	1.23	1.04	1.30	2.01	0.93
12. Miscellaneous goods and services	1.22	1.53	2.55	2.44	1.20	1.68	1.57	0.73	0.76

Source : Own computation

Table 4.13 - $Rigid_C$ Indicator of Price Rigidity - Decreases.

COICOP	AUS	BEL	GER	FRA	ITA	LUX	NED	POR	SPA
01. Food and non alcoholic beverages	4.16	2.86	5.30	1.91	1.29	2.61	3.66	2.84	1.88
02. Alcoholic beverages, tobacco and narcotics	2.05	1.15	1.75	0.58	1.13	1.18	1.74	0.48	0.40
03. Clothing and footwear	13.38	3.19	20.25	11.33	1.53	2.69	3.37	1.52	1.26
04. Housing, water, electricity, gas and other fuels	0.98	0.93	1.83	1.96	0.67	0.99	0.58	0.35	0.91
05. Furnishing, household equipment and routine household maintenance	5.62	1.88	10.20	4.53	1.14	2.28	2.30	1.08	1.18
06. Health	1.00	1.72		3.97		3.06		0.22	1.63
07. Transport	1.27	0.57	1.47	1.12	1.09	0.63	0.74	0.22	0.91
08. Communications	1.18	1.90		1.63		2.47		1.38	
09. Recreation and culture	5.74	4.06	7.26	16.19	2.52	2.44	8.63	2.23	1.28
10. Education	0.08			1.30		2.03		0.11	1.93
11. Restaurants and hotels	0.99	0.87	2.47	1.25	1.52	0.87	1.82	1.04	1.19
12. Miscellaneous goods and services	1.92	1.43	2.90	2.58	1.45	1.20	1.79	0.38	1.05

Source: Own computation

4.3 Explaining Consumer Price Rigidities.

According to the results presented in the previous section, products such as food, clothing, cultural products and, for several countries, pharmaceutical and personal care products can be characterized by rigid prices. At the opposite end, house services, household equipment, furniture and household maintenance products have prices that can be considered to be flexible, in that they seem to adjust more easily to changes in their production costs. We now turn to the analysis of reasons for price rigidity.

4.3.1. Identifying the Determinants of Retail Price Rigidity.

Degree of Competition. From the economic theory point of view, a first important explanatory factor is the degree of competition that exists in the retail trade sector. Stronger competition should reduce the margin of retailers and strengthen the link between prices paid to the product manufacturer and retail prices. One may expect that a larger number of retailers is likely to induce more competition and to increase price flexibility. However, it is important to stress here that competition at the consumer level is, for most products and services, a local phenomenon. Therefore the total number of outlets may be an imperfect indicator of the extent of competition at the retail level. As an example, the existence of only two large supermarkets in a given geographic area may create strong competition.

The role of Intermediaries and Wholesalers. Intermediaries and wholesalers play an important role in the degree of transmission of producer price changes to the consumer prices. Both the degree of competition between wholesalers and the structure/organization of the trade sector (i.e. the number of successive intermediaries through which a given product has to get through before reaching the final consumer) plays a role. More numerous wholesalers may be an indication of stronger competition at the wholesale level, thus reducing price rigidities but it can also be a consequence of a larger number of "layers" between the producer and the consumer which, to the contrary, may lower the impact of a price change at the producer level on the price ultimately paid by the consumer.

The nature of the relationships between producers, wholesalers and retailers is likely to affect the pass-through of cost changes to consumer prices. Are there long-term contracts, possibilities to bargain rebates, etc.? If retailers have a strong bargaining power, they may impose price stability even if producers face a cost increase. On the other hand they may reduce prices even if production costs remain unchanged. From this point of view, large retailing chains may disconnect price changes at the consumer level from cost changes that are experienced at the producer level. In that sense, they would increase rigidity even if, in the former case, the frequency of price changes would not be affected.

Marketing Policy of Retailers. Finally, the marketing policy of retailers cannot be ignored as one of the possible driving forces of prices at the retail level, especially in supermarket chains. The marketing literature seems to indicate that there are basically two polar pricing policies for supermarkets (e.g. Shankar and Bolton, 2004). Some stores resort to the "Hi-Lo" price policy and base their attractiveness on frequent price promotions. The recent developments in the technology of price display that allow electronic stickers to be changed at almost no (direct) cost make this pricing policy much less expensive than it was a few years ago, at least for supermarkets. The alternative pricing policy is the "Every Day Low Price" (EDLP) policy whereby the attractiveness of the outlet is based on low and less varying prices than those of "Hi-Lo" outlets. Baudry *et al.* (2007) show that, indeed, prices tend to change more often in supermarkets so that the Hi-Lo policy may be seen to be relevant to explain supermarket pricing policy.

Although there is a consensus to consider that prices are, on average, lower in supermarkets than in corner shops, it is less obvious whether prices are more flexible in supermarkets. Indeed, even though prices change more often in supermarkets, these changes may be quite disconnected from cost changes and may be essentially the result of the above mentioned "Hi-Lo" pricing policy. In that sense, the observed frequent price changes should not be seen as an indication of greater price flexibility. The frequency and magnitude of promotions may be largely decided on the basis of the consumers' expected reactions rather than on cost changes (e.g. Owen and Trzepacz, 2002). This disconnection may then make price changes either overstate or understate cost changes. Another reason for the disconnection between price and cost changes in supermarkets is the possible existence of returns to scale in changing prices. When the store changes the price of one product for which costs or demand have changed, it may also change other prices at the same time. This is the explanation of small price changes by Lach and Tsiddon (2007) and Midrigan (2008), the absence of which is a problem for Golosov and Lucas (2007). The effect of these considerations on the frequency is unclear. While, on first thought, it seems that it would increase the frequency of price changes, it may not. This happens in a situation when an unimportant good (from the profit point of view) is subject to numerous cost and demand shocks. The firm may ignore them as it knows that, at some point, it will change the price when an important good is subject to a shock.

On the other hand, the EDLP policy should result in a close connection between cost changes and price changes. As a consequence, it is quite difficult to predict the expected impact of the relative importance of supermarkets in retail trade on price rigidity.

Finally, for goods subject to regulation, prices may be disconnected from changes to demand and costs. The effect of regulation on price changing policies is analyzed in section 6.1 below.

4.3.2. Retail Sector Data.

The availability of the statistical information about the above mentioned retail trade sector characteristics is unfortunately quite limited. Given the objective to cover the largest possible number of sectors/products and countries, the only source we can refer to is Eurostat. We have used the following information about the retail trade sector:

For each product *j* in the COICOP/NACE classifications for which we have computed the first indicator, the following characteristics have been measured:

- the total number of outlets selling product *j*. As several products can be sold both in specialized outlets and in non-specialized stores (e.g. bread in bakeries as well as in supermarkets), this total number of outlets is the sum of all stores (specialized or not) selling the product.

- the number of supermarkets selling the product j. As the data available on Eurostat website do not provide the number of supermarkets as such, we approximate it by the number of non-specialized stores with more than 10 employees obtaining majority of their turnover from food products. This approximation appears sensible: in the case of France, it implies 5400 supermarkets while the number of supermarkets using the French definition is about 6000.

- the number of other non-specialized stores selling product j.

- the number of wholesalers selling product j.

Each of these variables is observed over several years. However, the period may vary from one country to the other. Moreover, some figures provided by Eurostat on its website appear to be problematic, as they give rise to implausible year to year variations in the number of outlets. In order to obtain robust estimates of the different quantities above, we have therefore computed the median values of the corresponding variables over the years for which the information is available.

To make the estimates comparable across countries, we divided right hand side variables, where appropriate, by the median population of the country over the years of observation.

The variables used to characterize some of the characteristics of the retail trade sector are as follows:

- R1_stores = number of retail outlets selling product j divided by the country population(i.e. per 1000 inhabitants); this measures the overall degree of competition among retailers.

We distinguish the following categories of stores:

- R2_special = the number of specialized stores selling product j (per 1000 inhabitants);
- R3_super = the number of supermarkets selling product j (per 1000 inhabitants). This number is defined as the number of non-specialized stores selling product j, with more than 10 employees and a predominance of food products;
- R4_general = the number of other non-specialized stores selling product j, i.e. general stores and small supermarkets (per 1000 inhabitants);

Also, in order to check whether the structure of retail trade regarding competition at the wholesale level may influence price rigidity, we used the following indicators:

- R5_whole = the number of wholesalers selling product j (per 1000 inhabitants);
- R6_whole = the ratio of wholesalers to the total number of retail outlets.

4.3.3. Some Descriptive Statistics.

The next two tables provide a general overview of some basic characteristics of the retail trade sector in the nine countries we have considered in our analysis.

Table 4.14: Number of Stores and Wholesalers per Country
(based on median values 1995 - 2006)

			Non-specialized			
Country	**Retail stores**	**Specialized**	**supermarkets**	**general**	**Wholesale**	**Population**
AUS	29744	25165	577	4003	6093	8 043 046
BEL	58776	52049	965	5762	15229	10 286 569
GER	213305	184974	6295	22037	30319	82 348 767
SPA	404472	367681	1514	35278	77863	40 720 483
FIN	18439	14441	631	3367	4555	5 188 008
FRA	261954	229440	5144	27370	57192	61 181 559
ITA	538686	463602	4987	70097	90206	56 977 217
LUX	2585	2340	30	215	965	441 525
NED	63799	59930	1563	2307	21586	16 046 180
POR	120222	99640	537	20045	19694	10 292 999

Source: Eurostat

Broadly speaking, Spain, Italy and Portugal have the strongest density of outlets while Germany, Austria and the Netherlands are at the opposite end of the spectrum. Regarding the structure of retail trade, the picture is close to the previous one. Indeed, the former set

of countries exhibit the lowest share of supermarkets in the total number of outlets while the latter has the highest share.

Table 4.15: Ratios by Country

	Retail stores per 1000 inhabitants	Specialized stores per 1000 inhabitants	Supermarkets per 1000 inhabitants	General stores per 1000 inhabitants	Wholesalers per 1000 inhabitants	Wholesalers per retail stores
AUS	3.70	3.13	0.07	0.50	0.76	0.20
BEL	5.71	5.06	0.09	0.56	1.48	0.26
GER	2.59	2.25	0.08	0.27	0.37	0.14
SPA	9.93	9.03	0.04	0.87	1.91	0.19
FIN	3.55	2.78	0.12	0.65	0.88	0.25
FRA	4.28	3.75	0.08	0.45	0.93	0.22
ITA	9.45	8.14	0.09	1.23	1.58	0.17
LUX	5.85	5.30	0.07	0.49	2.18	0.37
NED	3.98	3.73	0.10	0.14	1.35	0.34
POR	11.68	9.68	0.05	1.95	1.91	0.16

Source: Own computation

There are clearly two "models" of retail trade. Retail trade in Latin countries seems to be composed of many small, specialized outlets (likely corner shops) while Anglo-Saxon countries have a more concentrated structure with more large supermarkets and significantly fewer corner shops. However, as the previous descriptive analysis has shown, there does not seem to exist a corresponding ranking of these countries in terms of price rigidity, except for Spain.

4.3.4. Regression Results.

The goal of the regression analysis is to assess the impact of the characteristics of the retail trade sector on price rigidity across sectors (and countries). Before discussing estimation results, it is necessary to emphasize that these econometric results should be considered with caution. Indeed, the significance of the estimated impact of the regressors is reduced since, as the descriptive statistics shown above clearly show, the indicators tend to be collinear and the size of our samples is not very large.

Besides these statistical and econometric issues, one must also keep in mind that competition is a firm/outlet very specific characteristic. In the case of retail trade in particular, the spatial dimension of the competition between retailers is clearly fundamental. Unfortunately, the data available to us do not allow, at least regarding consumer prices, to take this feature into account. This is a common problem. Even CPI

data at the micro level do not provide the information required to assess the degree of competition faced by outlets in their close environment.

Table 4.16: Estimated Impact of the Number of Outlets per 1000 Inhabitants on the RigidA2 Indicator (COICOP Classification)

	1	2	3	4	5	6	7	8	9	10	11	12
	coef.	**t-stat**	**coef.**	**t-stat**	**coef.**	**t-stat**	**coef.**	**t-stat**	**coef.**	**t-stat**	**coef.**	**t-stat**
Constant	1.652	5.25	1.514	5.00	2.546	2.52	1.232	4.24	0.657	1.23	2.036	4.99
01. Food and non alcoholic beverages	0.944	2.02	0.504	1.13	0.270	0.47	0.606	1.24	-0.015	-0.03	-0.015	-0.04
02. Alcoholic beverages, tobacco and narcotics	-0.630	-1.53	-0.824	-1.85	-0.840	-1.81	-0.819	-1.78	-1.084	-2.27	-0.960	-2.22
03. Clothing and footwear	0.857	1.95	0.488	1.13	0.292	0.55	0.574	1.23	0.053	0.12	0.053	0.13
04. Housing, water, electricity, gas and other fuels	-1.070	-2.25	-1.073	-2.14	-2.110	-1.93	-0.790	-1.57	-0.228	-0.33	-1.607	-2.82
05. Furnishing, household equipment and routine household maintenance	0.003	0.01	-0.350	-0.81	-0.540	-1.03	-0.268	-0.58	-0.767	-1.73	-0.767	-1.93
06. Health	0.647	1.61	0.688	1.59	-0.470	-0.42	1.023	2.2	1.271	1.97	-0.108	-0.21
07. Transport	-0.400	-1.11	-0.440	-1.10	-1.620	-1.44	-0.094	-0.21	0.092	0.15	-1.287	-2.60
09. Recreation and culture	-0.130	-0.34	-0.278	-0.68	-0.360	-0.83	-0.243	-0.58	-0.453	-1.02	-0.453	-1.14
12. Miscellaneous goods and services	ref.		ref.		ref.		ref.		ref.		ref.	
Dummy_BE	-0.05	-0.15										
Dummy_ES	0.671	1.47										
Dummy_FR	-0.22	-0.72										
Dummy_DE	ref.											
Total number of stores / population	-0.860	-3.25	-0.463	-2.65								
Number of specialized stores / population					-0.250	-0.7	-0.555	-2.36				
Number of supermarkets / population					-6.720	-0.83			7.886	1.33		
Number of general stores / population					-1.540	-1.55					-1.502	-2.72
Number of observations	32		32		32		32		32		32	
R^2	0.70		0.58		0.61		0.56		0.49		0.59	

Despite these important caveats, some of our estimation results seem to be quite robust across several models and samples. Let us first consider the impact of the number of outlets per 1000 inhabitants on price rigidity. The first two pairs of columns of Table 4.16 show the estimated effect of the total number of outlets per 1000 inhabitants on price rigidity as measured by our first indicator, using the COICOP classification.[64] We consider two models: the first one includes country and product dummies (columns 1 and 2); the second includes only product dummies (columns 3 and 4).

[64] The results obtained using the NACE classification are provided in the appendix.

As the results in the first two columns of this table show and as could be expected from the descriptive statistics provided in section 4.1 about the rigidity indicators, there does not seem to be very strong and systematic differences in the price rigidity across the four countries we consider here. We can observe that the most flexible products are those including an important energy component (COICOP 4 and 7) while the most rigid ones are as expected, food products, clothes and health products (COICOP 1, 3 and 6). The corresponding product dummy coefficients are not statistically significant when one uses the COICOP classification, but become more significant with the NACE classification, most likely due to a larger number of observations in the latter case (see Appendix C).

The most interesting conclusion that appears here is that the total number of outlets per 1000 inhabitants seems to affect price rigidity in the right direction. The more numerous the outlets selling a given product j are, the less rigid the prices of this product appears to be. This is in line with the prediction from the theory. It is then worthwhile going into a more detailed analysis of this impact. For that purpose, we have split the total number of outlets as explained just above. Unfortunately, given the correlations between the three categories we have considered (specialized shops, supermarkets, general stores) the estimated coefficients we get when we include them together are not significant. Including them separately tend to show that two of them have a favourable influence on price flexibility: the specialized shops and the general stores. (Large) supermarkets do not appear to exert the same influence on price rigidity as their competitors.

It is worthwhile mentioning that these results also hold when price rigidity is measured with our third indicator (see the last columns of Table 4.17 below). However, quite surprisingly given its high correlation with our first indicator, the results obtained using our second indicator did not lead to any significant result.

In order to check the robustness of our conclusions, we have also estimated regressions where the sample has been split in two parts. The first included products which are sold in specialized stores as well as in supermarkets and other non-specialized stores; the second included products which are sold only in specialized stores. Because the number of products in the COICOP classification we use is quite limited, this part of the analysis has been made using the NACE classification for which more groups of products can be defined, thus increasing the number of observations.

The results provided in Table 4.18 confirm the above conclusions. They show that, when considering separately products which can be sold both in specialized and non-specialized stores (i.e. general stores or supermarket) and those which are not, the estimated coefficients tend again to show that increased competition through a larger number of specialized shops or general stores is more effective than an increase in the number of supermarkets. However, when considering the products that are sold in specialized outlets only, increasing their number does not seem to have a very significant effect on price rigidity. But this might be partly due to the lower number of observations available for this

specific regression and/or to the higher heterogeneity of this category which includes services and some durable goods.

Table 4.17: Estimated Impact of the Number of Outlets per 1000 Inhabitants on Three Rigidity Indicators (COICOP Classification)

Indicator:	***Rigid*$_{A2}$**						***Rigid*$_{B}$**						***Rigid*$_{C}$**					
	coef.	**t-stat**	**coef.**	**t-stat**	**coef.**	**t-stat**	**coef.**	**t-stat**	**coef.**	**t-stat**	**coef.**	**t-stat**	**coef.**	**t-stat**	**coef.**	**t-stat**	**coef.**	**t-stat**
constant	1.51	5.00	1.23	4.24	2.04	4.99	0.57	5.57	0.56	5.95	0.57	4.77	2.64	2.91	1.55	1.78	3.12	3.10
01. Food and non alcoholic beverages	0.50	1.13	0.61	1.24	-0.02	-0.04	-0.27	-1.92	-0.27	-1.79	-0.28	-2.09	2.93	2.29	3.97	2.79	1.40	1.13
02. Alcoholic beverages, tobacco and narcotics	-0.82	-1.85	-0.82	-1.78	-0.96	-2.22	-0.56	-3.69	-0.56	-3.60	-0.57	-3.78	0.23	0.18	0.72	0.56	-0.49	-0.39
03. Clothing and footwear	0.49	1.13	0.57	1.23	0.05	0.13	0.17	1.15	0.17	1.08	0.16	1.19	5.99	4.70	7.00	4.95	4.51	3.63
04. Housing, water, electricity, gas and other fuels	-1.07	-2.14	-0.79	-1.57	-1.61	-2.82	-0.46	-3.24	-0.46	-3.31	-0.47	-2.98	-1.41	-1.13	-0.27	-0.22	-1.96	-1.47
05. Furnishing, household equipment and routine household maintenance	-0.35	-0.81	-0.27	-0.58	-0.77	-1.93	-0.33	-2.19	-0.32	-2.02	-0.33	-2.40	2.94	2.29	4.00	2.80	1.38	1.11
06. Health	0.69	1.59	1.02	2.20	-0.11	-0.21	-0.28	-2.11	-0.28	-2.02	-0.29	-1.90	-0.23	-0.17	1.30	0.93	-1.35	-0.92
07. Transport	-0.44	-1.10	-0.09	-0.21	-1.29	-2.60	-0.45	-3.12	-0.44	-2.80	-0.46	-2.83	-0.52	-0.42	1.41	1.04	-2.22	-1.66
09. Recreation and culture	-0.28	-0.68	-0.24	-0.58	-0.45	-1.14	-0.14	-1.00	-0.14	-0.99	-0.14	-1.03	4.26	3.49	4.60	3.69	3.76	3.03
12. Miscellaneous goods and services	ref.		ref.		ref.		ref.		ref.		ref.		ref.		ref.		ref.	
Total number of stores / population	-0.46	-2.65					-0.01	-0.11					-1.38	-3.79				
Number of specialized stores / population			-0.55	-2.36					-0.01	-0.10					-2.32	-3.55		
Number of general stores / population					-1.50	-2.72					-0.01	-0.10					-2.19	-3.23
Number of observations	32		32		32		73		73		73		78		78		78	
R^2	0.58		0.56		0.59		0.40		0.40		0.40		0.44		0.43		0.41	

Finally, we also consider the possible impact of wholesalers on price rigidity. Indeed, these agents contribute to the transmission (or non-transmission…) of producer price changes to the consumer level.

We include two different measures of their "importance" in the retail trade sector. The first reflects the structure of the retail sector. It is defined as the ratio of the number of wholesalers to that of retail outlets selling a product j. The second one is the analogue of the above indicators for retail trade, i.e. the number of wholesalers per 1000 inhabitants. Unfortunately, the number of observations available for running these regressions is limited by the absence of wholesalers data for some groups of goods/services. The results

Table 4.18: Estimated Impact of the Number of Outlets per 1000 Inhabitants on the RigidA2 Indicator per Type of Product (NACE classification)

	Products sold in specialized stores and supermarkets						**Products not sold in supermarkets**	
	coef.	**t-stat**	**coef.**	**t-stat**	**coef.**	**t-stat**	**coef.**	**t-stat**
constant	1.004	2.85	0.365	0.67	1.184	2.68	0.701	2.02
15. Manuf. of food products and beverages	0.142	0.30	0.544	1.06	0.544	1.14		
16. Manuf. of tobacco products	-0.549	-1.11	-0.355	-0.64	-0.261	-0.50		
18. Manuf. of wearing apparel. dressing. dyeing of fur	1.486	2.75	0.681	1.33	0.681	1.43		
19. Tanning & dressing of leather. manufacture of luggage. etc	0.703	1.55	0.791	1.54	0.791	1.65		
22. Publishing. printing & reproduction of recorded media	1.721	2.90	0.670	1.31	0.670	1.40		
23. Manuf. of coke. refined petroleum products. nuclear fuel	0.520	1.13	0.725	1.41	0.725	1.52		
24. Manuf. of chemicals & chemical products	1.596	3.32	1.160	2.26	1.160	2.43		
29. Manuf. of machinery & equipment n.e.c	-0.050	-0.11	-0.050	-0.10	-0.050	-0.10		
32. Manuf. of radio. TV. communication equipment	ref.		ref.		ref.			
33. Manuf. of medical. precision & optical instruments. watches							0.013	0.03
34. Manuf. of motor vehicles. trailers & semi-trailers							1.178	2.00
36. Manuf. of furniture; manufacturing n.e.c.							0.528	0.85
40. Electricity. gas. steam and hot water supply							0.384	0.70
41. Collection. purification. distribution of water							ref.	
Number of specialized stores / population	-1.621	-2.73					-1.065	-1.65
Number of supermarkets / population			3.250	0.58				
Number of general stores / population					-1.087	-2.04		
Number of observations	35		35		35		17	
R^2	0.49		0.35		0.44		0.37	

are presented in Table 4.19 below. None of them appear to have any significant impact on price rigidity. This again may be due to the ambiguous meaning of the "raw" number of wholesalers. A larger number of wholesalers can be an indication of more competition, favourable to more price flexibility. But it may also mean that there are more

intermediaries through which the product has to go before reaching the consumer and this is likely to have the opposite effect. Again here, we are facing the limits of studying microeconomic behaviours with rather aggregate data

Table 4.19: Estimated Impact of the Number of Wholesalers on the RigidA2 Indicator (COICOP classification)

	coef.	**t-stat**	**coef.**	**t-stat**	**coef.**	**t-stat**	**coef.**	**t-stat**
Constant	1.469	4.28	1.309	5.15	1.499	3.73	1.218	5.65
01. Food and non alcoholic beverages	0.524	1.14			0.505	1.11		
02. Alcoholic beverages, tobacco and narcotics	-0.779	-1.63			-0.794	-1.13		
03. Clothing and footwear	0.527	1.14			0.515	0.78		
04. Housing, water, electricity, gas and other fuels	-1.180	-1.89			-1.061	-1.89		
05. Furnishing, household equipment and routine household maintenance	-0.312	-0.68			-0.324	-0.50		
06. Health	0.715	1.58			0.701	1.39		
07. Transport	-0.399	-0.92			-0.418	-0.74		
09. Recreation and culture	-0.258	-0.61			-0.270	-0.62		
12. Miscellaneous goods and services	ref.				ref.			
Total number of stores / population	-0.463	-2.60	-0.314	-1.76	-0.476	-1.60	-0.433	-2.15
Number of wholesalers / Number of retail stores	0.084	0.30	-0.143	-0.59				
Number of wholesalers / population					0.069	0.06	0.923	1.32
Number of observations	32		32		32		32	
R^2	0.59		0.10		0.58		0.14	

4.3.5. Conclusions

Our results indicate that a larger number of retailers has a positive effect on price flexibility. However, the number of large supermarkets does not seem to have a significant effect on price flexibility. Food products are not as flexible as one might think. This may explain the result. Another possible explanation lies in marketing policies. As previously emphasized, a Hi-Lo policy may increase the frequency of price changes in supermarkets. However, these price changes may be quite disconnected from movements in costs. In other words, when the management chooses a policy of frequent price changes, this need not imply that prices are flexible.

V. PRODUCER PRICE RIGIDITY IN THE EURO AREA.

5.1. Assessing the Degree of Producer Price Rigidity across Sectors and Countries

We now turn to the analysis of producer prices. As already mentioned, much less is known about producer than about consumer prices. The early studies relied on data collected directly by researchers. This is possible for consumer prices, which can be checked in stores, but not for producer prices. In the IPN project, fewer statistical offices released producer prices, and they have been less complete than the consumer data sets. An additional difficulty is that many (if not majority) of producer products do not have fixed prices; the transaction price depends on the size of the purchase, relationship with the customer etc. Furthermore, a producer price is less meaningful than a consumer price. What matters is the total effective cost of transaction which depends on warranty terms, delivery timing and conditions etc.

The character of exchange is also different in case of business to business (B2B) and business to consumer transactions. Parties in the B2B transactions are typically better informed, often interact directly with each other, and have non-anonymous repeated relationships. Not surprisingly, firms attach great importance to the repeated nature of the transactions, as evidenced by the survey responses stressing the importance of implicit and explicit contracts.

In the end, however, the process of changing producer prices is not dissimilar from the process of changing consumer prices. A decision has to be made, the new optimal price computed, reaction of competitors and customers taken into account, sales personnel informed etc. In particular, the costs of adjustment for some B2B transactions are quite high. Levy *et al* (1999) analyze price adjustment for an industrial firm and report that about 30% of the cost of price change is related to the physical costs as well as the cost of the decision process, and the remaining 70% involves the costs of communicating the price change and bargaining with customers; most of this cost is the cost of travel and time for sales managers. So we expect that the general results for producer price changes will be similar to those for consumer price changes.

While the degree of consumer price rigidity could be assessed with all three indicators, data only allow analyzing producer price rigidity with our third indicator. As discussed in Section 3, the third indicator requires NACE 2 digit information about the average size of price changes and the volatility of the relevant producer price index. Such information is available in four countries: Belgium, Germany, France and Spain. The sectoral coverage varies across countries. In general, all the manufacturing sector (NACE 2x and NACE 3x sectors) is covered in the four countries. The values of the third indicator are provided in

Table 5.1. The NACE 2 digit sectoral frequency of price changes (also available for Portugal) is presented in Table 5.2.

Table 5.1: *Rigid*$_C$ Indicator of Producer Price Rigidity by NACE 2 Digit Sectors

NACE 2 digit sector	Belgium			Germany			France			Spain		
	$\Delta p \neq 0$	**$\Delta p > 0$**	**$\Delta p < 0$**	**$\Delta p \neq 0$**	**$\Delta p > 0$**	**$\Delta p < 0$**	**$\Delta p \neq 0$**	**$\Delta p > 0$**	**$\Delta p < 0$**	**$\Delta p \neq 0$**	**$\Delta p > 0$**	**$\Delta p < 0$**
10	**-**	-	-	**-**	-	-	**-**	-	-	**1.27**	1.25	*1.28*
13	**1.22**	1.10	*1.51*	**-**	-	-	**-**	-	-	**-**	-	-
14	**3.45**	3.80	*2.73*	**-**	-	-	**0.41**	0.40	*0.44*	**1.05**	1.06	*1.04*
15	**3.26**	3.26	*3.26*	**1.50**	1.50	*1.50*	**0.90**	0.93	*0.86*	**0.66**	0.68	*0.64*
16	**-**	-	-	**-**	-	-	**0.23**	0.27	*0.12*	**0.23**	0.26	*0.15*
17	**4.52**	4.05	*5.06*	**3.40**	3.34	*3.47*	**3.12**	3.06	*3.19*	**1.02**	1.02	*1.02*
18	**4.06**	4.87	*3.38*	**4.41**	3.97	*5.08*	**3.78**	3.42	*4.20*	**2.24**	2.04	*2.57*
19	**2.06**	2.06	-	**1.32**	0.97	*2.24*	**1.92**	1.80	*2.19*	**0.88**	0.84	*0.97*
20	**1.69**	1.71	*1.67*	**3.00**	3.17	*2.86*	**1.75**	1.77	*1.72*	**0.81**	0.81	*0.80*
21	**1.62**	1.46	*1.77*	**0.64**	0.70	*0.57*	**0.82**	0.87	*0.75*	**0.42**	0.45	*0.39*
22	**0.49**	0.37	*0.70*	**5.07**	4.22	*6.12*	**-**	-	-	**0.77**	0.82	*0.69*
23	**0.55**	0.47	*0.65*	**0.19**	0.22	*0.16*	**0.37**	0.40	*0.34*	**0.65**	0.65	*0.64*
24	**1.29**	1.21	*1.38*	**1.72**	1.76	*1.68*	**1.25**	1.25	*1.25*	**0.64**	0.68	*0.60*
25	**1.79**	1.93	*1.64*	**3.27**	3.27	*3.27*	**2.38**	2.59	*2.16*	**0.93**	0.95	*0.90*
26	**2.02**	2.16	*1.81*	**6.53**	6.14	*6.89*	**0.71**	0.69	*0.73*	**0.86**	0.86	*0.84*
27	**0.58**	0.59	*0.57*	**0.71**	0.70	*0.72*	**0.54**	0.59	*0.47*	**0.38**	0.38	*0.37*
28	**1.34**	1.11	*1.63*	**2.51**	2.51	*2.51*	**2.04**	2.14	*1.88*	**0.75**	0.77	*0.72*
29	**4.98**	4.16	*6.15*	**1.60**	1.45	*1.96*	**2.00**	1.95	*2.10*	**0.91**	0.94	*0.82*
30	**0.62**	0.38	*1.01*	**0.60**	0.64	*0.59*	**-**	-	-	**0.87**	0.64	*1.11*
31	**2.84**	2.51	*3.14*	**3.39**	3.25	*3.54*	**2.89**	2.83	*2.97*	**0.93**	0.94	*0.92*
32	**2.70**	2.65	*2.73*	**1.36**	1.31	*1.39*	**1.85**	1.83	*1.86*	**4.54**	4.45	*4.64*
33	**0.13**	0.10	*0.17*	**2.62**	2.47	*2.87*	**-**	-	-	**0.73**	0.75	*0.71*
34	**2.52**	2.62	*2.37*	**1.03**	0.97	*1.24*	**1.48**	1.55	*1.40*	**0.55**	0.54	*0.58*
35	**1.08**	1.08	-	**1.97**	1.72	*2.69*	**-**	-	-	**0.52**	0.55	*0.44*
36	**0.79**	0.79	*0.79*	**1.03**	1.05	*0.99*	**1.73**	1.67	*1.85*	**0.88**	0.88	*0.88*
40	**0.48**	0.37	*0.70*	**-**	-	-	**1.65**	1.95	*1.29*	**1.09**	1.01	*1.20*
41	**0.81**	0.74	*0.99*	**-**	-	-	**0.19**	0.19	*0.19*	**-**	-	-

Source : Own computation

We also use, as an alternative measure of price rigidity, the frequency of price changes. As argued above, in general it is not a reliable measure of price rigidity because different products are produced using different inputs with costs that do not all vary in the same direction and/or with the same magnitude. Thus, the underlying dynamics of costs may be very different between two given sectors. Based on this argument, bivariate analysis which link the frequency of price changes to a structural variable such as the sectoral mark-up or the sectoral Lerner indicator are not very informative on the link between

competition and price rigidity because sectoral differences in cost structure are neglected. Now, does it mean that the frequency of price changes is useless for the sectoral analysis of price rigidity? In many cases, the frequency of price changes is the only measure available. However, because our estimates rely on a multivariate analysis that relates the frequency of price changes to a bunch of indicators, including cost structure indicators, we can interpret our estimations as analysis of the determinants of price rigidity. Furthermore, as can be seen in Table 5.4, the (negative) correlation between $Rigid_C$ and the frequency of price changes is quite high in absolute value. Therefore, unlike for consumer prices, we use the frequency of producer price changes below to assess price rigidity. This allows us to use a wider sample of countries

Table 5.2: Frequency of Producer Price Changes by NACE 2 Digit Sectors

NACE 2 digit sector	Belgium[1]		Germany[3]		France[4]		Italy[5]		Portugal[6]		Spain[7]	
	$\Delta p \neq 0$	$\Delta p > 0$	$\Delta p \neq 0$	$\Delta p > 0$	$\Delta p \neq 0$	$\Delta p > 0$	$\Delta p \neq 0$	$\Delta p > 0$	$\Delta p \neq 0$	$\Delta p > 0$	$\Delta p \neq 0$	$\Delta p > 0$
10	-	-	-	-	4.3	2.9	-	-	-	-	74.5	38.1
13	10.02[2]	7.0	-	-	-	-	-	-	-	-	-	-
14	10.42[2]	7.0	-	-	15.8	11.1	-	-	-	-	17.2	9.9
15	23.3	11.1	27.7	14.4	31.3	17.0	26.5	13.5	20.7	-	26.8	15.0
16	12.02[2]	11.0	-	-	14.5	11.0	-	-	9.3	-	27.1	18.1
17	18.9	7.8	18.4	9.7	11.3	5.9	13.6	7.9	9.0	-	11.1	6.6
18	13.3	4.1	8.3	5.0	6.9	3.7	-	-	5.0	-	10.0	6.3
19	12.4	3.8	8.6	6.2	7.9	5.6	14.1	8.2	-	-	13.1	8.9
20	22.8	5.2	20.4	9.5	11.3	6.5	8.9	7.4	12.2	-	10.2	6.7
21	26.6	12.7	29.7	16.1	19.1	10.4	23.8	13.4	-	-	32.7	17.0
22	18.1	6.6	17.0	9.4	12.0	6.7	0.8	0.8	-	-	12.5	8.1
23	89.02[2]	51.0	94.2	46.5	85.0	46.1	-	-	66.5	-	93.1	49.5
24	22.2	18.8	30.9	15.8	23.2	13.0	16.7	9.8	11.1	-	29.5	15.9
25	18.2	12.5	14.8	7.6	12.5	6.5	6.8	3.9	7.1	-	15.4	8.7
26	17.8	9.3	24.0	11.5	22.9	13.0	21.9	12.0	4.0	-	15.8	9.4
27	45.3	37.5	48.6	26.8	52.4	30.1	27.2	13.4	24.3	-	55.2	29.3
28	16.8	10.3	13.8	7.7	11.5	6.8	3.8	3.0	3.2	-	11.1	7.2
29	12.0	3.9	8.3	5.9	9.5	6.1	10.8	7.2	-	-	7.8	5.5
30	31.6	31.0	29.9	8.3	16.7	7.4	5.5	2.8	-	-	16.6	8.4
31	14.8	4.2	18.1	9.3	13.7	7.8	24.1	7.1	16.6	-	15.0	8.7
32	14.8	6.8	13.8	4.7	14.7	4.5	6.0	1.7	-	-	9.0	4.6
33	8.6	3.7	8.9	5.5	8.7	6.0	1.5	0.9	-	-	8.6	5.2
34	6.5	3.6	7.9	6.3	15.6	8.6	2.8	2.7	-	-	13.4	9.2
35	12.6	4.0	5.9	4.4	8.9	6.1	8.5	5.4	-	-	10.3	7.6
36	9.2	4.0	8.9	6.4	10.0	6.7	3.3	2.9	17.9	-	8.8	6.5
40	63.52[2]	42.2	-	-	21.5	11.8	-	-	-	-	7.9	4.4
41	14.02[2]	10.0	-	-	20.6	16.8	-	-	-	-	-	-

Sources : [1]Dhyne (2008); [2] Cornille and Dossche (2008); [3]Stahl (2006); [4]Gautier (2008); [5]Sabbatini *et al.* (2005); [6] Dias, Dias and Neves (2004); [7] Álvarez, Burriel and Hernando (2008);

In order to identify the sectors characterized by a high degree of price rigidity, we have run a principal component analysis using i) the set of the 3 standardized $Rigid_C$ indicators for the four euro area countries, ii) the set of the3 standardized $Rigid_C$ indicators augmented by the set of standardized frequencies of price changes / increases / decreases for the four countries for which $Rigid_C$ indicator is available. This exercise has been done for the 16 sectors that are observed in all four countries. The first component summarizes 52% (for the first set of 12 variables) and 62% (for the second set of 24 variables) of the total variance of the standardized dataset.
In the case of the first set of variables, the first component is given by

$$\begin{aligned} PCA1_i = {} & 0.3212 Rigid_{C,\mathrm{BEL}} + 0.3415 Rigid^{+}_{C,BEL} + 0.2829 Rigid^{-}_{C,BEL} + \\ & 0.2534 Rigid_{C,\mathrm{GER}} + 0.2450 Rigid^{+}_{C,GER} + 0.2668 Rigid^{-}_{C,GER} + \\ & 0.3494 Rigid_{C,\mathrm{FRA}} + 0.3400 Rigid^{+}_{C,FRA} + 0.3540 Rigid^{-}_{C,FRA} + \\ & 0.2165 Rigid_{C,\mathrm{SPA}} + 0.2106 Rigid^{+}_{C,SPA} + 0.2246 Rigid^{-}_{C,FRA} \end{aligned}$$

while in the case of the second set of variables, it is given by

$$\begin{aligned} PCA1_i = {} & 0.1707 Rigid_{C,BEL} + 0.1776 Rigid^{+}_{C,BEL} + 0.1529 Rigid^{-}_{C,BEL} + \\ & 0.1396 Rigid_{C,\mathrm{GER}} + 0.1382 Rigid^{+}_{C,GER} + 0.1441 Rigid^{-}_{C,GER} + \\ & 0.1996 Rigid_{C,\mathrm{FRA}} + 0.1998 Rigid^{+}_{C,FRA} + 0.1970 Rigid^{-}_{C,FRA} + \\ & 0.0969 Rigid_{C,\mathrm{SPA}} + 0.0955 Rigid^{+}_{C,SPA} + 0.0991 Rigid^{-}_{C,SPA} + \\ & -0.2417 Freq_{\mathrm{BEL}} - 0.2452 Freq^{+}_{BEL} - 0.1812 Freq^{-}_{BEL} + \\ & -0.2483 Freq_{\mathrm{GER}} - 0.2517 Freq^{+}_{GER} - 0.2420 Freq^{-}_{GER} + \\ & -0.2492 Freq_{\mathrm{FRA}} - 0.2502 Freq^{+}_{FRA} - 0.2447 Freq^{-}_{FRA} + \\ & -0.2521 Freq_{\mathrm{SPA}} - 0.2526 Freq^{+}_{SPA} - 0.2508 Freq^{-}_{SPA} \end{aligned}$$

In order to build a composite indicator of downward price rigidity, we have run a third PCA exercise based on the subset of the 4 standardized Rigid_C indicators for price decreases and on the 4 standardized frequencies of price decreases. For this exercise, the first PCA summarize 57% of the total variance and is given by

$$\begin{aligned} PCA1_i = {} & 0.2692 Rigid^{-}_{C,BEL} + 0.25231 Rigid^{-}_{C,GER} + 0.3472 Rigid^{-}_{C,FRA} + 0.1531 Rigid^{-}_{C,SPA} + \\ & - 0.3520 Freq^{-}_{BEL} - 0.4440 Freq^{-}_{GER} - 0.4433 Freq^{-}_{FRA} - 0.4497 Freq^{-}_{SPA} \end{aligned}$$

In all cases, the first component is increasing in the standardized $Rigid_C$ indicators. In the second and third cases, it is also decreasing in the standardized frequencies. Therefore we can use these components as an aggregate rigidity index for the euro area and use this composite indicator to classify the NACE sectors according to the degree of price rigidity. The first component associated to the third exercise will specifically classify sectors according to the degree of downward price rigidity.

The three composite indicators are provided in Table 5.3. Based on these two composite indicators, we find low degree of price rigidity in the following five manufacturing sectors: NACE 23 ‘Manufactures of coke, refined petroleum products, nuclear fuel’,

NACE 27 'Manufactures of basic metals', NACE 21 'Manufactures of paper and paper products', NACE 24 'Manufactures of chemicals and chemical products' and, to a lesser extent, NACE 36 'Manufactures of furniture' and NACE 15 'Manufactures of food products and beverages'. The sectors with rigid prices are NACE 17 'Manufacture of textile' NACE 18 'Manufacture of wearing apparel, dressing, dyeing of fur', NACE 29 'Manufacture of machinery and equipment n.e.c', NACE 31 'Manufacture of electrical machinery and apparatus' and NACE 32 'Manufacture of radio, TV and communication equipment'.

Table 5.3: The Ranking of NACE Sectors using the Composite Indicators.

	PCA 1 (1st set)		PCA 1 (2nd set)		PCA 1 (3rd set)	
NACE	Estimated score	Ranking	Estimated score	Ranking	Estimated score	Ranking
15	-0.847	7	-1.077	5	-0.751	4
17	3.452	15	3.019	15	1.623	14
18	5.256	16	4.662	16	2.549	16
20	-0.211	9	0.848	7	0.137	6
21	-2.603	3	-1.933	3	-1.187	3
23	-3.847	1	-11.287	1	-6.541	1
24	-1.716	4	-1.354	4	-0.502	5
25	0.736	11	1.527	11	0.815	11
26	0.537	10	0.676	6	0.369	7
27	-3.583	2	-5.638	2	-2.615	2
28	-0.428	8	1.156	10	0.776	10
29	1.728	12	2.796	14	1.780	15
31	2.007	13	2.170	12	1.132	13
32	2.193	14	2.317	13	0.893	12
34	-0.988	6	1.127	9	0.758	8
36	-1.686	5	0.992	8	0.762	9

Source : Own computation

In terms of sectoral ranking, our indicators seem to indicate that sectors that use a large share of raw material inputs (refined petroleum, basic metal) have more flexible prices. At the other end of the rigidity spectrum we find manufacturing of durable and capital goods. Somewhat surprisingly, the textile sector is also characterized by a high level of intrinsic price rigidity.

The sectoral ranking is only slightly affected when the frequencies are included in the principal component exercise (mostly for the sectors in the middle of the distribution) and do not differ when focusing on downward price rigidity.

The correlation between our third indicator and the frequency of price changes is negative (see table 5.4 below). While not perfect, in some countries (France, Spain) it is large in absolute value. This suggests that, unlike in the case of consumer prices, the frequency of price changes can provide a reasonable estimate of the degree of nominal price rigidity for

producer prices. That permits us to extend the set of countries being analyzed beyond the four countries for which the $Rigid_C$ indicator can be calculated.

Table 5.4: Correlations between $Rigid_C$ and the Frequency of Price Changes

	Belgium	**Germany**	**France**	**Spain**
Linear correlation				
Common sample (16 sectors)	-0.47	-0.39	-0.67	-0.31
Country specific sample	-0.36	-0.33	-0.52	-0.19
Spearman Rank correlation				
Common sample (16 sectors)	-0.45	-0.31	-0.75	-0.72
Country specific sample	-0.26	-0.25	-0.71	-0.41

Source : Own computation

5.2. Explaining Producer Price Rigidity.

The purpose of this section is to conduct an econometric analysis of the determinants of price rigidity in the euro area manufacturing sector. To do so, we consider the 6 euro area countries analyzed in Vermeulen *et al.* (2007): Belgium, Germany, France, Italy, Portugal and Spain. For these countries we have data on the frequency of price changes at the NACE 2 digit level. As mentioned in the previous section, the frequency of price changes may sometimes be a poor indicator of price rigidity and our third indicator of price rigidity should be preferred for such an econometric exercise. But since the number of sectors/countries for which we have information on the frequency of price changes is larger than the number of sectors/countries for which we can compute our third indicator, the analysis focuses on the frequency of price changes instead of the RigidC indicator.

The problem with using the frequency of price changes to analyze price rigidity, especially in bivariate analysis, is that sectoral differences in the frequency may be due to of differences in production costs, rather than price rigidity. Therefore, in order to draw meaningful conclusions, the differences in the cost structure across the sectors have to be controlled for. Thus, in this section, we provide both a bivariate analysis of the link between the frequency of price changes (or our third indicator whenever appropriate) and potential explanatory factors of price rigidity and price stickiness and we also conduct a multivariate econometric analysis that controls for sectoral cost differences.

Analyses of the determinants of price stickiness had already been done at the national level in six countries: Cornille and Dossche (2008) and Dhyne (2008) for Belgium, Stalh (2006) for Germany, Gautier (2008) for France, Sabbatini *et al.* (2005) for Italy, Dias, Dias and Neves (2004) for Portugal and Álvarez, Burriel and Hernando (2008) for Spain. The main results that emerge from the national analyses are that the share of energy products in the cost structure of a sector increases the frequency of price changes while the

share of labour costs reduces the frequency of price changes. The impact of competition on the frequency of price changes is less obvious. To our knowledge, this is the first cross-country analysis on this issue. This section considers whether the same conclusions are obtained from the analysis of harmonized cross-country/cross-sector data.

5.2.1. Data and Variables.

As mentioned above, we have collected for this paper all the quantitative evidence available on the frequency of producer price changes in euro area countries. Based on the statistical information published in Vermeulen *et al.* (2007), Cornille and Dossche (2008), Stahl (2006), Gautier (2008), Sabbatini *et al.* (2005), Dias, Dias and Neves (2004), Álvarez, Burriel and Hernando (2008) and in Section 6.4., we have built a panel data set of frequencies of price changes in 6 euro area countries at the NACE 2 digit level.

To explain the cross-sector / cross-country differences in the frequency of price changes, we use the national input-output tables for 2000 that are available on the Eurostat website. We use four indicators of cost structure: the share of energy inputs in total costs, the share of labour in value added, the share of imported inputs and a measure of production complexity.

Product market competition is considered to be an important factor through which policy can affect price rigidity. To assess the effect of the degree of product market competition we use two measures of domestic market competition and one of international competition. The first domestic measure is the sectoral Lerner index, which is a proxy of the degree of domestic competition. The second is the sectoral mark-up, as estimated in Christopoulou and Vermeulen (2008). The measure of the degree of international competition is the degree of openness to international trade. These measures and the way they affect the frequency of price changes are described in the following sub-sections.

The share of energy inputs

We define the share of energy inputs as:

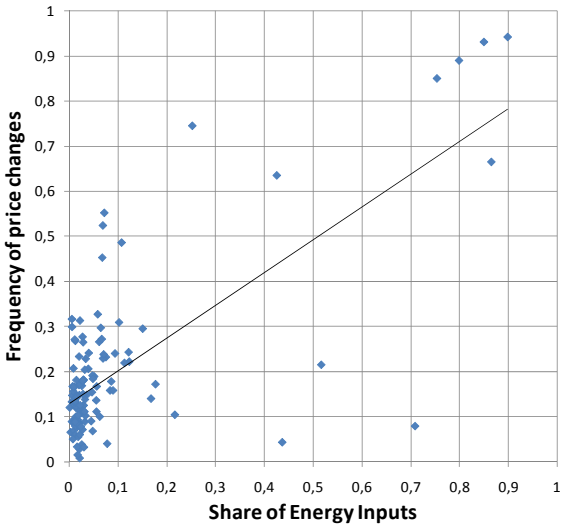
$$Energy_{ij} = \frac{Input_{10ij} + Input_{11ij} + Input_{23ij} + Input_{40ij}}{Tcosts_{ij}} \qquad (12)$$

where $Input_{10ij}$, $Input_{11ij}$, $Input_{23ij}$, $Input_{40ij}$ are, respectively, the demand of sector i in country j for products in the following categories: CPA 10 "Coal and lignite; peat", CPA 11 "Crude petroleum and natural gas", CPA 23 "Coke, refined petroleum products and

nuclear fuels" and CPA 40 "Electricity, gas, steam and hot water". $Tcosts_{ij}$ denotes the total production costs (including labour costs) of sector i in country j.[65]

As prices of raw materials, and in particular prices of oil products are volatile, the price of a product that has a large share of energy inputs should change more frequently than the price of a product that needs little energy to be produced. Based on Figure 5.1, this relation seems to hold.[66] The simple correlation between the two series (not controlling for potential country effect) is 0.7274 and is significant at all standard levels of significance.

Figure 5.1: Frequency of Price Changes and Energy Content



Source : Own computation

The share of labour inputs

We define the share of labour inputs as:

$$Labour_{ij} = \frac{WB_{ij}}{VA_{ij}} \tag{13}$$

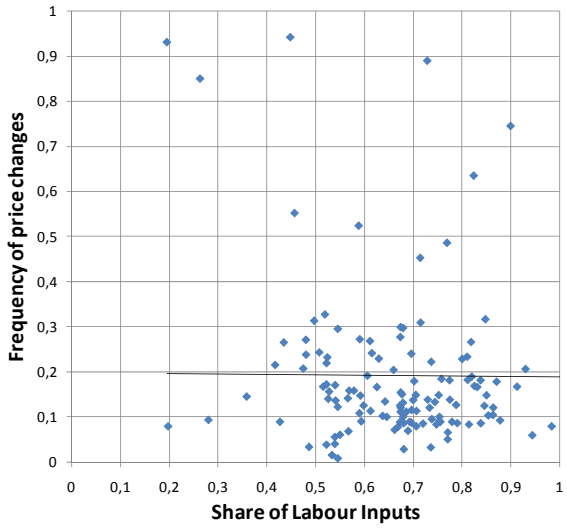
[65] The CPA classification is the EU official classification of products by activity. In the input-output tables, the NACE sectors are found in columns while the CPA products are found in rows. A single entry Aij in the input-output table gives the amount of product i used by sector j.

[66] It may be mostly driven by the NACE 23 sector 'Coke, refined petroleum products and nuclear fuels'.

where WB_{ij} and VA_{ij} are respectively the total wage bill and the value added of sector i in country j.

Since wages change quite infrequently, usually once a year (see Heckel *et al.*, 2008), the price of a product that requires a large share of labour inputs should change less often than the price of a product with low labour share. Based on Figure 5.2, this relation seems to hold but it is not as strong as with our first explanatory variable. In fact, the simple correlation between the two series (not controlling for potential country effects) is equal to -0.0415, which is not significantly different from 0.

Figure 5.2: Frequency of Price Changes and Labour Share



Source : Own computation

The share of imported inputs

We define the share of imported inputs as:

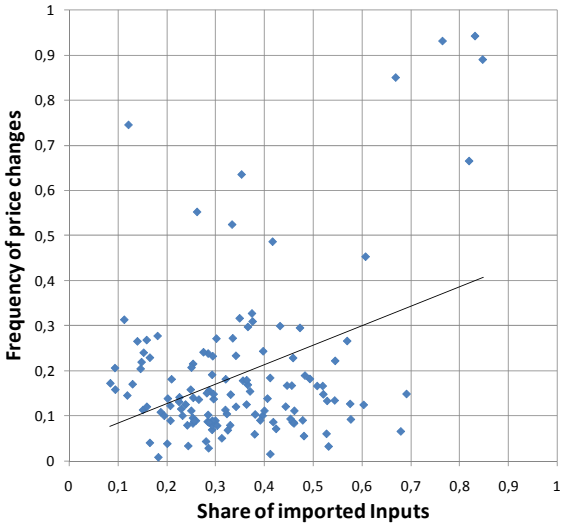
$$Import_{ij} = \frac{TImported_{ij}}{TInputs_{ij}} \tag{14}$$

where $TImported_{ij}$ and $TInputs_{ij}$ are, respectively, total imports of material inputs and total material inputs used by sector i in country j.

In general, prices of imported inputs may vary more frequently than prices of domestic inputs due to exchange rate volatility and/or due to more intense competition on the

international markets. Therefore the price of a product that requires a large share of imported inputs should change more frequently than the price of a product that needs few imported inputs to be produced. Based on Figure 5.3, this relation seems to hold. The simple correlation between the two series (not controlling for potential country effect) is equal to 0.3850 and is significantly positive at all standard level of significance.

Figure 5.3: Frequency of Price Changes and Import Content



Source : Own computation

An indicator of production complexity

We define production complexity using the following indicator

$$Complexity_{ij} = 1 - \sum_{l=1}^{59} \left(\frac{Input_{ijl}}{TInputs_{ij}} \right)^2 \tag{15}$$

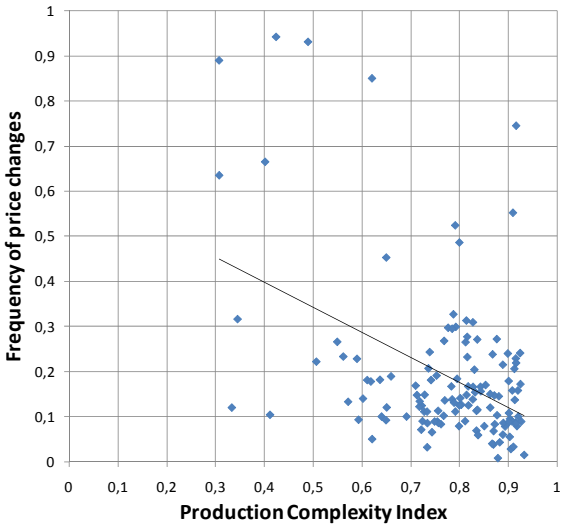
where $Input_{ijl}$ denotes the inputs of product category l consumed by sector i in country j.

This indicator is equal to 1 minus a Herfindhal index computed using the production cost structure of each sector. If a sector uses only one input, the complexity index is equal to 0. If it equally uses inputs from all the 59 CPA 2 digit products (which describes the most complex production process), the complexity indicator is close to unity (0.985). It is worth mentioning that the computation of the complexity index uses the contribution of all

59 CPA 2 digit products (including services and trade) and not only the contribution of inputs produced by the manufacturing sector.

When the prices of different inputs evolve in different directions (some increase, some remain constant, some decrease), the incentive to change the price of the final product may be reduced. This suggests that the price of a product that requires many different inputs should change less frequently than the price of a product that needs only one main input to be produced. Based on Figure 5.4, there indeed seems to be a negative relation between the frequency of price changes and our complexity indicator. The simple correlation between the two series (without controlling for potential country effect) is equal to -0.4428 and is significantly negative at all standard level of significance.

Figure 5.4: Frequency of Price Changes and Production Complexity



Source : Own computation

The degree of domestic product market competition.

The first measure the degree of product market competition is the Lerner index at the sectoral level. In the literature, this indicator is defined as percentage mark-up over marginal costs:

$$Lerner = \frac{Price - Marginal\ Cost}{Price} \tag{16}$$

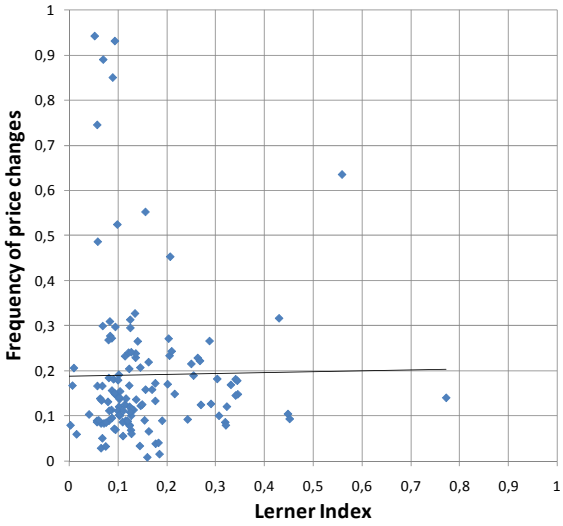
This measure captures the degree of market power of producers. Empirically, we approximate it by:

$$Lerner_{ij} = \frac{VA_{ij} - WB_{ij}}{Prod_{ij}} \tag{17}$$

where $Prod_{ij}$ is the production of sector i in country j.

Sectors with small values of the Lerner index are characterized by more intense product market competition than sectors with high values of the Lerner index. In markets with low degree of competition or high mark-ups firms can absorb changes in marginal costs without changing their prices. Therefore sectors with high values of the Lerner index should be characterized by less frequent price changes. However, based on Figure 5.5, there seems to be no strong relation between these two variables. Indeed, the simple correlation between the two series (without controlling for potential country effect but excluding 2 outliers characterized by negative values of the Lerner index) is not significantly different from zero at all standard significance levels (-0.0216).

Figure 5.5: Frequency of Price Changes and Product Market Competition (Lerner Index)



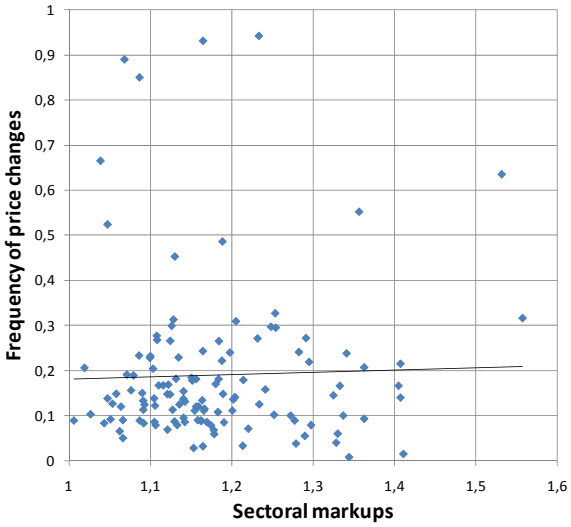
Source : Own computation

The second measure of domestic product market competition we use is the measure of sectoral mark-ups estimated in Christopoulou and Vermeulen (2008), henceforth C-V index.[67] As indicated in Figure 5.6, there seems to be no strong link between the sectoral mark-ups and the frequency of price changes. Indeed, the simple correlation between the

[67] Christopoulou and Vermeulen (2008) do not provide an estimate of sectoral markups in Portugal so, in order to use the largest cross-sectional sample, we computed for Portugal the markups using the methodology presented in Christopoulou and Vermeulen (2008) and the EU KLEMS database (March 2008 release).

two series (without controlling from potential country effect) is not significantly different from 0 at all standard level of significance (0.0295 with Portuguese data, 0.0726 without Portuguese data).

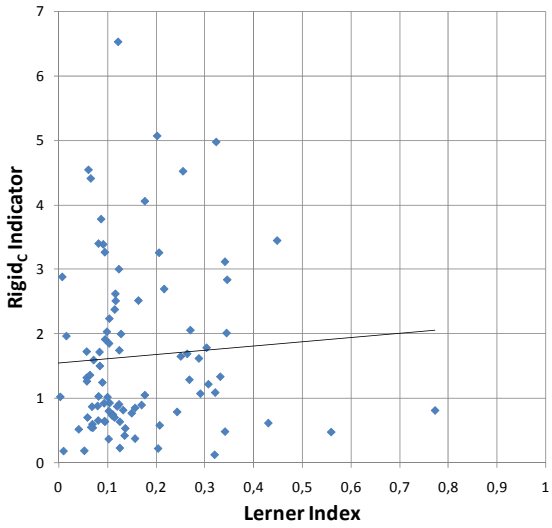
Figure 5.6: Frequency of Price Changes and Product Market Competition (C-V Index)



Source : Christopoulou and Vermeulen (2008), own computation

As discussed above, the relationship between the degree of competition and the frequency of price changes may be misleading in bivariate analysis since differences in the cost structure are not controlled for. Therefore we also consider the relationship between the two measures of domestic market competition and the $Rigid_C$ indicator of price rigidity (the only one available for producer prices). It is shown in Figure 5.7 below. We find that the degree of price rigidity seems to increase with the Lerner index but the relationship is still not significant: the simple correlation is 0.0936. A stronger but negative (and still non significant) correlation is found with the sectoral markups: the simple correlation is -0.2039. Based on the bivariate analysis, there is therefore little evidence on the link between product market competition and price rigidity.

Figure 5.7: $Rigid_C$ Indicator and Product Market Competition (Learner Index)



Source : Own computation

The degree of international competition

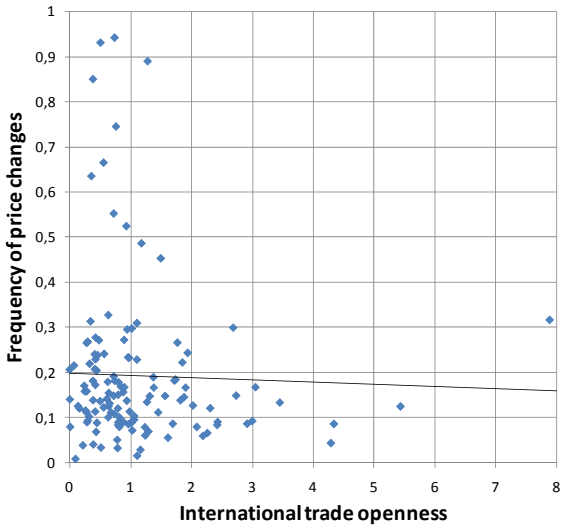
Finally, we compute an indicator of the degree of international competition as:

$$Opennes_{ij} = \frac{M_{ij} + X_{ij}}{Prod_{ij}} \tag{18}$$

where M_{ij} and X_{ij} are respectively the total imports of sector i in country j and the total exports of CPA product j from country i.

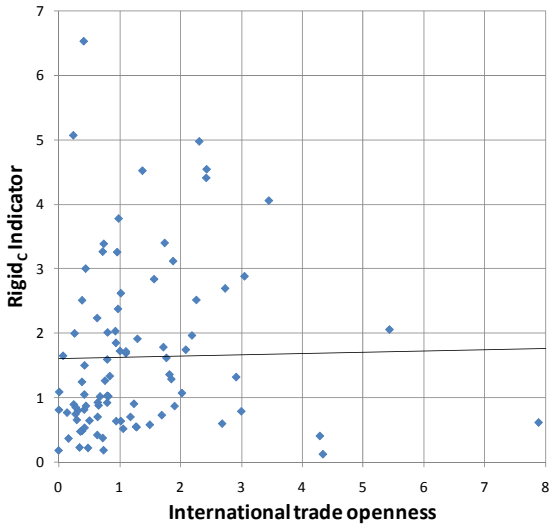
A larger exposure to international trade should increase the frequency of price changes both through more intense competition and through exchange rate pass-through into domestic prices. However, based on Figure 5.8, this relation does not seem to hold. Indeed, it seems that the relation between the two variables is actually negative. However, the simple correlation between the two series (not controlling for potential country effect) is equal to -0.0850, which is not significantly different from 0 at the standard levels of significance. The correlation between our third indicator of price rigidity and our measure of trade exposure (Figure 5.9) is also not significant (0.0545)

Figure 5.8: Frequency of Price Changes and Exposure to International Trade



Source : Own computation

Figure 5.9: $Rigid_C$ Indicator and Exposure to International Trade



Source : Own computation

The correlations for the bivariate relationships are summarized in Table 5.5. The bivariate analysis suggests that the higher is the share of energy or imported inputs the higher is the frequency of price changes in a given sector. Production complexity reduces the frequency of price adjustment. Competition either at the national or international level does not seem to play an important role. Therefore, cost structure seems to be the main determinant of the degree of price stickiness. This result from a harmonized data set is in line with the findings of individual countries' IPN papers summarized in Vermeulen *et al*. (2007) and the results presented in Section 6.6. But of course bivariate studies present only a partial

picture and so we now turn to econometric analysis of the determinants of the rigidity of producer prices.

Table 5.5: Summary of Bivariate Correlations

Correlation with	Frequency of price changes	RigidC Indicator
Share of energy inputs	0.727*	
Share of labour costs	-0.042	
Share of imported inputs	0.385*	
Production complexity	-0.443*	
Domestic competition (Lerner index)	-0.022[1]	0.094
Domestic competition (markup index[2])	0.073[3]	-0.204
International competition	-0.085	0.055

Notes: [1] Excluding two outliers with negative values of the Learner index.
[2] Based on Christopoulou and Vermeulen (2008)
[3] Excluding Portugal the value is 0.030
Significant values denoted with a '*'

5.2.2. Econometric Results

Explaining the frequency of price changes

We now turn to a multivariate econometric estimation of the determinants of price stickiness. We estimate the relation between our six explanatory factors and the frequency of price changes using two methods (i) a simple OLS regression and (ii) a nonlinear estimation method proposed by Papke and Wooldridge (1996)[68], with and without country dummies. Our results are summarized in Table 5.6.

Our best model, based on the Bayesian information criteria (BIC), is the QML model without country dummies**,** using the Lerner index as a measure of product market competition. Our comments will therefore focus on this specification. It is worth noting here that the results of the estimation are quite stable across the different specifications and, according to QML estimation, when controlling for all our explanatory variables there is no significant difference across countries.

[68] This estimation method explicitly takes into account the fact that the explained variable is only defined in the [0, 1] interval. OLS regressions could generate negative estimated frequencies or estimated frequencies larger than 1, which is not possible in the QML framework.

Table 5.6: Determinants of the Frequency of Producer Price Changes
(# obs = 130)

	OLS				QML			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Energy$_{ij}$	0.6613	0.6598	0.6797	0.5437	3.2115	3.0706	3.3404	2.3739
	(4.53)	(3.90)	(3.91)	(2.79)	(4.06)	(3.40)	(3.34)	(2.44)
					[0.4712]	[0.4463]	[0.4872]	[0.3426]
Labour$_{ij}$	-0.0783	*-0.0586*	-0.0887	*-0.0454*	-0.4876	*-0.3645*	-0.5188	*-0.2617*
	(-6.60)	(-1.64)	(-4.21)	(-1.30)	(-5.86)	(-1.88)	(-3.50)	(-1.36)
					[-0.0715]	[-0.053]	[-0.0757]	[-0.0378]
Import$_{ij}$	*-0.0183*	*0.0164*	*-0.0348*	*0.1367*	*-0.2992*	*0.0853*	-0.3391	*0.9185*
	(-0.22)	(0.16)	(-0.31)	(1.09)	(-0.50)	(0.12)	(-0.44)	(1.15)
					[-0.0439]	[0.0124]	[-0.0495]	[0.1326]
Complexity$_{ij}$	-0.3568	-0.2798	*-0.3125*	-0.4275	-2.3282	-1.8406	-2.0560	-2.7527
	(-2.26)	(-2.43)	(-1.53)	(-2.22)	(-2.57)	(-2.77)	(-1.76)	(-2.66)
					[-0.3413]	[-0.2675]	[-0.2999]	[-0.3973]
Lerner$_{ij}$	-0.2850	-	-0.3500	-	-1.7433	-	-2.0605	-
	(-2.42)		(-2.33)		(-2.51)		(-2.05)	
					[-0.2555]		[-0.3005]	
Markups$_{ij}$	-	*-0.0705*	-	*0.049*	-	*-0.3999*	-	*0.4226*
		(-0.62)		(0.39)		(-0.52)		(0.54)
						[-0.0581]		[0.0610]
Openness$_{ij}$	*-0.0035*	*0.0003*	-0.0047	*-0.0089*	*-0.0271*	*-0.0027*	-0.0378	*-0.0683*
	(-1.66)	(0.03)	(-2.03)	(-0.73)	(-1.48)	(-0.04)	(-1.79)	(-0.91)
					[-0.0040]	[-0.0004]	[-0.0055]	[-0.0099]
Constant	0.5216	0.4704	-	-	*0.7557*	*0.3278*	-	-
	(3.44)	(2.63)			(0.85)	(0.26)		
Belgium	-	-	0.5505	*0.3652*	-		0.8685	*-0.4796*
			(3.42)	(1.76)			(0.90)	(-0.35)
Germany	-	-	0.5283	0.4621	-		0.7848	*0.1885*
			(3.09)	(2.02)			(0.80)	(0.13)
France	-	-	0.5115	*0.4533*	-		0.6275	*0.1029*
			(2.83)	(1.92)			(0.60)	(0.07)
Italy	-	-	0.4727	*0.3996*	-		0.3265	*-0.3184*
			(2.61)	(1.63)			(0.31)	(-0.20)
Portugal	-	-	0.4521	*0.3404*	-		0.2196	*-0.7038*
			(2.80)	(1.51)			(0.23)	(-0.48)
Spain	-	-	0.5125	*0.4198*	-		0.6744	*-0.1165*
			(3.14)	(1.86)			(0.71)	(-0.08)
R^2	0.6173	0.6345	0.8347	0.8504	-	-	-	-
BIC	-172.43	-174.10	-156.22	-162.57	-589.15	-555.40	-565.47	-532.20

t-stat based on robust standard errors in brackets
Marginal effects at the sample mean in square brackets.
In italics, not significantly different from 0 at the 5% level

The estimation results confirm the positive relation between the energy content and the frequency of price changes. A larger energy content increases significantly the frequency of price changes. According to the QML estimates, an increase of 1 percentage point of the energy content increases, at the sample mean, the frequency of price changes by almost 0.5 percentage points (0.4712).

The other variables have a negative impact on the frequency of price changes. As expected, labour share and the degree of product's complexity reduce significantly the frequency of price changes. While the labour share has a relatively small impact (marginal effect of 0.0715 at the sample mean), the degree of product's complexity has a larger influence (marginal effect at the sample mean of -0.3413). Increased complexity negatively affects the frequency of price changes. As mentioned above, if a lot of different inputs enter in the production process of one good, the response of prices to changes in the price of one particular input might be relatively small because the change in production costs implied by this input might be compensated by changes in the price of other inputs.

Finally, we do not find any significant impact of the share of imported inputs on the frequency of price changes. While we expected a positive relation between these two variables, the estimated effect is negative but highly non significant (*t-stat* below 0.5).

In contrast to the bivariate analysis above and the national studies conducted within the IPN, the cross-country analysis also indicates that increasing sectoral competition, approximated by the Lerner index, raises significantly the frequency of price changes. However, when the product market competition is proxied by estimated sectoral markups, we find no significant link between price rigidity and product market competition. Therefore we obtain only weak evidence in favour of a negative relation between competition and price rigidity. It seems that product market competition is unable to explain cross-sector differentials in price stickiness / price rigidity. However, the degree of product market competition could partly explain cross-country differences in price rigidity. Therefore, fostering competition could reduce the cross-country differentials observed in the euro area.

The analysis does not cover the service sector for which the data are not available (except for our estimates of the frequency of price changes in some NACE 2 digit services sectors in Belgium in section 6.4). Our results indicate that, if our results can be extended to the service sector, fostering competition may have a limited effect on the frequency of price changes there. As services have high labour content, however, the frequency of price changes in services will always be low if structural reforms of the service markets do not go with any structural reforms of the labour market.

Finally, based on our estimation results, the degree of sectoral openness to international trade does not significantly influence the frequency of price changes. However, this is only based on cross-sectional analysis. In a time series perspective, this might not be the case. Nevertheless, based on these estimates, cross-sectors cross-country differences in the degree of openness to international trade do not explain cross-sector cross-country differences in the frequency of price changes.

Explaining the Frequency of Price Increases and Decreases

The analysis conducted in the previous sub-sections looked at price changes regardless of their direction. However, explanatory variables might affect differently the occurrence of

price increases and price decreases. Therefore, we replicate the econometric estimations presented above for price rises and price cuts separately. Table 5.7 presents the results obtained for the price increases equations while the results associated to the price decreases are summarized in Table 5.8.

Table 5.7: Determinants of the Frequency of Producer Price Increases (OBS# = 117)

	OLS				**QML**			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Energy$_{ij}$	0.3571 (4.13)	0.3352 (3.36)	0.3720 (3.72)	0.2740 (2.45)	2.2230 (4.45) [0.1943]	1.8445 (3.02) [0.1595]	2.3082 (3.69) [0.2002]	*1.2214* (1.70) [0.1047]
Labour$_{ij}$	-0.0447 (-5.25)	*-0.0216* (-0.34)	-0.0542 (-2.96)	*-0.0190* (-0.24)	-0.3532 (-3.96) [-0.0309]	*-0.2814* (-0.54) [-0.0243]	-0.4434 (-2.69) [-0.0385]	*-0.4504* (-0.70) [-0.0386]
Import$_{ij}$	*-0.0553* (-1.25)	*0.0016* (0.03)	*-0.0782* (-1.26)	*0.0593* (0.79)	*-1.0066* (-1.93) [-0.0880]	*-0.1745* (-0.27) [-0.0151]	*-1.1857* (-1.82) [-0.1028]	*0.3430* (0.48) [0.0294]
Complexity$_{ij}$	-0.2365 (-2.66)	-0.1972 (-2.91)	*-0.1935* (-1.62)	-0.2879 (-2.52)	-2.1432 (-3.19) [-0.1873]	-1.9251 (-3.48) [-01664]	*-1.7768* (-1.85) [-0.1541]	*-2.4995* (-3.01) [-0.2144]
Lerner$_{ij}$	-0.1733 (-2.27)	-	*-0.2255* (-1.81)	-	-1.2359 (-1.94) [-0.1080]	-	*-1.6542* (-1.55) [-0.1435]	-
Markups$_{ij}$	-	*-0.0532* (-0.66)	-	*-0.0037* (0.04)	-	*-0.3933* (-0.53) [-0.0340]	-	*0.2110* (0.29) [0.0181]
Openness$_{ij}$	*-0.0025* (-1.49)	*-0.0115* (-1.72)	*-0.0027* (-1.65)	*-0.0137* (-1.85)	*-0.0333* (-1.35) [-0.0029]	-0.1370 (-2.33) [-0.0119]	*-0.0350* (-1.47) [-0.0030]	-0.1693 (-2.72) [-0.0145]
Constant	0.3422 (3.96)	0.3232 (2.44)	-	-	*0.0853* (0.13)	*-0.0235* (-0.02)	-	-
Belgium	-	-	0.3538 (3.92)	0.2851 (2.14)	-	-	*0.1940* (0.28)	*-0.4898* (-0.42)
Germany	-	-	0.3272 (3.44)	0.3377 (2.42)	-	-	*-0.0255* (-0.03)	*-0.1000* (-0.08)
France	-	-	0.3286 (3.25)	0.3433 (2.42)	-	-	*-0.0238* (-0.03)	*-0.0661* (-0.05)
Italy	-	-	0.3029 (3.00)	0.3119 (2.12)	-	-	*-0.3980* (-0.50)	*-0.5557* (-0.44)
Spain	-	-	0.3305 (3.64)	0.3275 (2.35)	-	-	*0.0283* (0.04)	*-0.2224* (-0.19)
R^2	0.6272	0.6424	0.8397	0.8536	-	-	-	-
BIC	-299.49	-290.67	-284.14	-280.22	-520.33	-486.71	-501.46	-468.12

t-stat based on robust standard errors in brackets
Marginal effects at the sample mean in square brackets.
In italics, not significantly different from 0 at the 5% level

Table 5.8: Determinants of the Frequency of Producer Price Decreases (OBS# = 117)

	OLS				QML			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Energy$_{ij}$	0.2595	0.2279	0.2712	*0.1580*	1.4705	*0.8715*	*1.5102*	*0.0131*
	(3.36)	(2.40)	(2.88)	(1.63)	(2.24)	(1.19)	(1.31)	(0.02)
					[0.0988]	[0.0580]	[0.0982]	[0.0009]
Labour$_{ij}$	-0.0402	*-0.0924*	-0.0425	*-0.1250*	*-0.4831*	*-1.3169*	*-0.8162*	-2.1670
	(-4.97)	(-1.68)	(-2.31)	(-1.86)	(-1.74)	(-1.87)	(-0.74)	(-2.48)
					[-0.0325]	[-0.0877]	[-0.0531]	[-0.1415]
Import$_{ij}$	*0.0539*	*0.0806*	*0.0391*	*0.1334*	*0.3962*	*1.0558*	*0.1473*	1.5740
	(0.99)	(1.15)	(0.49)	(1.73)	(0.49)	(1.33)	(0.14)	(1.96)
					[0.0266]	[0.0703]	[0.0096]	[0.1028]
Complexity$_{ij}$	-0.2286	-0.1994	*-0.1977*	-0.2875	-2.2804	-2.3635	*-1.8833*	-2.7983
	(-2.12)	(-2.23)	(-1.50)	(-2.28)	(-2.17)	(-2.45)	(-1.35)	(-2.29)
					[-0.1532]	[-0.1574]	[-0.1224]	[-0.1828]
Lerner$_{ij}$	-0.1648	-	*-0.1782*	-	*-1.0264*	-	*-1.2903*	-
	(-2.33)		(-1.44)		(-1.44)		(-0.98)	
					[-0.0689]		[-0.0839]	
Markups$_{ij}$	-	*-0.0363*	-	*0.0020*	-	*0.0955*	-	*0.6797*
		(-0.48)		(0.03)		(0.11)		(0.77)
						[0.0064]		[0.0444]
Openness$_{ij}$	-0.0023	0.*0029*	-0.0024	*0.0010*	*-0.0364*	*0.0274*	*-0.0373*	*-0.0095*
	(-2.14)	(0.28)	(-2.12)	(0.10)	(-1.42)	(0.32)	(-1.49)	(-0.11)
					[-0.0024]	[0.0018]	[-0.0024]	[-0.0006]
Constant	0.2776	*0.2930*	-	-	*-0.4719*	*-0.4248*	-	-
	(2.55)	(1.81)			(-0.43)	(-0.22)		
Belgium	-	-	0.2725	*0.2954*	-	-	*-0.2252*	*-0.3689*
			(2.34)	(1.74)			(-0.15)	(-0.19)
Germany	-	-	0.2754	0.3647	-	-	*-0.2123*	*0.1927*
			(2.44)	(2.02)			(-0.13)	(0.09)
France	-	-	0.2488	*0.3352*	-	-	*-0.6613*	*-0.2731*
			(2.13)	(1.88)			(-0.42)	(-0.13)
Italy	-	-	0.2458	*0.3177*	-	-	*-0.8325*	*-0.7204*
			(2.07)	(1.72)			(-0.55)	(-0.34)
Spain	-	-	0.2631	*0.3266*	-	-	*-0.3751*	*-0.3760*
			(2.33)	(1.82)			(-0.25)	(-0.18)
R^2	0.5222	0.5480	0.7371	0.7731	-	-	-	-
BIC	-274.33	-270.421	-258.04	-261.97	-516.04	-483.06	-497.25	-464.65

t-stat based on robust standard errors in brackets
Marginal effects at the sample mean in square brackets.
In italics, not significantly different from 0 at the 5% level

As in the case for the frequency of price changes, our best models of the frequency of price rises and of the frequency of price cuts are the QML estimation without country dummies, indicating that there seems to be no systematic cross-country differences.

The estimation results presented in Tables 5.7 and 5.8 are generally in line with those presented in Table 5.6. The higher is the energy content or product complexity, or the lower is the labour content, the higher is the frequency of both price increases and

decreases. The openness to international trade affects neither the frequency of price increases nor price decreases.

Results are somewhat different for the share of imported inputs and for the degree of product market competition. The share of imported inputs significantly reduces the frequency of price increases and seems to have a positive (but not significant) impact on the frequency of price decreases. These two opposite impacts on the frequency of price rises and price cuts are in line with the argument that firms may substitute domestic inputs by imported inputs to reduce costs. This reduces their incentive to increase price of the final products but raises the incentive to cut prices. The two opposite effects explain why this variable has no significant impact on the frequency of price changes. It only affects the relative importance of the occurrences of price increases and price decreases (composition effect).

The Lerner index is a significant explanatory variable of the frequency of price increases but has no statistically significant impact on the frequency of price decreases.[69] Based on the results presented in Tables 5.7 and 5.8, it seems that increasing competition increases strongly the frequency of price increases but does not significantly increase the occurrence of price cuts. Such a result might indicate that increasing product market competition, by reducing the mark-ups, speeds up the price adjustments in response to increases in costs but not to cost decreases.

5.2.3. Summary.

Using statistical information produced by the IPN on the frequency of producer price changes and structural indicators derived from the input-output tables for 6 euro area countries (Belgium, Germany, France, Italy, Portugal and Spain), the purpose of this section was to conduct a harmonized analysis of the determinants of the frequency of price changes in the euro area manufacturing sectors.

Similarly to the findings in the different national contributions produced within the IPN (see Vermeulen *et al.*, 2007, for a synthesis of these papers), we find that i) prices of products with high energy content are changed more frequently; ii) prices of products with high labour content are changed less frequently ; iii) the imports content of a product does not affect the frequency of price changes ; iv) prices of complex products are changed less frequently.

However, we do not find any relation between the degree of exposure to international trade and the frequency of price changes.

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[69] This result, however, is not confirmed by our alternative measure of product market competition.

Finally, our results based on a panel data set for six Euro-area countries indicate that competition may affect the frequency of price changes. The result is, however, not strong. We use two proxies for market competition and the effect of competition is significant only with one. This may be because the two measures we use are poor proxies for market competition. When firms are asked directly about the competition in their market the clear result is that the frequency of price changes is positively affected by perceived competition (see sections 2.3.7 , 2.4.6 as well as 4.3 above).

VI. FURTHER ISSUES IN PRICE RIGIDITY.

We now turn to additional issues related to price rigidity. We start by analyzing the effect of regulation on the frequency of price changes. Then we turn to studying the effect of the Euro on the frequency and size of price changes. Finally we provide country studies on the importance of sticky prices and on producer price rigidities. Given the limited data availability, the analysis in this section is based on individual countries: Austria for regulated prices, Austria and Belgium for the effect of the Euro, Belgium for the importance of sticky prices and France for producer price rigidities.

6.1. Comparison of Regulated and Unregulated Prices in Austria.

In this section we compare the behaviour of regulated and unregulated prices. The limited availability of the data restricts our analysis to Austria. As the results are consistent with expectations, we think they can be generalized to other countries. As will be seen below, prices of regulated products are stickier: they change less frequently, by smaller amounts, and price decreases are rare. This is, in general, consistent with the menu cost model described in section II. The cost of price adjustment for regulated products is higher as the firm has to provide a request for the regulatory authority and convince it that the price change is, indeed, needed. This raises the amount of management time needed to conduct the price change and so raises the cost. In an inflationary environment regulated firms are unlikely to ask for prices to be reduced even if demand or costs fall. A price reduction, going against the trend of the general price level, would lead to a future request for a price increase; hence it imposes further costs and is typically avoided.

The analysis of price behaviour of regulated products is important from policy perspective. The excessive stickiness should be taken into account when price regulation/deregulation is contemplated. This is particularly important in the current inflation environment, with a distinct possibility of a falling price level. Unless the regulatory authority forces regulated prices to be reduced, in the case of general deflation the relative price of regulated products will increase and nominal price adjustment will be hindered.

Our analysis focuses exclusively on price regulation as an impediment to nominal adjustment. Other forms of regulation, such as quality and maintenance provisions, environmental standards, technical requirements etc could, in principle, have an effect on price flexibility. They are not considered in this report since the effect is probably secondary and information on these types of regulation is not available at the product category level.

6.1.1. Data

The analysis is based on a dataset of micro CPI data for Austria. [70] The dataset covers the period January 1996 to June 2006 and contains a total of about 4.5 million monthly price observations for a total of 668 products.[71] Statistics Austria excluded a number of products due to confidentiality considerations. We excluded a few more products which we classified as outliers due to price changes that indicated an error (whenever the average size of price increases or decreases was more than 50%). The resulting dataset of 641 products and services covers about 80% of all the products and services in the Austrian CPI.[72]

To assess the effect of regulation on price setting, we define a dummy variable for products which are subject to some form of regulation. Our notion of regulated prices (or administered prices) covers prices directly set by local or federal authorities (such as public fees) and prices that are influenced by public authorities to a significant extent, either directly at the consumer price level (e.g. health care services, cultural services) or via the prices at the wholesale level (e.g. some telecommunication service prices or electricity prices). The definition of price regulation follows the harmonized definition of the ECB for administered prices set up for the purpose of defining a sub-index of the HICP for administered prices: "Administered prices cover all goods and services the prices of which are fully (directly) set or mainly (to a significant extent) influenced by the government (central, regional, local government or national regulators)". Covered in the definition of administered prices are: price changes approved by government and other national supervisory authorities; the effects of restriction in the consumer price level (price caps/price floors), if effectively binding; the effects of permanent (e.g. long-term) restrictions on consumer price changes; rents offered at a heavily subsidized price level to low-income households; household fixed out-of-pocket expenditures for health, education and social services. According to this definition, which was sometimes subjective, 122 products and services are subject to some form of price regulation.

We defined the dummy variable for regulated goods only in the cross-section of products but not over time, and so we cannot capture changes in regulation over time with this dummy. The decision whether a product is classified as regulated or not is based on the majority of months the product or service item was or was not subject to price regulation.

Overall regulated products constitute almost 19% of our sample by CPI weights. Of these, a majority - 74% - are services (14% of the entire sample), 21% are energy products (4% of the entire sample and 5% in the non-energy industrial goods category (less than 1% of

[70] Some parts of the following text draw on Baumgartner *et al.* (2005) and on Glatzer and Rumler (2007).
[71] The weights used in the calculation of weighted averages are the CPI weights applicable to the respective baskets of goods and services. Specifically, this means that the weights differ slightly between the periods 1996-1999, 2000-2005, and 2006 but remain constant within those periods.
[72] For more details on the dataset see Baumgartner *et al.* (2005).

the entire sample) where we classified only two goods as regulated. There are no data on regulated prices of food.

6.1.2. Comparing the Frequency of Price Changes for Regulated and Unregulated Products.

As can be seen from Table 6.1, the frequency of price changes in Austria varies greatly across sectors. Prices of energy products are changed most frequently (on average, 42% of prices are changed each month), followed by unprocessed food (25%), processed food and services (both around 13%) and industrial goods excluding energy (11%).

Table 6.1: Average Frequency and Size of Price Changes in Austria, 1/96-6/06

Main CPI components (weight)	Frequency of price changes per month in %	Frequency of price increases per month in %	Frequency of price decreases per month in %	Average size of price increases %	Average size of price decreases %
Unprocessed food (7.0%)	25.0	13.1	11.7	20.4	22.7
Processed food (11.3%)	13.2	7.1	6.0	15.0	16.1
Energy (9.3%)	42.2	23.3	18.8	5.1	4.1
Market-based energy items (5.4%)	*66.1*	*35.8*	*30.3*	*4.4*	*4.3*
Energy items subject to regulation (3.9%)	*8.6*	*5.7*	*2.8*	*6.0*	*3.9*
Industrial goods (excluding energy) (35.8%)	10.6	5.5	4.5	13.1	18.5
Market-based (35.2%)	*10.7*	*5.6*	*4.6*	*13.2*	*18.7*
Subject to regulation (0.6%)	*4.7*	*4.4*	*0.3*	*7.1*	*4.7*
Services (36.6%)	13.4	8.1	5.0	8.2	8.8
Market-based services (22.4%)	*18.4*	*11.0*	*7.2*	*7.5*	*9.8*
Services subject to regulation (14.2%)	*5.4*	*3.7*	*1.7*	*9.5*	*6.8*
Total	15.8	8.8	6.7	11.3	13.9
Market-based (81.3%)	*18.1*	*9.9*	*7.8*	*11.9*	*15.3*
Subject to regulation (18.7%)	*6.1*	*4.1*	*1.8*	*8.7*	*6.0*

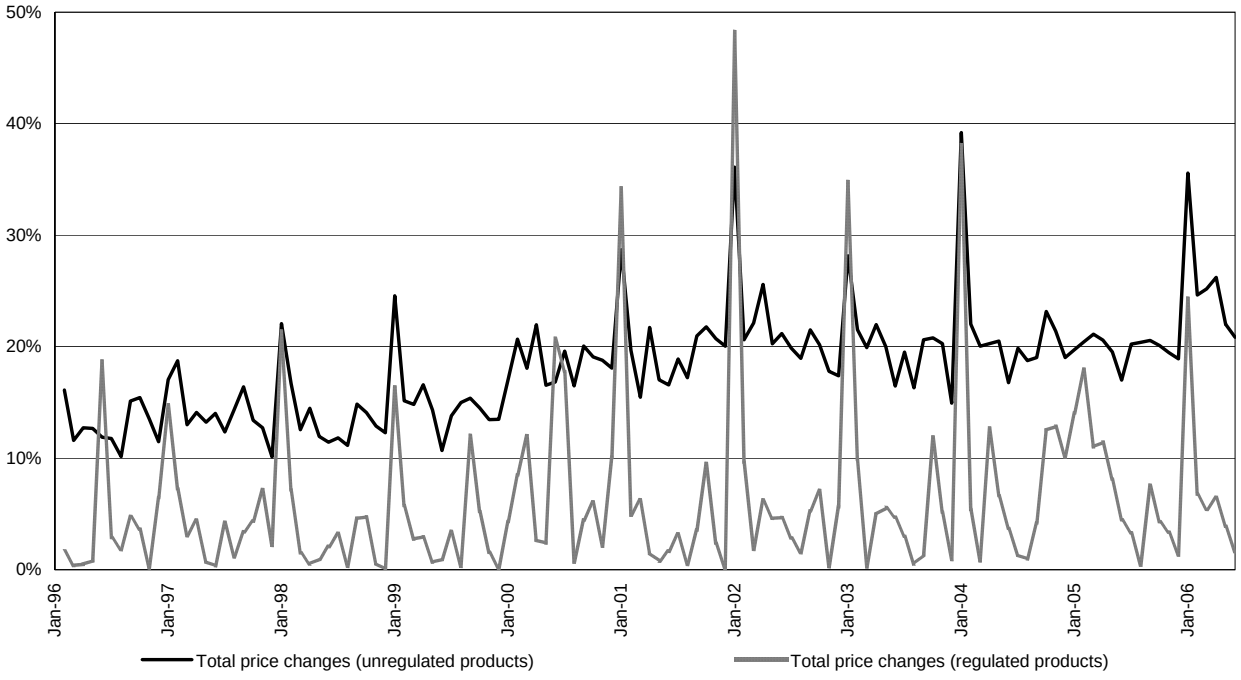
Source: OeNB, Statistics Austria.

Note: Observation period = January 1996 – June 2006.

Figure 6.1 shows the monthly frequency of price changes for regulated and unregulated products. It is clear from Figure 6.1 and Table 6.1 that the frequency of price changes for products classified as regulated is much lower than for unregulated products. Overall, the frequency of price changes for regulated goods is 6% while for unregulated goods is 18%. While this comparison suffers from composition effects (for example, there are no regulated prices for food), we find that regulation greatly reduces the frequency of price changes, roughly speaking by a factor of three.

Prices of regulated products are changed less frequently in every sector. In the energy sector the frequency for regulated products is 9% while for unregulated products it is almost an order of magnitude higher (66%). It should be noted that the very large difference may be due to different composition of the two groups: regulated products are mainly electricity and natural gas while unregulated products include fuels for transport and heating. The electricity market was deregulated in Austria in 2001, the natural gas market in 2002. However, these markets are still not competitive as the incumbent (publicly-owned) providers continue to hold dominating market share and therefore we classify these products as regulated.

Figure 6.1: Monthly Frequency of Price Changes for Regulated and Unregulated Products in Austria, 1/96-6/06



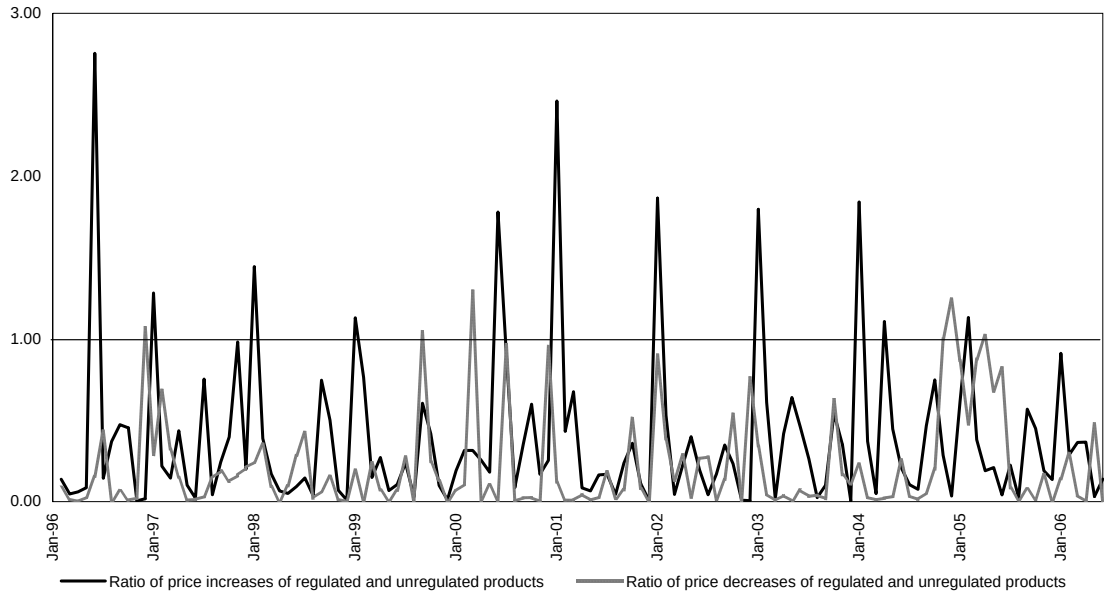
Source: OeNB, Statistics Austria.

The difference in frequencies is large for services: the frequency of price adjustment for services that are regulated by public authorities (e.g. educational services, public transport, health care services and public fees) is 5% while for market-based services (e.g. services in the accommodation and restaurant industry, leisure services) it is 18%. For industrial goods we observe the same pattern of a large difference in the frequency of price changes between the products classified as regulated and unregulated. However, in this case the

sample of regulated prices includes only two products, both related to health care: vaccines and prescription eyeglasses.
The effect of regulation on the frequency of price changes is much more pronounced for price decreases. The frequency of price increases for regulated products is 2.5 times smaller than for unregulated products; for price decreases the ratio is 4.5. For example, for unregulated energy products the frequency of price decreases and increases is similar, while for regulated energy products it is twice smaller.

As can be seen from Figure 6.1, the frequency of price changes of regulated products is smaller than of unregulated products in most months. The exceptions are January in most years as well as June 1996 and June 2000. The reason is that a very large proportion of regulated price changes take place in January. Regulated products exhibit a much more pronounced seasonal price setting pattern and price changes in January strongly dominate the yearly figure. This can be seen from Figure 6.2 which shows the monthly ratio of the frequency of price changes of regulated to unregulated products, separately for increases and decreases. The ratios are smaller than one in almost all months, with the exception of months in which the frequency of price increases (and to a smaller extent price decreases) for regulated products is unusually high.

Figure 6.2: Monthly Ratio of the Frequency of Price Increases and Decreases for Regulated and Unregulated Products in Austria, 1/96-6/06



Source: OeNB, Statistics Austria.

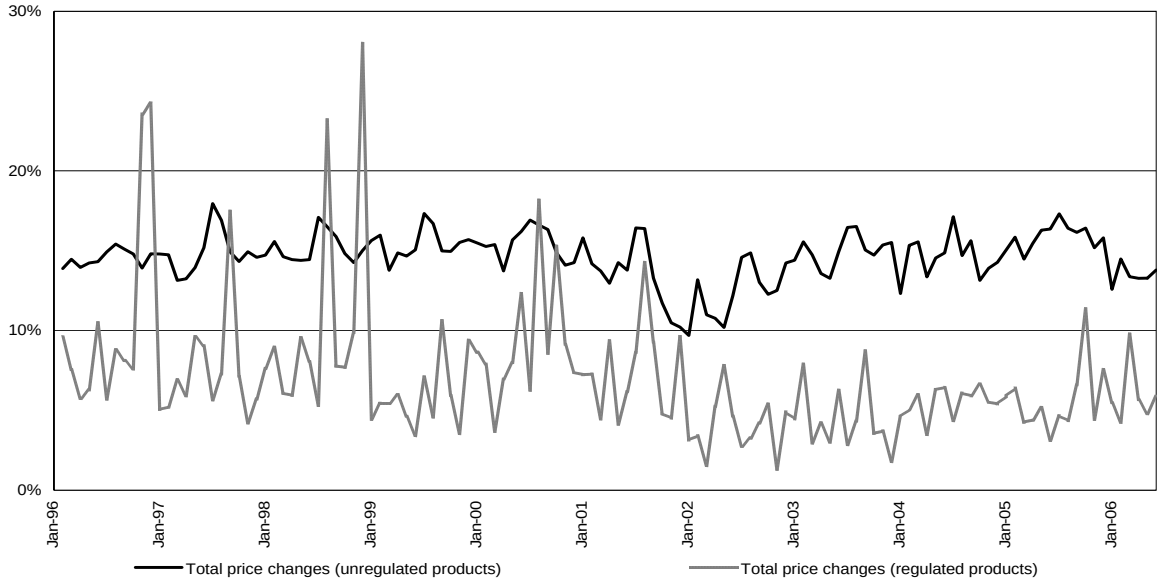
6.1.3. Comparing the Size of Price Changes for Regulated and Unregulated Products.

Price increases as well as price decreases of regulated products are smaller on average than those of unregulated products (see the last two rows of Table 6.1). This could reflect a composition effect of regulated items which are dominated by services and energy products which both are characterized by a somewhat lower-than-average size of price changes. Comparing within sectors (see Table 6.1) we find that, in most cases, price changes of regulated goods are smaller; the exceptions are price increases in the service sector and price decreases in energy.

The effect of regulation on the size of price changes is much more pronounced for price decreases. Price decreases of regulated products are 60% smaller than for unregulated products; for price increases the difference is only 25%. As a consequence, unlike for unregulated products, where price decreases are bigger in absolute value than price increases, for regulated products price increases are almost 50% bigger (8.7% versus 6%). This is the case in almost all months (see Figure 6.3). Price increases are larger for every type of regulated products.

It is interesting to note that for regulated products – unlike for unregulated products – the size of prices changes is larger in the first half of the sample than in the second half (see Figure 6.3). Furthermore, at the time of the cash changeover in January 2002, the size of price changes for unregulated products falls dramatically while for regulated products it is no smaller than in a number of other months after the cash changeover. Thus, a cash changeover effect on the size of price changes shows up mostly for prices of unregulated products.

Figure 6.3: Monthly Size of Price Changes for Regulated and Unregulated Products in Austria, 1/96-6/06

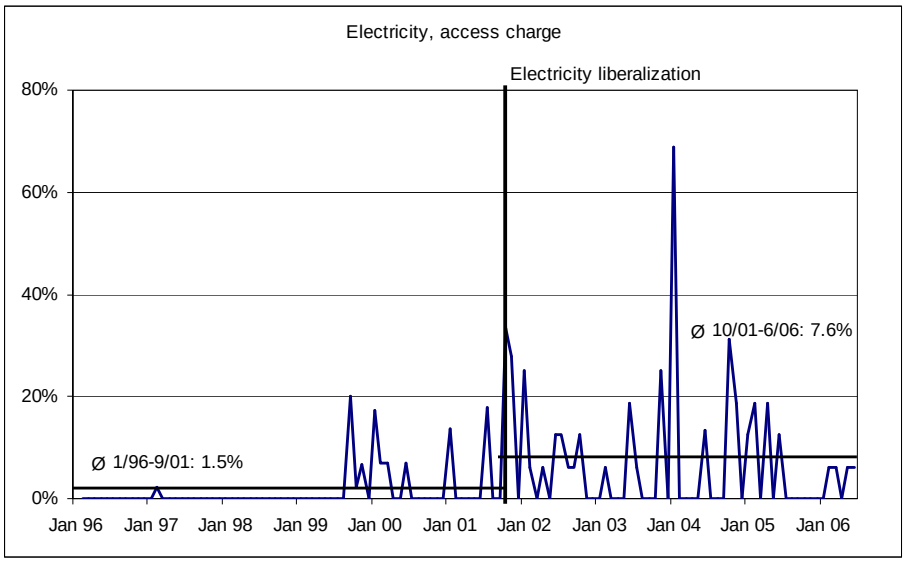


Source: OeNB, Statistics Austria.

6.1.4. The Effect of Deregulation.

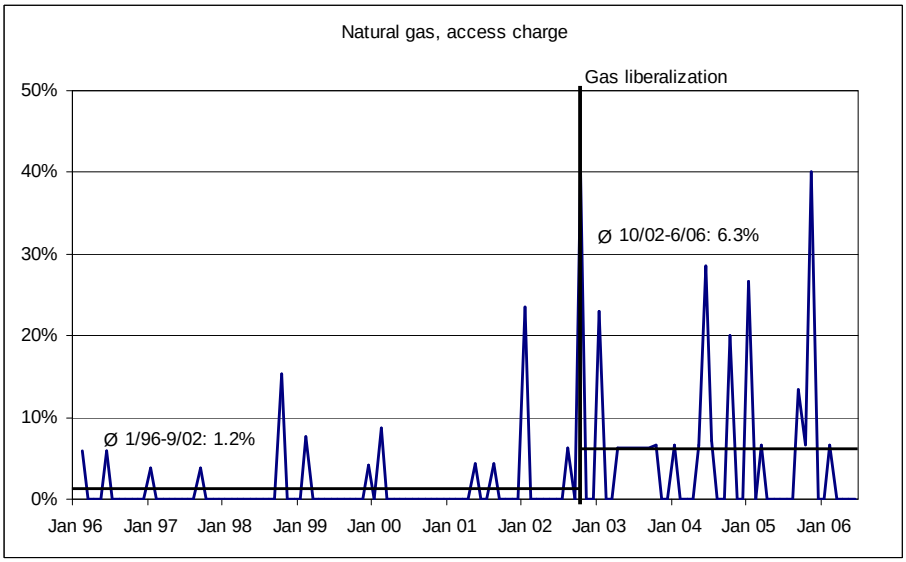
We can also analyze the frequency of price changes over time for some of the products which have been deregulated during the sample period. As already mentioned, the electricity market in Austria was opened to private providers in October 2001 and the natural gas market followed in October 2002. We classify both products as regulated since, in our opinion, some effects of regulation on pricing remained. The analysis of time series allows us, however, to see if there was an effect of deregulation on the frequency of price changes. These time series are shown in Figures 6.4 and 6.5 below. As can bee seen from both figures, the frequency of price changes is noticeably higher after the liberalization than before. This shows that deregulation and liberalization of network industries in Austria has led to more price flexibility in those markets.

Figure 6.4: Frequency Price Changes of Electricity in Austria, 1/96-6/06



Source: OeNB, Statistics Austria.

Figure 6.5: Frequency Price Changes of Natural Gas in Austria, 1/96-6/06



Source: OeNB, Statistics Austria.

6.1.5. Conclusions.

Our analysis shows that regulation has a large and unambiguous effect on price setting in Austria. Prices are changed about three times as often when price setting is determined by market forces than when they are directly set or influenced by public authorities. Price changes of regulated products are smaller than of unregulated products. The effect of regulation is more pronounced for price decreases, both for the frequency and size. This implies that further deregulation of product and service markets should result in lower aggregate price stickiness, by raising the frequency and size of price changes. Deregulation will have a greater effect on the downward rigidity of prices, substantially raising both the frequency and size of price decreases. This is particularly important in the current, low inflation environment and would become even more crucial in a deflationary environment.

Of course deregulation is often not possible or not desirable. While deregulating prices would increase their flexibility, the social benefits from regulation have to be taken into account. In many cases these will be more important, for example in industries in which there is a natural monopoly. Deregulation has its limits when maintaining the purpose of price regulation clearly outweighs the benefits from deregulation.

6.2. The Introduction of the Euro and Price Adjustment

The introduction of the Euro has been a major shock to price setting, as goods had to be repriced to the new currency. In principle a price can be converted exactly to its value in Euros, with some minimum rounding to the nearest cent. But in practice the introduction of the Euro has generated additional price changes, as could be expected from theoretical models described in section 1.2. As the menu cost model in section 1.2.1 implies, since the new price had to be set, some firms used the conversion as an opportunity to change price, thus reducing the cost of pricing. The fair pricing model in section 1.2.5 implies that some firms would take the opportunity of reduced information content of prices at the time of conversion to raise prices. The practice of charging attractive prices (pricing points – see 1.2.4) means that prices could not be converted exactly and so needed to be changed.

In this section we analyze the effect of the introduction of the Euro on price behaviour, using data from Austria and Belgium. We look at both the immediate effect – around January 2002 – and subsequent price behaviour. The introduction of the common currency was widely expected to increase competition as it facilitated price comparisons and so market integration. An important question for this study, therefore, is whether it affected price changing policies after the immediate period of the conversion.

6.2.1. Price Setting in Austria before and after the Introduction of the Euro

In January 2002, all coins and notes of the former Austrian Schilling were replaced by the new euro currency. From then on, all prices were quoted in euro. In the transition period from October 2001 to the end of February 2002, the Euro-Related Pricing Act required all Austrian businesses to display their prices in both currencies. During this period, price setters were also required by law to refrain from unjustified price increases. We can therefore use the dataset introduced in the previous section, which covers the period January 1996 to June 2006 to examine the characteristics of price setting during the euro cash changeover and also compare these characteristics in the periods before and after the changeover.

More Frequent and Smaller Price Changes at the Cash Changeover

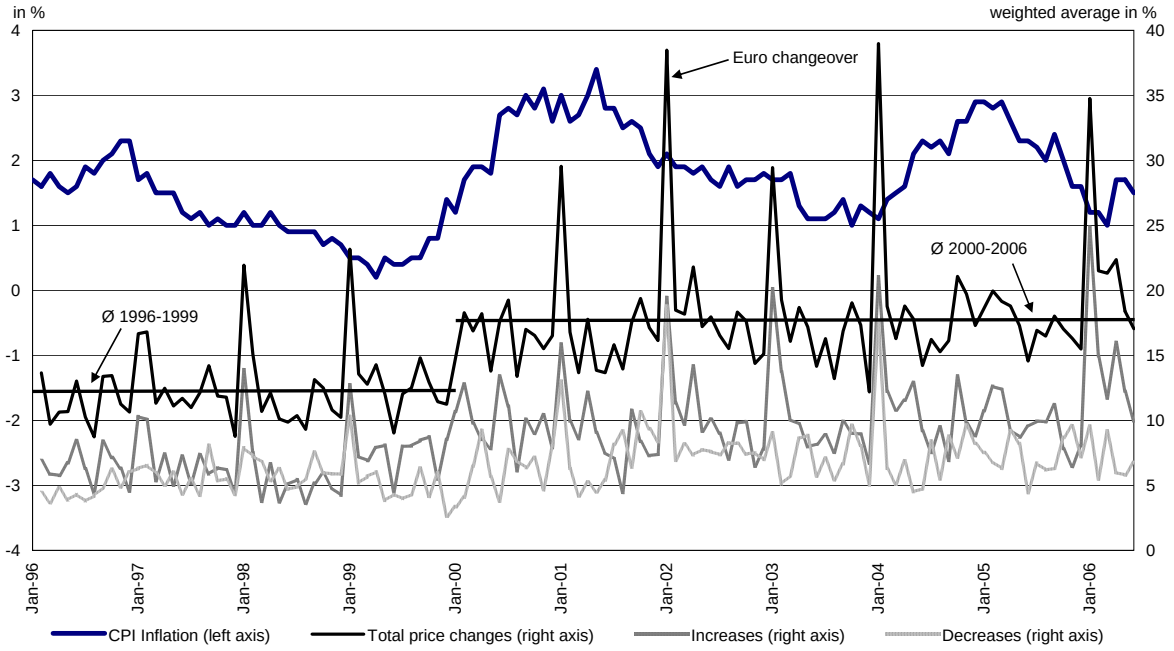
Figure 6.6 shows the average frequency of price changes, price increases and decreases per month aggregated for all products in our dataset (80% of the CPI) and Figure 6.7 shows the average size of all price changes and for price increases and decreases over the period from January 1996 to June 2006. In the month of the cash changeover in January 2002, the monthly frequency of price changes increased to nearly 40% (see the right axis in figure 6.6) which was also more pronounced than in the first month of each previous year.[73] It is therefore clear that the introduction of euro cash brought about more price adjustments than usual. Yet the fact that basically 40% of all prices in our data set were adjusted at the time of the changeover also means that approximately 60% of all prices were converted exactly into the new currency.

An interesting question in this context is whether prices were predominantly increased at the time of the cash changeover. It turns out that, from December 2001 to January 2002, price changes were about 51% increases (dark shaded line in Figure 6.6) and 49% decreases (light shaded line), thus balancing each other out in terms of inflationary effects. In the months immediately after the cash changeover, we can observe a majority of price increases, but this does not differ substantially from the seasonal patterns observed in other years (for example the first halves of 2001 and 2004), thus it cannot be attributed to the cash changeover.

Another striking development can be seen in the size of price changes (Figure 6.7) during the cash changeover: Roughly from mid-2001 onward, the average size of price changes dropped noticeably (for price increases and decreases alike), bottoming below 10% in January 2002 and only returning to its previous levels toward the end of 2002. This indicates that the cash changeover had an influence on price setting in Austria not only in

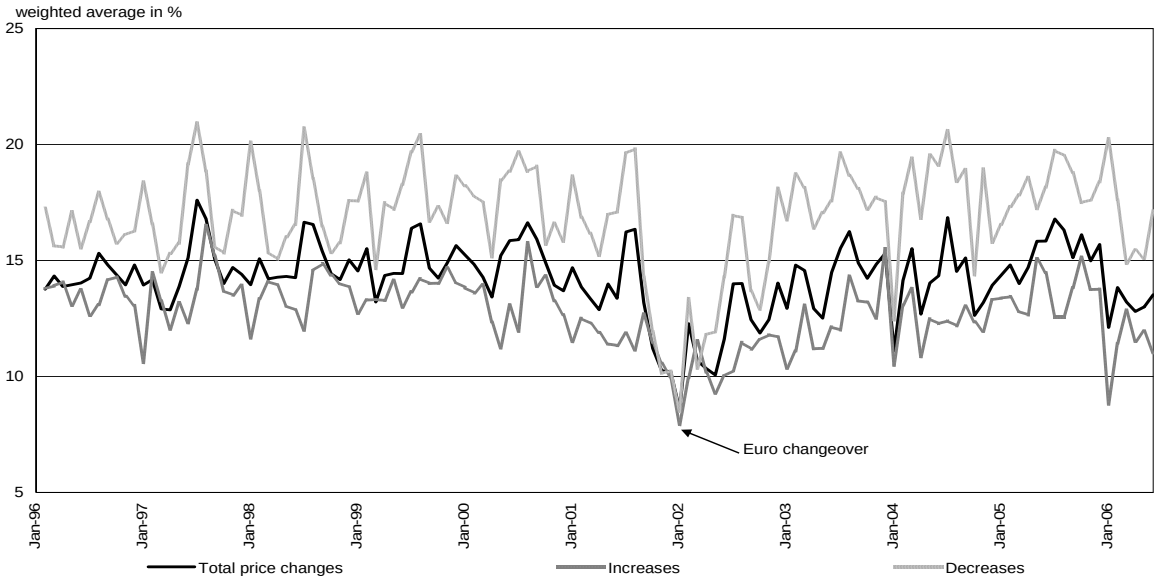
[73] Due to two changes in the composition of the basket (each at the beginning of 2000 and 2005) and the resulting changes in definitions for many products, all price changes in January 2000 and in January 2005 have been excluded from the analysis.

Figure 6.6: Monthly Frequency of Price Changes in Austria, 1/96-6/06



Source: OeNB, Statistics Austria.

Figure 6.7: Size of Price Changes in Austria, 1/96-6/06



Source: OeNB, Statistics Austria.

January 2002 but also in the six months before and after the conversion. In that period, consumer prices were adjusted more often but by smaller amounts.

Higher Frequency of Price Adjustments after the Euro Changeover

The pattern in the monthly frequency of price adjustments (Figure 6.6) does not show obvious differences between the period immediately preceding the cash changeover (2000 to 2001) and the ensuing period (2002 to 2006): The frequency fluctuates – with few exceptions, notably in January – between 13% and 20%, and no clear trend can be seen over that period. The frequency of price changes is definitely higher at the end of our observation period than at the beginning, but a trend shift does not seem to have occurred at the time of the euro cash changeover.

However, a trend shift is certainly visible in the average frequency of price adjustments from 2000 onward: the average frequency of price adjustments is almost 6 percentage points higher than the values observed before 2000 (the averages of the two sub-periods are shown as horizontal lines in Figure 6.6). Table 6.2 shows the average frequencies of price changes for various observation periods. An indication that the trend likely occurred in 2000 rather than with the cash changeover in 2002 can be found in the second-to-last column of Table 6.2, which gives the average frequency of price changes for the intermediate period January 2000 to December 2001. For all sectors and the total of all products, the frequencies are much closer to the averages observed in the period 2002 to 2006 than in the period 1996 to 1999.

This discussion indicates that the frequency of price changes increased not at the time of cash changeover but two years earlier. There were three reasons for a change at this time. First, a number of liberalization and deregulation measures in network industries were taken around the year 2000, and those measures also probably affected the frequency of price changes. In 1999, the market for telecommunications services in Austria was completely liberalized, and in 2001 the Austrian electricity market was opened up to private providers, as was the natural gas market in the following year. The new competition structure on these markets brought about more frequent price adjustments on the part of new providers as well as the former monopolists. This is documented for electricity and gas prices in Figures 6.4 and 6.5 in the previous section. Another example in this context is the COICOP group “communication” (the telecommunications market was liberalized in 1999): On the average over the period from 1996 to 1999, 5.8% of all prices in this group were adjusted each month, while the corresponding figure for 2000 to 2006 was roughly twice as high at 11.5%. A similar but not quite as pronounced pattern can be observed for the energy as well as the service components before and after the year 2000 in Table 6.2.

Second, it could be linked to the increase in the inflation rate in 2000 and the higher values recorded since then (see the thick line in Figure 6.6), as the inflation rate is roughly the product of the frequency and the size of price adjustments. While the size of price

adjustments (see Figure 6.7) and also the relative proportions of price increases and decreases remained broadly stable over time, a higher rate of inflation – given constant weights – can only be explained by an increase in the frequency of price adjustments.

There is probably also a statistical reason for the trend shift in the frequency of price adjustments in 2000. Starting that year, the inflation rate was calculated on the basis of a new basket of goods and services using a new weighting scheme and including several new products. In addition, according to Statistics Austria, the introduction of the new basket was accompanied by innovations in data collection, which may have had an impact on the frequency of price adjustments as well: The number of outlets and the number of prices surveyed were increased; more supermarkets – probably with more flexible price setting – and fewer corner shops were surveyed to account for changes in consumption habits; and the quality of price surveys and statistics was generally improved. If these measures had a significant impact on the data collected, then the increase in price adjustment frequency would at least in part be a statistical artefact due to the transition to the new CPI basket.

Table 6.2: The Average Frequency of Price Changes in Various Periods (% per month).

Main CPI components	**Before the cash changeover**	**After the cash changeover**	**Old basket of goods and services**	**New basket of goods and services**	**Intermediate period**	**Overall period**
	01-1996 to 12-2001	**01-2002 to 06-2006**	**01-1996 to 12-1999**	**01-2000 to 06-2006**	**01-2000 to 12-2001**	**01-1996 to 06-2006**
Unprocessed food	22,0	28,9	20,4	28,1	25,6	25,0
Processed food	12,3	14,4	11,2	14,6	14,7	13,2
Energy	38,8	47,4	35,6	47,8	48,2	42,2
Industrial goods (excluding energy)	9,2	12,1	8,5	11,8	10,7	10,6
Services	10,9	15,9	9,3	15,7	14,0	13,4
Total	13,8	18,2	12,4	18,0	16,8	15,8

Source: OeNB, Statistics Austria.

The seasonal patterns in price adjustments, especially the conspicuous peaks each January, did not change much after the euro cash changeover; if anything, after 2002 the peaks in January were even more pronounced than before (see Figure 6.6). The values for January 2004 and January 2006 are especially remarkable, as they are nearly as high as the value recorded during the changeover in January 2002. This, indeed, qualifies the earlier statement that the euro cash changeover led to an unprecedented increase in price

adjustments.[74] Based on this observation, we may conclude that in recent years the phenomenon of price adjustments occurring predominantly at the start of the year has increased independently of the euro cash changeover.

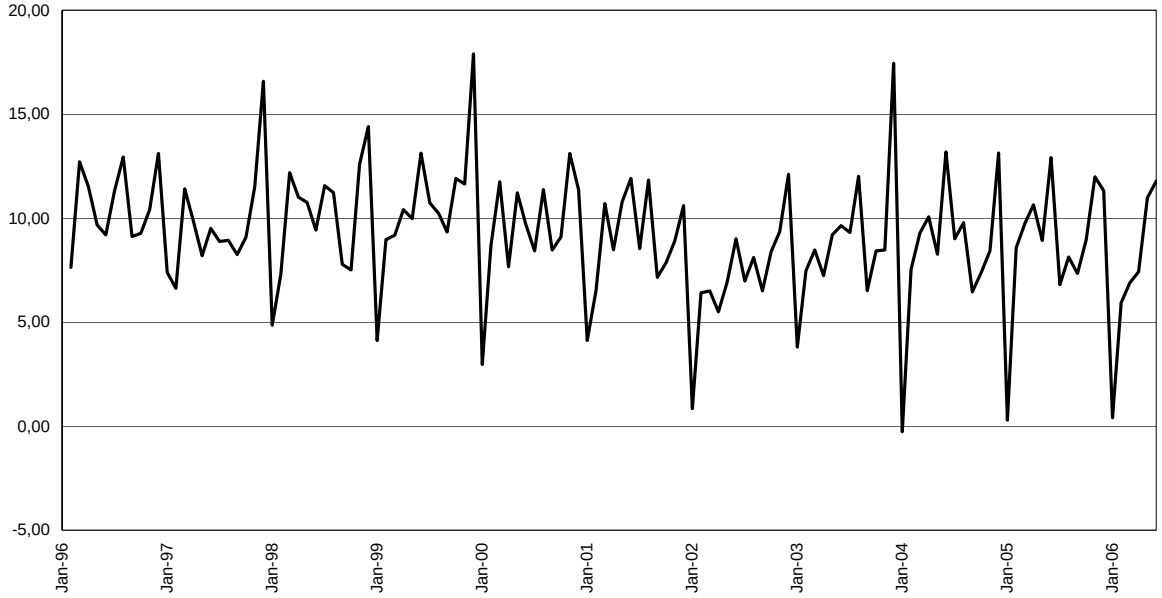
The changeover period remains unique in terms of the average size of price changes: Figure 6.7 shows that the substantial drop during the time around the changeover was only temporary. In the course of 2003, the size of price adjustments returned to its previously recorded level of approximately 15% and has fluctuated around that mark ever since. Therefore, the euro cash changeover influenced price setting in Austria for approximately one-and-a-half years, specifically from mid-2001 to early 2003. Unusual but short declines in the size of price adjustments were again observed in January 2004 and in January 2006; this is linked to the aforementioned phenomenon of price adjustments occurring more frequently in January but by smaller amounts.

Summing up, although there is a clear difference in the average frequency of price changes calculated for the periods before and after the cash changeover (13.8% versus 18.2%), the cash changeover does not seem to be the cause for this difference. When considering the time periods before the year 2000 and after that, which coincides with the periods for which different CPI baskets were defined, we find an even more pronounced difference in the price adjustment frequencies of 12.4% versus 18.0%. Our analysis thus indicates that the trend shift in the frequency of price changes occurred in 2000 and that the higher frequency thereafter can be partly explained by economic and partly by statistical factors, but not the cash changeover.

To complete the analysis of the effect of the Euro on price changes, and on price flexibility, we look at the value of kurtosis of the distribution of the frequency of price changes across sectors. Carvalho (2006) and Nakamura and Steinsson (2007) show that under both Calvo-type and state-dependent pricing the distribution of the frequency of price changes across sectors matters (see sections I.3.2 and I.3.3). This is because the stickiest prices have an excessive role on the aggregate price stickiness. The presence of firms with sticky prices (i.e. firms that change prices infrequently) significantly slows down aggregate adjustment.

[74] However, the frequency of price decreases (light shaded line in Figure 6.65) in January 2002 was still not exceeded by the values for January in any other year.

Figure 6.8: Monthly Kurtosis of the Frequency of Price Changes across All Products in Austria, 1/96-6/06



Source: OeNB, Statistics Austria.

One measure of the role of the slow adjusters is the kurtosis of the distribution. As can be seen from Figure 6.8, the value of kurtosis fell over time and it appears that the decline took place around the time of Euro adoption. A lower kurtosis means that the distribution of frequencies of price changes became more peaked, with thinner tales, i.e. with fewer values of particularly low frequencies of price changes. In other words, firms with sticky prices became less common. This implies greater aggregate flexibility.

6.2.2. The Effect of Euro Introduction on Price Setting in Belgium

We now turn to the analysis of the effect of the introduction of the Euro on price setting practices in Belgium. Angeloni, Aucremanne and Ciccarelli (2006) study six Euro area countries, using quarterly data on frequency of price changes from the 3rd quarter of 1994 to at most the 4th quarter of 2003. They do not find a significant impact of the introduction of the euro on the frequency of price changes. The frequency increases around the time of the Euro cash changeover in January 2002 but then returns to the pre-euro values. No significant differences was observed between the pre and post Euro cash changeover period, either in terms of frequency of price changes or in the average size of

price changes.

One potential problem of the results obtained by Angeloni, Aucremanne and Ciccarelli (2006) could be that the observation period was too short to address this question. They only looked at the impact up to 8 quarters after the change over. This may be too soon to observe a significant impact of the euro on price setting practices through the competition channel.

Using the National Bank of Belgium business survey data, we have access to a longer observation period (our observation period ends in December 2007, see section 6.4 for more details). Therefore, we can address this question for the Belgian economy. To do so, we estimated the sectoral frequency of price changes in 4 sub-samples (1990-1995[75], 1995-2000, 2001-2007 and 2003-2007) and we tested if the sectoral distribution of the frequency of price changes was significantly different in the different sub-samples using the nonparametric Wilcoxon Sign Rank test. The results are in Table 6.3.

Table 6.3: Wilcoxon Sign Rank Test of the Comparison of Two Sub-samples

$H_0 : i \leq j$	1990-1995	1995-2000	2001-2007	2003-2007
1990-1995	-	2.128	1.307	1.419
1995-2000		-	0.197	0.090
2001-2007			-	0.220

Source : Own computation

A value of the Wilcoxon Sign Rank test negative and smaller than -1.64 would indicate that the sectoral distribution of the frequency of price changes observed in sample period *i* (the row) is significantly "smaller" than the sectoral distribution of the frequency of price changes in sample *j* (the column). In other words, this would mean that the sectoral distribution of price changes has significantly shifted to the right, towards more frequent price changes between sample periods *i* and *j*. If the introduction of the euro had positively affected the frequency of price changes in a majority of sectors, we would expect a negative value of the Wilcoxon Sign Rank test. However, our results seem to indicate no significant shift in the distribution of the frequency of price changes, even when the cash changeover period is taken into account. Using a longer time horizon seems therefore to confirm the results obtained by Angeloni, Aucremanne and Ciccarelli (2006). Based on these and Austrian results we conclude that the introduction of the Euro had at most a temporary effect on the frequency of price changes and price flexibility.

Overall we do not find evidence that the introduction of the Euro had significant effects on price setting in Austria or Belgium.

[75] During the 1990-1995 period, the NBB business survey covered only manufacturing, construction and trade sectors.

6.3. Inflation and Price Changes

The inflation rates in Euro area countries have been changing very significantly in 2008. The increase in inflation in the first three quarters was caused by rapid increase in the prices of food and energy. This was followed by a collapse of food and energy prices and a slowdown in the inflation rate that would last into 2009. While it is difficult to make predictions in the current economic environment, there are concerns about strong disinflation in the Euro area some time in 2009.

Given these changes in inflation, a relevant question is how they affect price adjustment at the level of individual firms. In this section we provide some evidence from Belgium and Austria.

6.3.1. Inflation and Food Prices in Belgium

In January 2008, the Belgian government asked the National Bank of Belgium to analyze the price developments observed in the second semester of 2007. The results of this analysis were published in a special issue of the NBB Economic Review in April 2008.

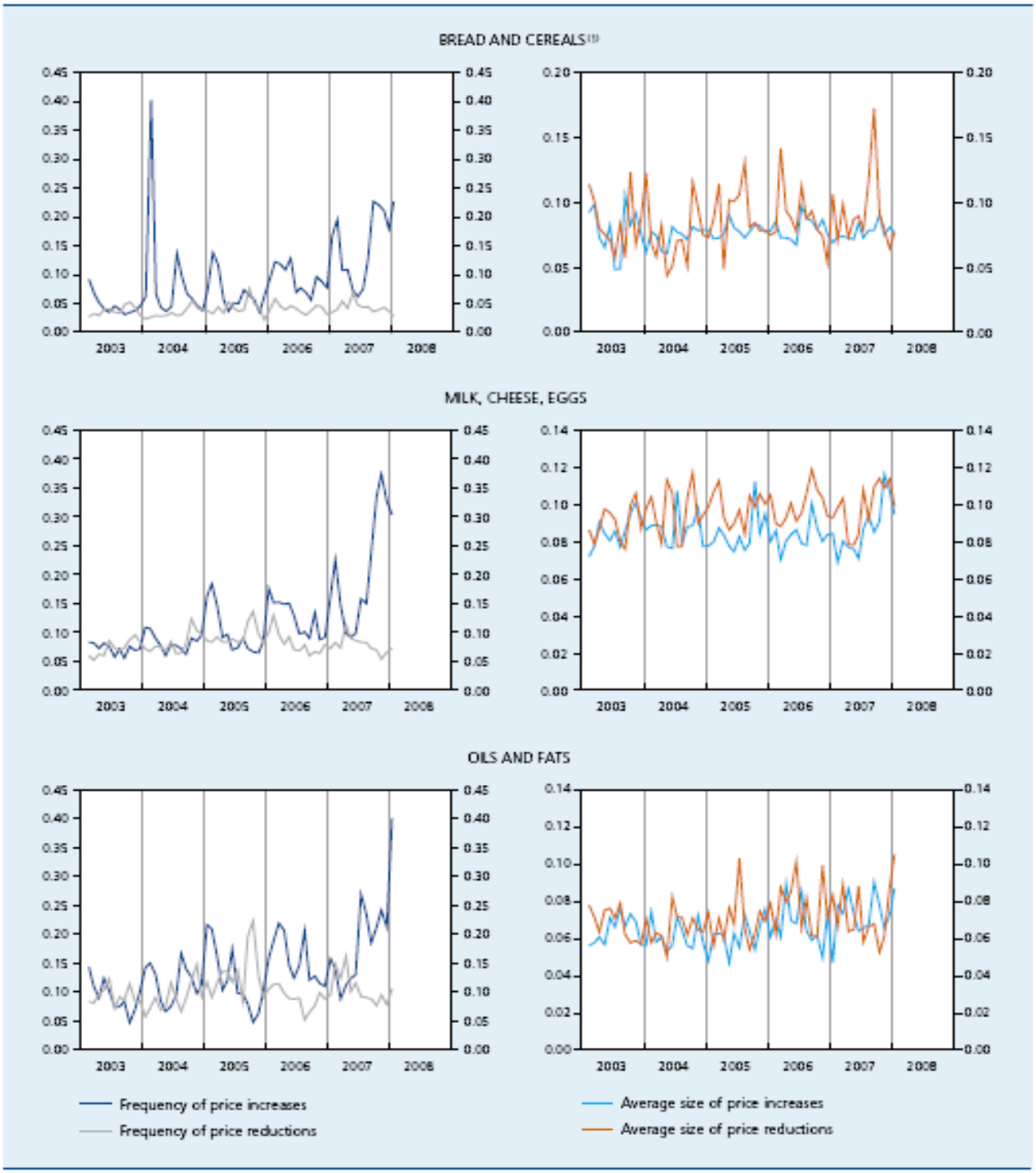
Part of the analysis focused on the question of price adjustment and provided useful information about the firm reactions to cost variations.

Using micro data, characterizing price developments of the 84 processed food products included in the Belgian CPI basket over the January 2003 – January 2008 period, the report focuses on the COICOP categories that experienced the highest inflation rate during the second semester of 2007 (‘‘Bread and cereals’’, ‘‘Milk, cheese, eggs’’ and ‘‘Oils and fats’’).

The inflation rate is given by $\pi_t = \sum_{i=1}^{N} w_{it}\left[\ln\left(p_{it}\right) - \ln\left(p_{i,t-1}\right)\right]$, where p_{it} is the price of a product sold in period t in outlet i and w_{it} is the weight attached to that particular product in the total basket. This simple equation illustrates the two possible sources of inflation. Inflation may be the result of either an increase in the average magnitude of non zero price adjustments or from an increase in the frequency of price changes.

The analysis of the NBB clearly indicates that the increase of the inflation rate observed in those three COICOP categories was mainly driven by increases in the frequency of price changes, and more precisely by an increase in the occurrence of price increases. During the same period, the frequency of price cuts has slightly decreased, so that overall the frequency of price changes rose significantly. The average size of price adjustment did not change much. This is illustrated in Figure 6.9. The fact that higher inflation makes price

Figure 6.9: Frequency and Average size of Price increases and Decreases for Three COICOP Categories.



Source: NBB Economic Review, special issue, April 2008

increases more, and price decreases less common is well known; see, for example, section 2.3.7 and Figure 2.7). In response to the increase in food commodity prices, retailers seem therefore to have sped up their price adjustments but they continue to adjust their prices by regular amounts. These results are in line with state dependent pricing models such as the traditional (*S,s*) model which imply that the size of the adjustment is constant but the frequency of adjustment varies with the volatility of the shocks.

The NBB also reports that the price adjustments that occurred in the second half of 2007 were mostly carried out in a single move rather than gradually. In terms of competition, it seems also that the lowest prices were adjusted more speedily and by larger amounts than the highest prices; as a result price dispersion has fallen.

6.3.2. Inflation and Price Stickiness in Austria.

Since most of the analyses on price stickiness and price rigidity in this report are based on IPN data, they do not cover the most recent period of rapid price increases since about fall 2007. As the results are all based on datasets that span over a time period of low and stable inflation, there is no automatic extension of our findings to the environment of higher and more variable inflation rates. Therefore, a natural question is if and how the findings in this report extend to a high inflation environment. Given that there are no micro price data for high inflation periods available, an indirect way of examining this question is by looking at the cross-sectional differences in inflation rates. Specifically, we ask how price stickiness is affected by average inflation in the cross section of products by regressing average frequency of price changes on average inflation of these products and a number of control variables. The coefficient obtained provides a measure of the elasticity of price stickiness with respect to inflation.

This analysis is based on the same dataset of micro prices for Austria as used in section 6.1: monthly price observations from January 1996 to June 2006 for 641 products and services. The variables we use in the regression are averages for each product over time, i.e. we exploit the cross-sectional dimension of the data.

The particular regression we run includes the frequency of price changes[76] of each product as the dependent variable, which is explained by the product-specific average inflation over the observation period, and a number of other characteristics of these products: the average size of price changes, the share of attractive prices (psychological prices ending in

[76] Since the dependent variable in this regression, the frequency of price changes is bounded between 0 and 1, estimating a linear model is not appropriate. One solution to this problem is transforming the dependent variable to the log-odds ratio, $\ln(freq/(1-freq))$, which is unbounded. The coefficients of this regression are not directly interpretable, but the marginal effect can be obtained by a simple transformation. For more details on the method, see Konieczny and Rumler (2006).

9 and round prices ending in 10 or 100) for each product, the share of prices changed in January, the share of sales prices for each product and dummies for the product groups (unprocessed food, processed food, energy, non-energy industrial goods and services) to control for group-specific effects. The regression results are shown in Table 6.4.[77]

The results indicate that products with higher average inflation are also characterized by a significantly higher frequency of prices changes. The marginal effect implies that when average monthly inflation increases by 1 percentage point, the frequency of price changes would increase on average by 5.2 percentage points. Although this result is statistically significant at the 5% level, its effect is quite small given that a 1 percentage point increase in monthly inflation is substantial. In annualized terms, this means that when inflation increases by 1 percentage point, the frequency increases only by 0.44 percentage points.

Table 6.4: Explaining the Frequency of Price Changes

Variable	Marginal effect	Sample means
Constant	-0.18***	
Average monthly inflation	0.052**	0.12%
Size of price changes	0.10	14.5%
Share of attractive prices	-0.04	60.1%
Share of price changes in January	-0.01**	195%
Share of sales prices	0.70***	4.7%
Processed food dummy	-0.06***	
Energy dummy	0.12**	
Industrial goods dummy	-0.11***	
Services dummy	-0.09***	
Adjusted R-squared	0.47	

Notes: Dependent variable is the log-odds ratio of the frequency of price changes across products. Marginal effects are evaluated at the sample means given in the last column. Estimation method is OLS; standard errors are White heteroskedasticity consistent. The number of observations is 641; observation period is 1996M1-2006M6. * indicates significance at the 10%, ** at the 5%, and *** at the 1% confidence level.

Apart from product-specific inflation, also the average size of price changes is positively related to the frequency of price changes. This has probably to do with sales pricing. Sales induced-price changes, which do occur frequently for a number of products like food items, tend to be bigger in size than regular price changes. However, the effect is not significant, once we control for sales (by including the share of sales in the regression).

[77] The total of 641 products contains a large number of products whose prices are subject to some form of regulation. Since the prices of those products are not determined by market forces, it could be argued that they should be excluded from our analysis (see Konieczny and Rumler, 2006). Therefore, we also perform the estimation with the sample constrained to those 517 products which are not subject to any form of price regulation. The results from this estimation are qualitatively the same as in Table 1 which confirms the robustness of our findings.

Furthermore, products for which attractive prices are common show a smaller number of price changes than others (p-value is 0.12). This is in line with the finding in the literature, see e.g. Baumgartner *et al.* (2005) and Konieczny and Rumler (2006), that adjustments of attractive prices are sometimes delayed when the optimal price changes just a little bit until a new attractive price is near optimal.

Seasonal price setting affects the frequency of price changes significantly negatively, which is to say that for those products and services for which we observe a larger proportion of price changes in January, the overall frequency is lower because a number of them are likely to be set in a time-dependent fashion every January which represents a longer-than-average duration.

Finally, the share of sales prices is positively related to the frequency of price changes because there seem to be many products in our database – mainly food items – for which we observe a large number of price changes that are induced by sales and promotions.

Our results provide only indirect evidence of how higher aggregate inflation affects price stickiness because it draws its information from the cross section of products only. But assuming that the relation between inflation and the frequency of price changes found from 1996 to 2006 holds up also in the recent period of rapid price increases, we can draw the general conclusion that price stickiness should be somewhat smaller in a higher inflation environment, in particular for those products where rapid price increases have been observed, like food and energy items. But the effect of inflation on price stickiness appears to be quantitatively small. Thus, we may conclude that our results for aggregate price stickiness and the comparison across countries hold also in the recent period of rapid price increases. The sectoral composition of price stickiness, though, might change, likely showing more frequent price changes for food and energy items, but a largely unaffected frequency for services and industrial goods (which account for the bulk of items in the CPI).

6.4. Economy-wide Evidence on the Importance of Sticky Prices in Belgium

Recent empirical studies based on large micro data sets that are used by statistical offices to compute either consumer (Bils and Klenow, 2004, Nakamura and Steinsson, 2008, Dhyne *et al.*, 2006) or producer (Nakamura and Steinsson, 2008, Vermeulen *et al.,* 2007) price indices provide useful insights about how frequently consumer or producer prices are changed, the picture is still incomplete. Some services are included in the CPI basket but most of the service sector, and especially the business service sector, is not included in

those analyses. Because in most countries there is no (corporate) Service Price Index[78], there are no quantitative micro data available on corporate service prices. Therefore, in order to obtain estimates of the frequency of price changes in this sector and a more complete picture of the situation at the aggregate level, one has to use other types of data.

A potential source of relevant data on price setting are the individual records from business surveys. In this type of survey, one may find information about the frequency of price changes for almost all the sectors of the economy. In this paper, we analyze the individual answers to the National Bank of Belgium Business surveys for the manufacturing, construction, trade and service sectors.

For each of these sectors, the business survey questionnaires include a question about the evolution of individual prices. For instance, in the questionnaire of the manufacturing sector, the firm has to answer the following question: Between period t and $t-1$, the selling price of your product a) increased b) remained unchanged c) decreased. Similar questions are also included in the questionnaires of other sectors.

Compared to studies based on micro price reports, this qualitative information allows us to analyze only the frequency of price changes but not their magnitude. However, as the Business surveys cover almost all the Belgian economy, this analysis may provide us with a unique estimate of the overall degree of price stickiness, an important parameter for macro modelling.

As cross-country differences in the frequency of price changes in the euro area are not large (see sections 2.2.3, 4.1 and 5.1) in comparison to sectoral differences, the estimates obtained for the Belgian economy and especially for the Belgian service sectors may also be considered as informative of the situation characterizing the euro area.

The purpose of this section is therefore to present a new set of estimates of frequency of price changes for the Belgian economy at the NACE 2 digit level and to compare it with the existing evidence available for the Belgian economy (Aucremanne and Dhyne, 2004, Aucremanne and Druant, 2005, and Cornille and Dossche, 2008). We use the information available in the 2000 Belgian Input - Output tables. We look at the relationship between the frequency of price changes and some variables capturing the cost structure or the degree of both domestic and international competition in the different sectors. In doing so, we extend the analysis in Cornille and Dossche (2008). Based on our estimates, we find that the cost structure is the major determinant of the sectoral frequency of price changes. The import content of a product also positively affects the frequency of price changes. The import content is the only channel through which the degree of openness to international trade positively affects the frequency of price changes. Finally, other factors related to the

[78] A Service Producer Price index and a Corporate Service Price Index are available respectively for the UK and Japan. Other service price indices are available in some countries but they focus on very narrowly defined services (architectural, legal or telecommunications...).

degree of competition do not seem to play an important role. While bivariate analysis tend to indicate a positive link between the degree of competition, approximated by the sectoral Lerner index, and the frequency of price changes, this link is not significant and becomes negative when other factors are taken into account.

6.4.1. The National Bank of Belgium Business Surveys

Since the mid 50', the National Bank of Belgium conducts surveys to evaluate the sentiment of business confidence. Initially, this survey was conducted only for the manufacturing sector. However, with the growing importance of the service sector, a specific survey for services has been introduced in the early 90's.
Each month, a panel of around 6,000 business leaders are contacted. They are asked about their assessment of the current economic situation and their expectations for the next three months.
More precisely, they must evaluate in period t how their situation, in terms of output, orders, sales, prices has evolved between $t-2$ and $t-1$, and how some key variables (employment, demand, prices) are expected to evolve between t and $t+3$. They typically have to choose between three answers to each question:

has increased
has not changed
has decreased

or

will increase
will not change
will decrease

These surveys are conducted on the basis of a panel. The same representative sample of businesses that are active in manufacturing industry, construction, trade and B2B services is sent a written survey at the start of each month.

For this article, we use the individual replies to the question relative to the evolution of prices between t-2 and t-1. For the manufacturing sector, we have access to individual information covering the period starting in January 1990 (the survey conducted in February 1990) and ending in December 2007 (the survey conducted in January 2008). For the B2B service sector, the observation period is shorter; it starts in January 1995. During those observation periods, the structure of the sample naturally evolved over time to maintain its representativeness of the Belgian economy. Therefore, some firms disappeared and had to be replaced. While entry and exit are a concern for the analysis of quantitative price data, this is less of a problem for qualitative data. With such data, the occurrence of a price change is directly identified in the first observation, while the

observation of the same product during two consecutive months is needed in order to identify a quantitative price change. In all, we observe 1,101,995 individual price setting decisions[79] (do I keep my price unchanged ? do I increase it ? do I decrease it ?), out of which 90,275 are price increases and 114,505 are price cuts. This data refers to 299 NACE 4 digit sub-sectors and 36 NACE 2 digit sectors (out of 59).

In order to increase the coverage of our analysis, we completed our estimates using existing empirical evidence available in Cornille and Dossche (2008) (henceforth CD) or Aucremanne and Dhyne (2004) (henceforth AD). Estimates of the frequency of price changes in the following sectors were taken out of these two articles : NACE 13 "Mining of metal ores" (CD), NACE 14 "Other mining and quarrying" (CD), NACE 16 "Manufacturing of tobacco products" (CD), NACE 23 "Manufactures of coke, refined petroleum products, nuclear fuel" (CD), NACE 40 "Electricity, gas, steam and hot water supply" (CD), NACE 41 "Collection, purification, distribution of water" (CD), NACE 55 "Hotels and Restaurants" (AD) and NACE 85 "Health care" (AD). Taking into account these additional sources of information allows us to cover 44 NACE 2 digit sectors which represent 84% of the Belgian GDP (according to the 2000 Belgian input - output table).

6.4.2. New Estimates of the Frequency of Price Changes in Belgium

As mentioned above, the micro data available allow identifying 299 NACE 4 digit sub-sectors. The basic estimation of the frequency of price changes is therefore conducted at that highly disaggregated level. The results are then aggregated using weights computed on the basis of the 2000 Belgian annual accounts. Using the annual turnover of the Belgian firms from the annual accounts, we compute the weight of each NACE 4 digit sub-sector and we use these weights to aggregate our results up to NACE 2 digit level. For additional aggregation, we then use the weights from the 2000 Belgian Input Output tables (Eurostat).

We find that the aggregate monthly frequency of price changes for the Belgian economy is 19.2%, which decomposes itself in a 9.9% frequency of price increases and a 9.3% frequency of price decreases. This aggregate frequency of price changes is between the CPI frequency of price changes of 17% in Aucremanne and Dhyne (2004) and the PPI frequency of price changes of 24% in Cornille and Dossche (2008). Considering very broad sectors of activity, we find the frequency of price changes of 24.4% (increases: 13.0 % / decreases: 11.4%) in the manufacturing sector, 20.3% (8.0% / 12.3%) in the building sector, 24.7% (11.8% / 12.8%) in the trade sector, 3.3% (2.9% / 0.4%) in hotels and restaurants and 8.8% (4.5% / 4.4%) in the service sector. The numbers do not support

[79] We simply consider that each observation represents a price-setting decision. However, based on the results for an ad-hoc survey on price-setting practices in Belgium (Aucremanne, Druant, 2005), Belgian firms review their pricing policy only once every 10 months on average.

the common perception that prices are sticky downwards. In almost every broad sector of activity about a half of all price changes are decreases. This is the case even in the service sector[80], in contrast to earlier results in Aucremanne and Dhyne (2004).

Our estimate of the frequency of price changes in the manufacturing sector is close to the one obtained in Cornille and Dossche (2008). The estimated frequency of price changes in the trade sector, which may be viewed as a proxy for the frequency of price changes for final consumer prices, exceeds the estimate obtained by Aucremanne and Dhyne (2004)

Table 6.5: Monthly Frequency of Price Changes by NACE 2 Digit Sector

NACE code	Freq	Freq(+)	Freq(-)		NACE code	Freq	Freq(+)	Freq(-)
13[1]	10.0	7.0	3.0		35	12.6	5.4	7.2
14[1]	10.4	7.0	3.4.		36	9.2	6.8	2.4
15	23.3	12.7	10.6		40[1]	63.5	42.2	21.3
16[1]	12.0	11.0	1.0		41[1]	14.0	10.0	4.0
17	18.9	7.8	11.1		45	20.3	8.0	12.3
18	13.3	5.5	7.8		50	14.5	8.6	5.8
19	12.4	8.0	4.4		51	27.3	12.9	14.3
20	22.8	9.5	13.3		52	23.9	10.7	13.2
21	26.6	12.1	14.4		55[2]	3.3	2.9	0.4
22	18.1	7.8	10.3		60	12.4	7.9	4.5
23[1]	89.0	51.0	38.0		63	10.1	4.1	5.9
24	22.2	12.8	9.4		64	9.2	2.2	7.0
25	18.2	11.6	6.6		65	18.6	7.2	11.4
26	17.8	8.9	8.9		67	10.5	3.9	6.6
27	45.3	21.7	23.5		70	6.0	3.3	2.6
28	16.8	7.9	9.0		71	10.9	5.6	5.3
29	12.0	6.5	5.6		72	10.6	3.4	7.2
30	31.6	6.2	25.4		73	8.3	3.9	4.4
31	14.8	6.0	8.8		74	6.8	3.6	3.2
32	14.8	2.9	11.9		85[2]	6.4	5.8	0.6
33	8.6	6.2	2.4		90	12.8	10.1	2.7
34	6.5	3.6	2.9		93	3.3	0.0	3.3.

Sources :NBB Business Survey and [1] Cornille, Dossche (2008), [2] Aucremanne, Dhyne (2004)

but is very close to those obtained by Bils and Klenow (2004) and Klenow and Kryvstov (2008) for the US CPI. We may also compare our estimates to those obtained through the ad-hoc survey on price setting practices conducted in 2004 by the NBB. Our estimates for manufacturing and trade exceed the frequencies derived from Aucremanne

[80] The only exception is associated to hotels and restaurants, for which almost all price changes are price increases. However, this result is not based on qualitative survey data but on CPI quantitative data.

and Druant (2005); on the other hand our estimates for construction and services are in line with their results. Our estimate of the frequency of price changes in services is also close to the corresponding frequency of price changes of 7% computed by Gautier (2008) for France.

Table 6.6: Frequency of Price Changes - Comparisons with Other Studies

Sector	Frequency	Other estimates
Manufacturing	24.4	Cornille, Dossche (2008): 24 Aucremanne, Druant (2005): 16.4 Vermeulen *et al.* (2008): 15[1] / 25[2] Nakamura, Steinsson (2008): 10.8[3] / 13.3[4]
Construction	20.3	Aucremanne, Druant (2005): 22.7
Trade	24.7	Aucremanne, Dhyne (2004): 17 Aucremanne, Druant (2005): 13.5 Dhyne *et al.* (2006): 15.1 Bils, Klenow (2004): 23.6 Nakamura, Steinsson (2008): 11.9[5] / 20.3[6]
Services	8.8	Aucremanne, Druant (2005): 10.2 Gautier (2008): 7

[1] Italy
[2] France
[3] Finished goods
[4] Intermediate goods
[5] Excluding sales
[6] Including sales

6.4.3. The Determinants of the Frequency of Price Changes

Frequency of Price Changes and Input Prices

As presented before, our results are very similar to the results obtained in previous studies. However, as our data set allows analyzing the frequency of price changes in 44 NACE 2 digit sectors, we are able to conduct a number of econometric exercises that address the question of the structural determinants of the frequency of price changes.

The first element that we want to investigate is the link between the frequency of input price changes and the observed frequency of price changes.

Such an exercise has been conducted by Hoffmann and Kurz-Kim (2006) using German micro CPI data. For a sample of 60 product categories included in the German CPI basket, the authors identify the price index for what they consider to be the main input of each

product[81]. Then they relate the observed frequency of price changes for these 60 product categories to the variability of the price index for their main input. They find that the more volatile the price of the main input, the more frequent are price changes.

Based on the sectoral cost structure embodied in the input-output tables, several authors (Álvarez, Burriel and Hernando, 2008, Cornille and Dossche, 2008, Vermeulen *et al.*, 2007) have looked at the link between the frequency of price changes and the energy and labour content of a good. Using sectoral estimates of the frequency of price changes at the NACE 3 digit level for the manufacturing sector, they relate this frequency to the shares of energy or wages in total costs obtained from the NACE 2 digit decomposition of the input-output tables. In this study, we follow the same idea. We consider also the construction, trade and service sectors and so we have enough observations to conduct our econometric exercise at the NACE 2 digit level for both the explained and the explanatory variables.

We use our sectoral estimates of the frequency of price changes to compute the expected frequency of price changes that is inherited from the frequency of changes in either input prices or wages. More precisely, we use the share of each NACE 2 digit sector in the cost structure of a given product and our estimates of the frequency of price changes to infer the frequency of price changes that would be the reflection of the frequency of all input prices (material inputs or labour inputs). We refer to this frequency as the *input derived frequency of price changes*, which is given by:

$$InputFreq_j = \sum_{i=1}^{n} s_{ij} Freq_i + s_{wj} Freq_w \tag{19}$$

with

$$s_{ij} = \frac{Input_{ij}}{\sum_{i=1}^{n} Input_{ij} + WB_j}$$
$$s_{wj} = \frac{WB_j}{\sum_{i=1}^{n} Input_{ij} + WB_j} \tag{20}$$

[81] For instance, the consumer price of bananas has to reflect the variation of the import price of bananas, the price of heating oil has to mainly relate to the price of oil on the international market, the hourly rate of a plumber has to relate to the evolution of wages etc. Ratfai (2006) does a similar exercise for meat prices in Hungary which the author relates to the producer price index of meat. Dhyne *et al.* (2008) follow a close path but they use the micro CPI data to extract the common driving variable instead of imposing the use of an ad-hoc input price.

where $Freq_i$, $Freq_w$, $Input_{ij}$ and WB_j are respectively the estimated frequency of price changes in sector i, an estimate of the monthly frequency of wage changes[82], the demand for CPA product[83] i consumed by sector j and the total wage bill of sector j.

This frequency gives us a benchmark to which one may compare the observed frequency of price changes. If the observed frequency of price changes in one sector lies below its input derived frequency, this means that the prices in that sector are changed less frequently than what would be implied by the input price volatility and therefore that additional sources of price stickiness might be at work in that sector.

Based on our estimates, 13 sectors out of 44 seem to be characterized by a much lower frequency of price changes than implied by cost changes. These sectors are “NACE 13 Mining of metal ores”, “NACE 14 Other mining and quarrying”, “NACE 16 Manufacture of tobacco products”, “NACE 28 Manufacture of fabricated metal products, except machinery and equipment”, “NACE 33 Manufacture of medical, precision and optical instruments, watches and clocks”, “NACE 36 Manufacture of furniture; manufacturing n.e.c.”, “NACE 55 Hotels and restaurants”, “NACE 60 Land transport; transport via pipelines”, “NACE 70 Real estate activities”, “NACE 71 Renting of machinery and equipment without operator and of personal and household goods”, “NACE 85 Health and social work”, “NACE 90 Sewage and refuse disposal, sanitation and similar activities” and “NACE 93 Other service activities”.

Prices are changed more frequently than implied by costs in 7 sectors. Among the "too frequent price changes" sectors, we find the NACE 23 "Manufacture of coke, refined petroleum products and nuclear fuels"[84]. Part of the explanation of the discrepancy observed for NACE 23 lies in our coverage of the input structure of this sector. If, on average, our 44 NACE 2 digit sectors cover 96% of the non-labour inputs consumed by each sector, this is not the case for this sector for which we are missing important inputs[85]. A poor coverage of the input structure is also affecting the computation of the input derived frequency for the NACE 15 "Manufacture of food products and beverages" as we do not cover CPA 01 "Products of agriculture, hunting and related services" which

[82] We assume that wages are typically changed once a year, so that the monthly frequency of wage changes is 1/12.

[83] The CPA classification is the EU official classification of products by activity. In the input-output tables, the NACE sectors are found in columns while the CPA products are found in rows. A single entry (A_{ij}) in the input-output table gives the amount of product i consumed by sector j.

[84] Our estimate of the frequency of price changes in this sector is mostly dominated by the frequency of price changes of refined petroleum products

[85] CPA 11 "Crude petroleum and natural gas; services incidental to oil and gas extraction, excluding surveying" represents 60% of the inputs consumed by the NACE 23 industry. Assuming a frequency of price changes for CPA 11 products of 100%, we compute an input derived frequency of price changes for NACE 23 of 80.6, which is much more in line with our estimate of the observed frequency for that sector.

represent almost 33% of the inputs consumed by NACE 15. For the other sectors, we neglect at most 10 percent of their input consumption. Therefore, this argument cannot fully explain the discrepancy observed in other sectors.

Among the 13 "too sticky" sectors, 7 are services. However, this does not mean that all services are characterized by excessive price stickiness. Indeed, as many other NACE 2 digit service sectors are characterized by a frequency of price changes in line or above the input derived frequency.

Table 6.7: "Observed" versus "Input-Derived" Frequency of Price Changes

NACE code	Freq	Input Freq		NACE code	Freq	Input Freq
13	10.0	29.4		35	12.6	14.2
14	10.4	19.6		36	9.2	16.3
15	23.3	19.3		*40*	*63.5*	*27.8*
16	12.0	18.6		41	14.0	14.1
17	18.9	18.8		45	20.3	18.1
18	13.3	16.8		50	14.5	13.1
19	12.4	16.6		*51*	*27.3*	*12.8*
20	22.8	20.2		*52*	*23.9*	*13.9*
21	26.6	21.8		55	3.3	16.8
22	18.1	17.8		60	12.4	17.8
23	*89.0*	*51.4*		63	10.1	13.9
24	22.2	24.6		64	9.2	11.1
25	18.2	19.2		*65*	*18.6*	*10.3*
26	17.8	18.2		67	10.5	10.0
27	*45.3*	*32.4*		70	6.0	17.1
28	16.8	22.7		71	10.9	17.7
29	12.0	14.7		72	10.6	11.2
30	*31.6*	*13.6*		73	8.3	10.8
31	14.8	16.4		74	6.8	11.1
32	14.8	14.2		85	6.4	11.7
33	8.6	14.2		90	12.8	19.1
34	6.5	11.2		93	3.3	18.3

In bold: sectors for which the observed frequency of price changes is more than 5 percentage points below the input derived frequency of price changes.

In italic: sectors for which the observed frequency of price changes is more than 5 percentage point above the input derived frequency of price changes.

Sources :NBB Business Survey and Eurostat

From a statistical point of view, using the sample of 44 sectors, a Wilcoxon Sign Rank test does not reject the assumption that the observed frequency of price changes is equal to the input derived frequency. The Wilcoxon Sign Rank test statistics associated to our

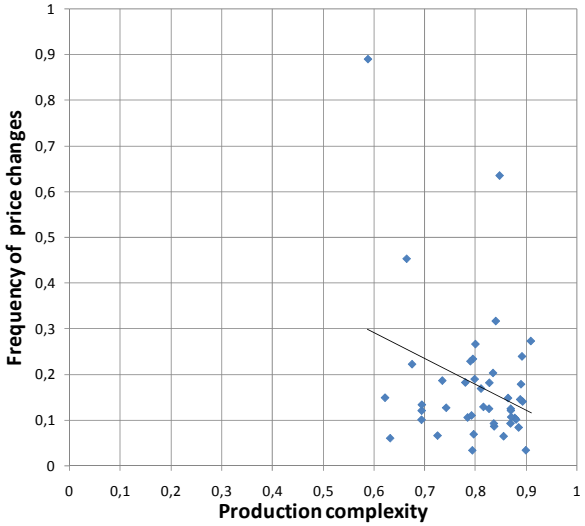
sample is equal to -1.447, larger than the critical value of -1.96. Therefore, the test does not reject the null hypothesis of equality between the two paired series.

Below we discuss bivariate relationships, followed by econometric analysis. The NACE 23 sector "Manufacture of coke, refined petroleum products and nuclear fuels" appears to be an outlier, based on the very high frequency of price changes so we provide the values of the correlations with and without that sector.

Frequency of Price Changes and Complexity

Another factor potentially affecting of the frequency of price changes is the production complexity of a product. If the production process mixes many different inputs, the prices of which change in various directions (some are increasing, some are decreasing), this may lead to a lower frequency of price changes than what is implied by the underlying frequencies of input price changes. Therefore, it might be important to control for the degree of production complexity when analyzing the degree of price rigidity of a given sector. To do so, we use the complexity indicator defined in section 5.2, equation (13).
There seems to be a negative correlation between the degree of production complexity and the frequency of price changes. This correlation of -0.31 is driven by the very high frequency of price changes observed in NACE 23 "Manufacture of coke, refined petroleum products and nuclear fuels" for which the CPA 11 "Refined petroleum products" represents 60% of total inputs. Excluding this sector, the correlation drops to a small -0.04. Therefore, it does not seem that the assumption that the degree of complexity of the production process decreases the frequency of price changes is supported by the data.

Figure 6.10: Frequency of Price Changes and Complexity



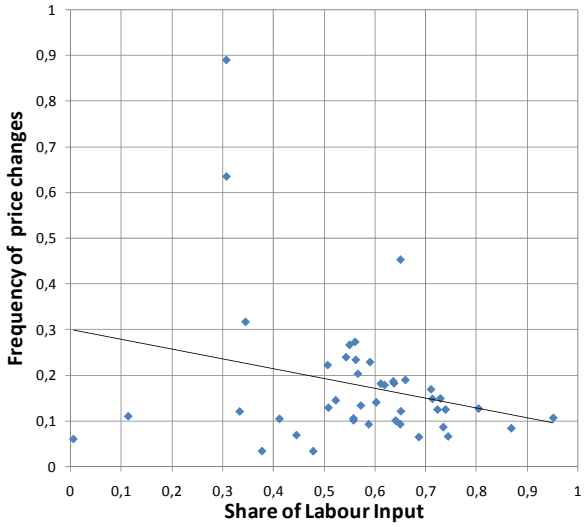
Sources :NBB Business Survey and Eurostat

Frequency of Price Changes and Labour Content

A traditional candidate to explain sectoral discrepancies in the frequency of price changes is the share of labour costs in total costs or value added (see Álvarez, Burriel and Hernando, 2008, Cornille and Dossche, 2008). As wages are changed less frequently than prices, we expect that the frequency of price changes will be lower in the more labour-intensive sectors[86]. Using the 2000 Belgian input-out tables, we address this question using the indicator defined in section 5.2, equation (13).

As for the complexity indicator, our estimates of the frequency of price changes are negatively correlated with the share of labour in the value added (-0.25). The correlation is equal to -0.13 when the NACE 23 sector is not considered in the computation.

Figure 6.11: Frequency of Price Changes and Labour Intensity



Sources :NBB Business Survey and Eurostat

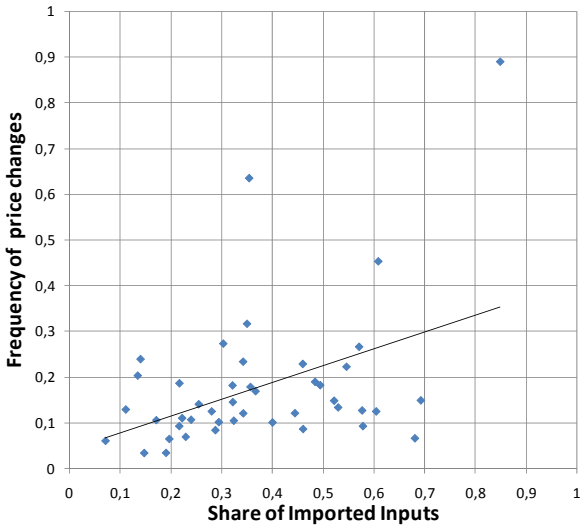
Frequency of Price Changes and Import Content

In terms of costs structure, a final explanatory variable of the frequency of price changes is the share of imported inputs. Following Álvarez, Burriel and Hernando (2008) , we investigate the link between the frequency of price change and the share of imported inputs defined in section 5.2, equation (18) with $X_{ij} = 0$

The following graph summarizes the link between our observed frequencies of price changes and the share of imported inputs:

[86] Note that this effect of wage stickiness on price stickiness is also captured in our input derived frequency of price changes.

Figure 6.12: Frequency of Price Changes and the Share of Imported Inputs



Sources :NBB Business Survey and Eurostat

This variable is positively correlated with the frequency of price changes (0.43) which is in line with our expectations. If part of the correlation is also related to the NACE 23 sector, this variable is still positively correlated with the frequency of price changes when the influence of this sector is neutralized[87]. For a small open economy as Belgium, it is not surprising to observe this positive link between the import content of the products and the frequency of price changes.

Frequency of price changes and competition

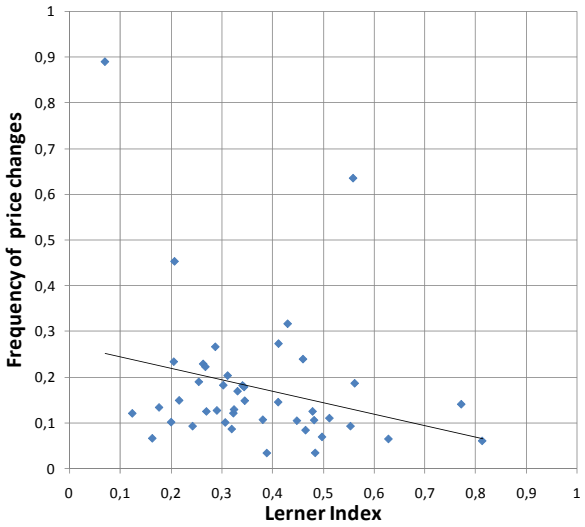
Several authors also address the issue of the relation between the frequency of price changes and the degree of market competition (Álvarez and Hernando, 2007, Cornille and Dossche, 2008, among others). In this paper, we use the information included in the Belgian 2000 input-output table to estimate a sectoral Lerner index at the NACE 2 digit level and we relate this measure with our estimates of the frequency of price changes.

To proxy the degree of market competition for each sector, we use the Lerner index, as defined in section 5.2, equations (16)-(17).

As other authors, we do not find a strong and clear link between the degree of price stickiness and the degree of market competition. While high values of the Lerner Index[88] tend to be related with low frequencies of price changes, the correlation between the two variables is only equal to -0.26 and drops to -0.07 if the NACE 23 sector is not considered in our analysis.

[87]The correlation equals 0.21 when the NACE 23 is not taken into consideration.
[88]This means a low degree of market competition.

Figure 6.13. Frequency of Price Changes and the Degree of Product Market Competition



Sources :NBB Business Survey and Eurostat

Alternatively, we also measure competition by using the sectoral mark-ups estimated for Belgium in Christopoulou and Vermeulen (2008)[89]. Both measures are positively correlated as their linear correlation is equal to 0.63 and their Spearman Rank correlation is equal to 0.76.

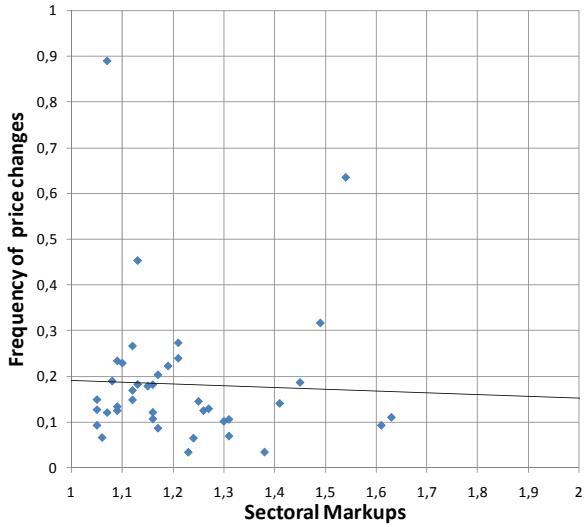
Using this alternative measure of market competition, we do not find a strong link between the degree of price stickiness and the relative mark-ups. Indeed, the correlation between the two variables is equal to -0.11 and slightly drops to -0.08 if the NACE 23 sector is not considered in the analysis.

Frequency of Price Changes and International Trade

Another way to tackle the relation between the frequency of price changes and the degree of market competition would be to look at the sectoral exposure to international trade. Sectors protected from international competition might change less frequently their prices than exposed sectors. Using the information included in the Belgian 2000 input-output table, we estimate an indicator of the sectoral openness to international trade at the NACE 2 digit level and we relate this measure with our estimates of the frequency of price changes.

[89] Based on Christopoulou and Vermeulen (2008), the level of the average relative mark-up in the Belgian economy is equal to 1.22, which is lower to the euro area average (1.37). Globally, product markets in Belgium should be considered more competitive than in other euro area countries. This is confirmed by a Wilcoxon Sign Rank Test which compares the sectoral mark-ups isin Belgium and in the Euro Area.

Figure 6.14: Frequency of Price Changes and Sectoral Markus



Sources : NBB Business Survey and Christopoulou and Vermeulen (2008)

To proxy the degree of sectoral openness for each sector, we first compute a sectoral indicator of intra-EU trade openness given by

$$Intra\_EU\_Openness_j = \frac{EU\_M_j + EU\_X_j}{Prod_j} \qquad (21)$$

where EU_M_j, X_j and EU_Prod_j represent respectively the imports, exports and total production of sector j.

Then we consider the degree of openness to extra-EU trade given by

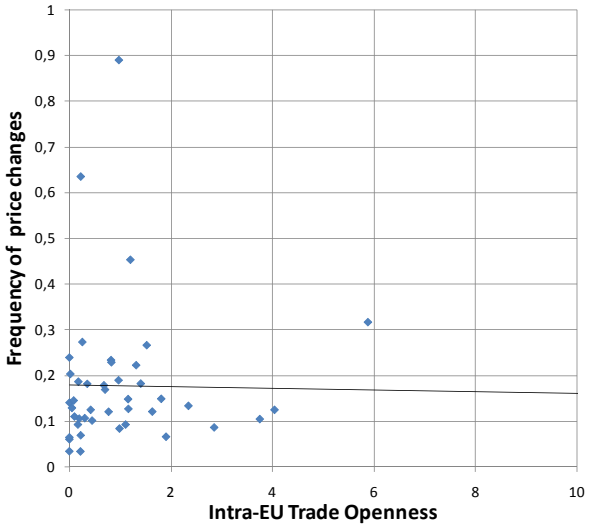
$$Extra\_EU\_Openness_j = \frac{non\_EU\_M_j + non\_EU\_X_j}{Prod_j} \qquad (22)$$

where $non\_EU\_M_j$ and $non\_EU\_X_j$ represent respectively the extra-EU imports and exports of sector j.

Similar to what is observed in other studies on this topic, we do not find a strong and clear link between the degree of price stickiness and the degree of either intra-EU or extra-EU trade openness. The degree of exposure to international competition does not seem therefore to influence the frequency of price changes in Belgium. The correlations between the two variables and the frequency of price changes are respectively equal to -

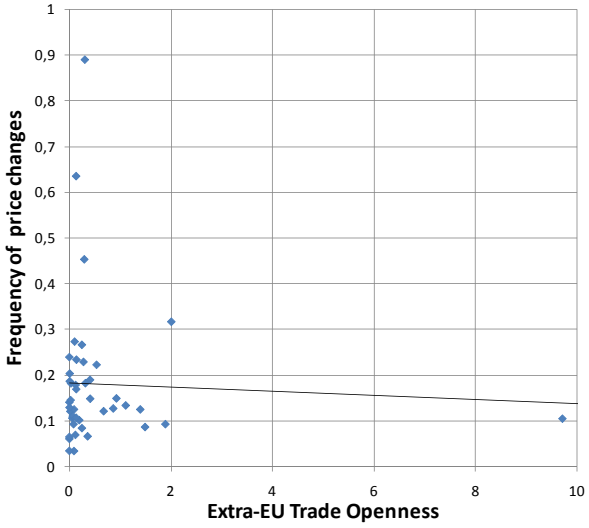
0.02 for intra-EU trade and -0.10 for extra-EU trade and are not affected by the NACE 23 sector.

Figure 6.15: Frequency of Price Changes and the Degree of Openness to Intra-EU Trade



Sources :NBB Business Survey and Eurostat

Figure 6.16: Frequency of Price Changes and the Degree of Openness to Extra-EU Trade



Sources :NBB Business Survey and Eurostat

6.4.4. A Multivariate Approach to Explaining the Frequency of Price Changes

The bivariate analyses presented in the previous sub-sections only deliver a partial explanation of the frequency of price changes. To obtain a better understanding of the determinants of the frequency of price changes, we use all the potential explanatory factors of the frequency of price changes in one econometric equation.

For this econometric exercise, we consider only one measure of global trade openness instead of the two separated indicators presented in Sub-section 5.2.3, because these two indicators are highly correlated. We also use a corrected value of the input-derived frequency of price changes for the NACE 23 and NACE 40 sectors that takes into account the contribution of CPA 10 and CPA 11 which are two important inputs for these sectors. Using these corrected measures[90], the large discrepancies observed for the NACE 23 and NACE 40 between the observed and input derived frequencies presented in Table 6.7 are reduced.

It is worth mentioning that, unlike in other studies, we do not include the share of energy inputs as an additional explanatory variable. The impact of the more volatile oil prices should in fact be captured in our analysis by the input derived frequency of price changes.[91]

As the frequency of price changes is a variable that takes its value between 0 and 1, we not only estimate a simple OLS regression but also a non linear regression using the QML estimation procedure proposed in Papke and Wooldridge (1996). The results associated to the OLS and QML regressions are respectively summarized in Tables 6.8. and 6.9.

Based on the OLS regression, it seems that two explanatory variables affect significantly the observed sectoral frequency of price changes. The most important factor is the input derived frequency of price changes. An increase in the input derived frequency naturally translates into an increase in the observed frequency and the coefficient associated with this variable is not statistically different from unity. The other significant variable is the degree of sectoral openness to international trade, which seems to affect negatively the frequency of price changes. This result is quite difficult to understand but seems to be highly significant. We expected a positive relation between the two variables as a larger exposure to international trade implies stronger competition and therefore stronger pressure on prices that should therefore react more rapidly to changes in costs.

[90] The corrected input derived frequency of price changes for NACE 23 and NACE 40 are respectively equal to 80.5% and 32.1%.

[91] Including a variable capturing the share of energy inputs in total costs, as in Dhyne (2008), generates strong multicolinearity, as it is highly correlated with the input derived frequency (correlation of 86%).

Table 6.8: OLS Linear Regression: Explained Variable: $Freq_j$

	Coef.	Robust Std. Err	t	P>|t|	[95 % Conf. Interval]	
Const	-0.317	0.2	-1.58	0.122	-0.723	0.0088
$InputFreq_j$	1.199	0.155	7.72	0	0.884	1.514
$Lerner_j$	0.109	0.11	0.98	0.331	-0.115	0.333
$Complexity_j$	0.251	0.246	1.02	0.315	-0.248	0.749
$Labour_j$	-0.037	0.115	-0.32	0.75	-0.27	0.196
$Import_j$	0.178	0.112	1.58	0.122	-0.05	0.406
$Openness_j$	-0.006	0.002	-3.33	0.002	-0.009	-0.002

Number of obs = 44
$F(6,37) = 23.45$
$Prob > F = 0.0000$
$R^2 = 0.7458$
$BIC = -74.467$

The second variable associated to international trade is almost significant at the 10% level and indicates that the larger is the share of imported inputs in the cost structure, the larger is the frequency of price changes. Based on results obtained in Section 5.2.2, the low significance of that variable may be due to a composition effect. As shown in Section 5.2.2, a larger share of imported inputs affects differently the occurrence of price increases and price decreases. Price increases are less frequent, while price decreases might be more frequent. If a net negative impact on the total frequency of price changes is found in Section 5.2.2 using cross-country data, the results presented above seem to indicate that the reverse is true when the sample is restricted to the Belgian economy.

Finally, the other variables have no statistically significant impacts on the frequency of price changes.

In terms of the sign associated to the different coefficients, the QML estimation confirms our OLS results. The share of imported inputs is now significant at the 10% level. The marginal effect computed at the sample mean confirms that an increase in the input derived frequency of price changes translates almost one to one to the observed frequency of price changes. Comparing both equations, the non linear estimates seem to provide better results than the OLS, based on the Bayesian Information Criteria (BIC).

As it seems that both specifications indicate that the marginal effect of the input derived frequency of price changes on the observed frequency is equal to one, we also estimate an equation relating the difference between the observed frequency and the input derived frequency with the other explanatory variables. What are the factors explaining the excess

or the shortage of frequency of price changes compared to the level implied by the sectoral cost structure? The results associated to this constrained equation are presented in Table 6.10[92]

Table 6.9: QML Non Linear Regression - Explained Variable : $Freq_j$

	Coef.	Robust Std. Err	t	P>|t|	Marginal effect	[95 % Conf. Interval]	
Const	-4.835	1.277	-3.790	0.000	-	-	-
$InputFreq_j$	7.009	1.740	4.030	0.000	0.973	0.478	1.468
$Lerner_j$	0.482	0.686	0.700	0.482	0.067	-0.121	0.255
$Complexity_j$	2.009	1.555	1.290	0.196	0.279	-0.153	0.710
$Labour_j$	-0.423	0.757	-0.560	0.576	-0.059	-0.267	0.149
$Import_j$	1.249	0.745	1.680	0.094	0.173	-0.032	0.379
$Openness_i$	-0.035	0.014	-2.420	0.016	-0.005	-0.009	-0.001

Number of obs = 44
BIC = -138.367

Based on Table 6.10, we observe that the variables that seem to explain the discrepancy between the observed frequency of price changes and the input derived frequency of price changes are the share of imported inputs (significant at the 10% level) and the degree of openness to international trade. As mentioned above, the price of imported inputs might be more volatile than the price of domestic inputs because of exchange rate fluctuations. Therefore, a larger share of imported inputs increases the frequency of price changes of domestic goods through a faster pass-through of international prices in domestic prices. Considering the other variables, the coefficient associated to the labour share is the only coefficient which has the expected sign.

Concerning the impact of product market competition, the Lerner index has no significant impact on the sectoral frequency of price changes, confirming the assumption that cross-sector discrepancies in the degree of price stickiness is mostly the reflect of differences in cost structure.[93]

[92] A Wald test supports the assumption that the coefficient associated to the input derived frequency is equal to one. Therefore, the restricted model can be considered as valid.
[93] Note that the use of the sectoral markups does not affect this conclusion.

Table 6.10 - OLS Linear Regression - Explained Variable : $Freq_j - InputFreq_j$

	Coef.	Robust Std. Err	t	P>|t|	[95 % Conf. Interval]	
Const	-0.239	0.19	-1.26	0.215	-0.623	0.145
$Lerner_j$	0.091	0.111	0.82	0.417	-0.134	0.316
$Complexity_j$	0.219	0.246	0.89	0.379	-0.28	0.718
$Labour_j$	-0.089	0.112	-0.8	0.43	-0.316	0.137
$Import_j$	0.232	0.12	1.93	0.061	-0.011	0.476
$Openness_j$	-0.005	0.001	-3.68	0.001	-0.008	-0.002

Number of obs = 44
F(5,38) = 4.86
Prob > F = 0.0015
R2 = 0.1943

6.5. Producer Price Rigidities in France.[94]

There are basically two statistical sources that allow characterizing the stickiness of producer prices in France. The first source is the set of price records collected by the French statistical institute (INSEE) for computing the producer price indices. Unfortunately, the access to these data is very restricted. Moreover, the information contained in the PPI (Production Price Index) database only refers to prices and nothing is available regarding their determining factors such as costs or demand (see Gautier, 2008 for more details about these data). A second source of information may be found in the business surveys conducted by both the INSEE and by the Banque de France. These business surveys ask about changes in variables such as their product price, their production level, the orders received, their intermediate input costs, etc. However, while the information collected by INSEE to compute the PPI is quantitative (i.e. is a given product price level) that obtained from the business surveys is qualitative: firms are asked to characterize the variations in the variables mentioned above as either large decreases, medium decreases or small decreases or small, medium or large increases. Although the nature of the information collected differs from that of the data used to compute the PPI, one must mention that the estimates of the frequency of price changes, a fundamental characteristic of price changes of interest for us, appears to be quite similar whatever dataset is used to compute these estimates (see Gautier and Sevestre, 2006). The main advantage of these business surveys is that they contain information about price variations as well as about changes in their main determining factors (intermediate input prices, production and demand as measured by orders received).

[94] This section heavily relies on Gautier and Sevestre (2006) and Loupias and Sevestre (2008).

In a recent paper, Loupias and Sevestre (2008) have used the data from the Banque de France business surveys to characterize producer prices rigidity. Indeed, producer prices can be said to be rigid as firms appear to change their prices less often than what would be expected from the frequency of changes in their environment. Indeed, a survey conducted by the Banque de France in 2004 (Loupias and Ricart, 2006) have shown that about 25% of French manufacturing firms having faced demand or cost shocks in 2003 did not change their prices during that same year. This observation can also be made using data from the Banque de France monthly business surveys. In table 6.1, a firm is considered to have experienced a change in its environment as soon as either the price of its intermediate inputs, the wage of its workers or its demand/production[95] level changed during the month under review.

Table 6.1 - Changes in the Environment and Price Changes

	Change in environment	**No change in environment**	**Total**
Price change	16.6	2.4	19.0
Non price change	60.9	20.1	81.0
Total	77.4	22.6	100.0

Source : Banque de France Business surveys merged with the ACEMO survey. The dataset contains 51,067 observations about 2,401 firms and the sample period is October 1998 to December 2005.

These figures clearly show that producer prices are rigid: most changes in the firm environment *do not* induce a price change since the probability of observing a price change given that the firm environment has changed is only 21%.

It is also worth mentioning that the likelihood of a price change is significantly higher after a cost variation than what it is after a change in demand/production. Despite the fact that the occurrence of demand changes is much more frequent than that of cost changes, prices change much more often after the occurrence of the latter than what they do after changes in demand. The nature of the shocks involved may explain this difference. Changes in demand/production may be more idiosyncratic than input price variations, thus leading to less price changes because of the uncertainty regarding the firms' competitors pricing decisions.

[95] Here, inventories are not considered. Demand and production are thus assumed to be equal. Robustness checks on the econometric results have shown that results are about the same whether we use the demand or the production variable.

Table 6.12: Probability of a Price Change, Conditional on Production and Cost Changes

	Probability of occurrence	Price change conditional on changes at t
Change in both costs and production	27.4	30.1
Change in costs only	14.8	25.4
Change in production only	35.3	12.9
No change in costs nor production	22.5	10.8
Total	100.0	19.0

Source : Banque de France Business surveys merged with the ACEMO survey. The dataset contains 51,067 observations about 2,401 firms and the sample period is October 1998 to December 2005.

In order to quantify econometrically the impact of the various factors that may impact producer prices, Loupias and Sevestre (2008) have estimated several ordered probit models. The first model they estimate is a standard state-dependent model in which price changes depend on the accumulated changes of costs and demand since the previous price change. The second model they estimate is a more flexible dynamic model in which past variations of costs and demands are allowed to have a different impact on price changes. Finally, they also estimate a model with asymmetries in order to check whether costs and demand increases have a similar or different impact on prices than decreases have. The dataset they use results from the merging of the series of the Banque de France monthly business surveys with another dataset obtained from the French Ministry of Labour containing information about firms wages and employment, as well as the set of monthly producer price indices computed by INSEE, the French national statistical institute, at the 2-digit NACE level.

The conclusions that can be drawn from their estimation results are as follows.

1. Changes in the price of intermediate inputs are the main driver of price changes. According to the standard state-dependent model estimates, the occurrence of an increase in intermediate input prices by 1 percentage point leads to an increase of 1.4% of the probability of a price increase (whose average is 10.5%) and a decrease of 1.2% of the probability of a price decrease (which equals 8.4% on average). However, the flexible dynamic model estimates show that more recent changes appear to have a greater impact on price changes than previous ones. Firms react quite fast to such cost variations.

2. Variations in the sectoral price index appear to be the second most powerful driver of price changes. According to the standard state-dependent model estimates again, the marginal effect of an increase of 1 percentage point in these cumulated variations raises the probability to observe a price increase by 1.1% and diminishes that to see a price decrease by 0.9%. Moreover, this impact is more equally spread over time than what is for intermediate input prices. The assumption underlying the standard state-dependent model

appears to hold as regards the impact of the competitors' price on the firm decisions.

3. Surprisingly, the impact of wages appears to be quite low in all estimated models. This limited impact of wage changes on prices is in accordance with the results of a set of surveys recently conducted by several central banks of the Euro area. In this survey, 59% of the firms declared that "no link exists between the timing of price and wage changes" (Druant *et al.,* 2008). Several explanations are proposed. First, the relative importance of intermediate inputs costs as compared to labour costs is the most evident explanation of such a difference. The share of intermediate input costs in total production of French manufacturing firms was about 70% in 2005 while that of labour cost was 20% (SESSI, 2008). It is then quite natural for shocks on intermediate input prices to have a stronger impact on prices than wage changes do. Another explanation may lie in the magnitude of the cost change corresponding to these two components of the production cost: the intermediate input price changes are likely to be of a larger magnitude than those of wages, thus leading to a higher likelihood to induce a price adjustment. According to Heckel *et al.* (2008), the average wage change in the French manufacturing industry is slightly above 2.2% while changes in intermediate good prices reported in Gautier (2008) are about 4%. This again certainly contributes to the larger impact of intermediate input changes. Moreover, this difference in magnitudes may have an indirect effect: the cost for the firm of non-adjusting the price is lower after a wage change than what it is when intermediate inputs prices change. Then, after a (small) wage change, the firm can decide to wait for making the necessary adjustment (See Konieczny and Rumler, 2006, for a theoretical model exploiting this argument). If, moreover, as shown in Levy *et al.* (2002), the sensitivity of prices to a cost shock is larger the larger the magnitude of the shock, this may also explain the lower sensitivity of prices to wage changes. Another possible explanation of the low impact of wage changes on prices might be found in the nature of the shocks associated with these variations. Variations in wages might be less easily incorporated by firms in their prices as they are less "visible" to the firms' customers than those of intermediate input prices. Firms would then postpone the price adjustments induced by wage changes until they proceed to price changes induced by intermediate inputs price variations. A fourth argument that may explain this limited impact of wage variations on prices is the possibility for firms to take benefit of productivity improvements associated with technological evolutions and/or with quantities adjustments in the labour input (e.g. see Fuss, 2008). Indeed, several studies have pointed to a limited sensibility of wages to productivity changes (e.g. see Biscourp *et al.*, 2005, Cardoso and Portela, 2005, Guiso *et al.*, 2005, and, more recently, Katay, 2007, and Fuss and Wintr, 2008). In other words, it could be that firms partially offset the consequences of wage increases through the "capture" of a fraction of productivity gains they are able to generate. Another interesting result to be noticed is that past wage changes appear to impact significantly price changes. It seems that firms that granted wage increases to their workers without having the possibility to adjust their prices immediately proceed to a "catch-up" after a while, maybe at the same time as they make a price adjustment associated with another cost or demand variation. However, this effect is not robust to alternative specifications of the model.

4. Variations in the demand/production level of the firm have a significant but rather low impact on the likelihood of a price change. This result is in line with both the descriptive statistics presented above and with the results of the surveys conducted in the Eurosystem (see Fabiani *et al.* 2006 and 2007): firms prices are more reactive to costs changes than they are to demand/production changes. A first possible explanation is that production appears to be more volatile than costs: in the sample used by Loupias and Sevestre (2008), the frequency of changes in the production only is about 35%, which is almost three times that of changes in costs only. Then, adjusting prices at the same pace would be probably very costly to firms, both in terms of internal management and in terms of management of the customer relationship. Second, variations in demand are probably more idiosyncratic (across time and/or across firms) than costs changes. Then, the level of uncertainty about both the durability of observed changes in demand and the price decisions of other firms is probably quite important regarding these variations in demand. This may explain why firms may decide to wait before changing their price when they face demand changes.

5. Finally, Loupias and Sevestre (2008) also present estimates of a model allowing for asymmetries. Their results show that cost increases are more rapidly and fully incorporated in prices than cost decreases. In particular, the transmission of intermediate input price increases to the product price is immediate and quite strong while this transmission is delayed and of a much lower magnitude when the shock corresponds to a decrease. At the opposite, there is some more symmetry in the reaction of prices to wage changes. Wage costs decreases are incorporated rather rapidly in price decreases, although this is to a lesser degree as compared to the reaction of prices to wage increases. It might be that wage decreases are associated with a labour management policy whereby firms try become more competitive, which would explain why, when wage costs are lowered, these gains are, at least partly, incorporated in prices. Their results also point to a strong asymmetry in the way prices are adjusted to the sectoral price inflation. Firms adjust their prices upward but do not seem to do it downward so often. This is not a surprise in an environment where, except for a few specific industries, inflation is positive. The need to lower prices is less stringent than to increase them in such an environment. Finally, it is also worth mentioning that the asymmetry they get regarding the reaction of prices to demand/production changes is not that important.

6.6. Summary of the Findings.

In this section we look at several issues using country data. The study of regulated and unregulated prices in Austria shows a very significant effect of regulation on the frequency of adjustment. Firms subject to price regulation change prices three times less frequently than unregulated firms. Regulated prices change by a smaller amount. Deregulation leads to more frequent price changes. The effect of regulation is more pronounced for price decreases (both frequency and size) than for price increases. Regulated prices are rarely cut. They are characterized by strong seasonality: a very large proportion of price changes is in January.

The introduction of the Euro required that firms convert prices from the old to the new currency. We analyze the effect on pricing policies with data from Austria and Belgium that end almost five years after the changeover, thus providing sufficiently long period to study the long run effects of Euro introduction. The forced price adjustment resulted in higher frequency of price changes around the time of the changeover. The effect on the size of price changes was dramatic: price changes were much smaller than usual for several months and in particular in January 2002. We do not, however, find permanent effects of the changeover on price flexibility. In Austria the frequency of price changes increases but the increase starts two years earlier. It may be caused by deregulation of electricity and gas prices or by the change in the composition of sampled goods. In Belgium, the frequency of price changes is higher than before the changeover for a few years but then return to the pre-Euro level.

There has been concern recently about the fast increase in food and energy prices in the Euro area. This trend has been replaced since September 2008 by rapid disinflation. We look at the effect of inflation on the frequency of food prices in Belgium, and on the frequency of price changes in Austria. In Belgium, higher inflation led to more frequent price changes and had limited effect on their size. More precisely, the frequency of price increases rose significantly, while the frequency of price cuts fell slightly. In Austria both increases and decreases became more frequent but the effect on decreases was smaller. More frequent price increases and less frequent decreases when inflation rises is a well known phenomenon. In several studies, however, the effects tend to cancel so that there is little effect on the overall frequency of price changes.

Further information on the behaviour of producer prices is obtained from detailed firm surveys conducted by the National Bank of Belgium and the Banque de France. We find that, in Belgium, the average frequency of producer price changes is 20%. This number varies between 25% in manufacturing and the trade sectors, 20% in the construction sector and 9% in the B2B sector. Price reductions are about as frequent as price increases, also in the B2B sector. This is in contrast to consumer services in which price increases are about four times as common as price decreases. The analysis of factors affecting price adjustment concludes that the main determinant of the sectoral frequency of price changes are input costs and, to some extent, the share of imported inputs.

Business surveys conducted by the Banque de France provide extensive information on factors affecting producer price changes in France. We find that producer price changes are indeed rigid: of firms that report change in their environment in a given period, almost 80% leave their prices unchanged. Firms are more likely to respond to cost changes than to demand or production changes. As in Belgium, intermediate input prices are the main driver of price changes. Wage changes do not have an immediate impact on prices, consistent with the fact that a majority of firms declare no link between the timing of price and wage changes. Finally, firms respond more rapidly to cost increases than to cost decreases.

VII. CONCLUSIONS AND POLICY RECOMMENDATIONS

Economic adjustment to nominal shocks depends not only on the frequency of price changes but on the degree of intrinsic rigidity: a situation in which the desired (optimal) price changes but the actual price remains constant. In this report we review the literature and list the characteristics of price behaviour in the Euro area available from earlier studies. We develop three indicators that allow the assessment of intrinsic rigidity. The first indicator compares the frequency and size of changes in the actual and in the optimal price. The second indicator compares the persistence of the CPI and the corresponding PPI inflation rates. The third compares the average price change to the volatility of the price index.

We use the three indicators to study the rigidity of consumer prices. Our analysis shows that the frequency of price changes may be a misleading indicator of intrinsic price rigidity. Crucial differences arise for food and for service prices. While retail prices of food change very often, mainly because producer prices are very volatile, they actually exhibit substantial intrinsic rigidity. On the other hand, the low frequency of price changes for services is due to the fact that the cost of providing services is quite stable. The reason for this stability is that the largest component of the cost is labour, and wages are changed quite infrequently, usually once a year. The level or intrinsic rigidity for services is actually moderate, similar to the level for manufactured products, for which prices change much more often.

Our results indicate that a larger number of retailers has a positive effect on price flexibility but the number of large supermarkets does not seem to have a significant effect.

Several studies analyzed factors underlying producer price rigidity in individual Euro area countries. We construct a harmonized data set and conduct cross-sectional analysis which allows a better assessment of six factors on producer price rigidity across Euro area countries. We concentrate on the frequency of price changes as data needed to estimate desired prices are not available. We find that there are no substantial differences across countries in the role of these factors. Share of energy in production costs has a strong positive effect, while the labour share in value added has a weak negative effect on the frequency of price changes. Prices of complex products (products that use many inputs) change less often; this may be because prices of various inputs change in different directions. The share of imported inputs, as well as the degree of sectoral openness, does not seem to have much effect on the frequency of price changes.

Individual country studies find little effect of competition on the frequency of price changes which is surprising in view of the theoretical literature. The harmonized analysis shows, however, that competition may affect the frequency of price changes. The result is not very strong. We use two proxies for market competition and the effect of competition

is significant only with one. This may be because the two measures we use are poor proxies for market competition. When firms are asked directly in surveys about the competition in their market the clear result is that it affects the frequency of price changes. Competition is a very microeconomic issue and to obtain clear results better data on competition in individual markets are needed. However, gathering the necessary data at the retail or at the producer level would require an enormous amount of work.

The study of regulated and unregulated prices in Austria shows a very significant effect of regulation on the frequency of adjustment. Firms subject to price regulation change prices three times less frequently than unregulated firms. Regulated prices change by a smaller amount. Deregulation leads to more frequent price changes. The effect of regulation is more pronounced for price decreases (both frequency and size) than for price increases. Regulated prices are rarely cut. They are characterized by strong seasonality: a very large proportion of price changes is in January.

The introduction of the Euro required that firms convert prices from the old to the new currency. We analyze the effect on pricing policies with data from Austria and Belgium that end almost five years after the changeover, thus providing a long period to study the long run effects of the Euro introduction. The forced price adjustment resulted in higher frequency of price changes around the time of the changeover. The effect on the size of price changes was dramatic: price changes were much smaller than usual for several months and in particular in January 2002. We do not, however, find permanent effects of the changeover on price flexibility. In Austria the frequency of price changes increases but the increase starts two years earlier. It may be caused by deregulation of electricity and gas prices or by the change in the composition of sampled goods. In Belgium, the frequency of price changes is higher than before the changeover for a few years but then returns to the pre-Euro level.

There has been concern recently about the fast increase in food and energy prices in the Euro area. This trend has been replaced since September 2008 by rapid disinflation. We look at the effect of inflation on the frequency of food prices in Belgium, and on the frequency of price changes in Austria. In Belgium, higher inflation led to more frequent price changes and had limited effect on their size. The frequency of price increases rose significantly, while the frequency of price cuts fell slightly. In Austria both increases and decreases became more frequent but the effect on decreases was smaller. The response of price changes in Belgium is consistent with other studies, in particular Gagnon (2007). The effect of inflation on the size of price changes is limited. The response of price increases and decreases to higher inflation is asymmetric. When inflation rises, price increases become more frequent and price decreases less frequent. This is important for two reasons. First, some studies find little effect of inflation on the frequency of price changes. This is the artefact of the effects on the frequency of increases and decreases cancelling each other. Second, as inflation rate falls, price decreases become more frequent and so prices become more flexible downward. Thus concerns about downward price rigidity are not justified.

Our findings lead to several policy implications. They concentrate on three issues: the frequency of price adjustment, causes of intrinsic rigidity and sectoral differences in the frequency of price changes. We discuss them in turn.

All theoretical models imply that a higher frequency of price changes leads to faster aggregate adjustment. Policies that increase the frequency of price changes are, therefore, desirable. Such policies include restricting price regulation, promoting competition and consumer search for the best price as well as reducing costs of price adjustment.

Evidence shows that prices of regulated products are stickier, i.e. they change less often, than of unregulated products. They are also likely more rigid, i.e. adjust to a smaller degree to changes in demand and costs. The high degree of stickiness and rigidity of regulated prices can be explained by costly price adjustment theories, which imply that the higher is the cost of price adjustment, the less frequent are price changes. For regulated goods the cost of price adjustment is high, because the firm must typically prepare the filing to regulatory body and often send senior management to the regulatory meeting. As the process often takes a lot of time, the decision to change a regulated price is made on the basis of past information. Theoretical models show that the aggregate rigidity is greater when price changes are based on past rather than on forward-looking information.

Increasing the frequency of price changes requires, therefore, the minimization of price regulation. In some sectors price deregulation is possible and should be undertaken. In other sectors deregulation is difficult or impossible to implement; this is the case in particular in sectors where there exists a monopoly brought about by regulatory environment, like the provision of electricity or transportation services. In those sectors considerations related to price flexibility are unlikely to be sufficient to lead to a wholesale reform. But even in these cases it is possible to increase price flexibility by simplifying the regulatory process. Two solutions should be relatively easy to implement. The firms should be able to initiate the price change process at the time of their choosing, rather than at regular intervals. This would allow them to react faster to large changes in costs (for example fuel costs) or demand. It should also in general be possible to index the regulated prices to either the general or sector-specific price level. The latter solution is particularly for products that are important inputs in many sectors of the economy, for example electricity.

Our results indicate that price regulation has a greater effect on price decreases than on price increases, for both frequency and size. We also report that as inflation declines, for unregulated goods price decreases become more, and price increases become less frequent. Regulated firms rarely lower prices and so when inflation is low and price decreases for unregulated goods common, the relative price of regulated to unregulated goods is subject to greater distortions. This implies that the benefit of deregulation will be larger in the current low inflation environment.

While the relationship between competition and the frequency of price changes is not entirely clear, it is probably because the competition measures us and other researchers use are poor proxies for the level of competition. For example markups are high in non-competitive markets. But they are also high in markets in which intense competition leads to rapid product innovation and differentiation. When firms are asked in surveys about the competition in the market in which they operate and the frequency of their price changes, the result is that the higher is the perceived market competition, the more frequent are price changes. So, overall, we believe that promoting competition will make price changes more frequent and aggregate price adjustment faster.

There are several methods of raising market competition well know from the microeconomic literature: ease of entry (including limiting obstacles to opening a new business), facile international trade, limited and clear regulations that are harmonized across countries, harmonized product standards, vigorous prosecution and penalties for collusion etc. In the case of prices, fostering competition requires the clarity of pricing. It is important as price obfuscation impairs the ability of customers to make price comparisons. Firms should be required to post their prices. Often prices of medical or legal services are not posted, which makes price comparisons difficult or even impossible. Posted prices should include the actual purchase cost and, in the case of transactions that involve several payments (for example rental agreements or mortgage payments) the entire payment schedule.

As discussed in the report, the search for the best price raises the frequency of price changes. Policies that facilitate the search for the best price include simplification and harmonization of product regulations and standards, requirements of posting actual pricing and prohibition of hidden charges and joint transactions, disclosure of the payment schedule for multi-payment transactions and, in some cases government – sponsored product comparisons. Product regulations and varying standards are often used by firms to create the impression of product differentiation and reducing competition. Posting actual prices permits price comparisons; they are further facilitated if firms are required to post the actual transaction price including all elements (for example, prohibiting airlines to post prices net of taxes, fuel surcharges etc. When firms provide incomplete cost of the purchase and/or hide some of the cost, the motivation is usual to make price comparison more difficult and build some pricing power. Joint transactions, by linking the price of one product to another, make price comparisons difficult and reduce incentives for the best price. Such practices are common in many countries for cell phone purchases, when the phone is subsidized whenever long-term contract is entered at the time of the purchase. Government-sponsored comparisons provide purchasers information that allow them to assess the benefits of switching to lower-cost products. For transactions involving many payments firms may attempt to hide information for future payments to obscure the actual price, resulting in erroneous price comparisons. For example in the case of medication government testing may clarify the differences and similarities between brand-name and generic drugs.

The above discussion focuses on the frequency of price changes, which is an easily accessible proxy for price flexibility. As we discuss in the report, however, what matters is intrinsic rigidity: the fact that prices do not adjust instantaneously and fully to changes in demand and costs. The appropriateness of policy should therefore not be assessed on the basis of the average frequency of price changes for a given product, but rather on its degree of intrinsic rigidity. In particular, whenever price changes are infrequent when the aggregate conditions are stable, policy intervention is not necessarily recommended. One particular cause for intrinsic rigidity falling under government policy is price collusion. Preventing firms from colluding with respect of their pricing policies would increase intrinsic rigidity.

The effect of sticky individual prices on aggregate adjustment depends on the distribution of the frequency of price changes across products. This is because the stickiest prices exert a disproportionate influence on aggregate flexibility. Polices should therefore be directed in particular on the slow adjusting sectors. In most economies, for consumer goods the slow-adjusting sectors involve mainly services. The prices of services change infrequently because their main cost – the price of labour – remains constant for extended periods of time. Hence a comprehensive labour market reform, which increases the flexibility of wages, would have a positive effect on the flexibility of prices as well. That is particularly important because over time the role of services in the economy increases.

Finally, there are relatively simple policies that would increase the frequency of price changes. The first one is the elimination of item-pricing laws: the requirement that price be attached to every unit of the good. Such requirement raises significantly the cost of changing prices and reduces their frequency. The second is subsidization of faster, more flexible pricing methods. Technological developments allow introducing new technologies, for example electronic tags in which prices can be changed wirelessly from the central computer. Such systems have been appearing in recent years in grocery and other self-serve stored.

The importance of subsidizing these faster pricing techniques is easily underestimated. The result of their introduction is a discrete jump in the frequency of price changes as adjustments become cheaper. The higher frequency of price changes creates a positive externality in that prices become more flexible and adjust faster to aggregate shocks. But for the decision whether to introduce the new technology, these external benefits are not taken into account by the firm. The firm compares the present value of the costs of the technology only to the benefits from reduced adjustment costs. The technology often is not introduced because the firm's benefit is marginally smaller than cost. A subsidy required for the firm to adopt the new technology may not be large. but it would increase the frequency of its price changes a lot. Hence a small subsidy leads to a large benefit in flexibility.

Some of the policy recommendations can be implemented in the short term. Item pricing laws should be relatively easy to change. So would some of the policies promoting search

for the best price, including requirement for sellers to provide clear and complete price information, inclusive of all fees and surcharges, prohibiting joint transactions and providing entire payment schedules for transactions involving several payments. In sectors in which sellers/providers do not customarily post their prices, for example legal and medical services, requirements to do so may be introduced (of course in practice industry lobbying may slow down the implementation of the changes). Comparisons across products, for example generic and brand-name, can be provided.

Other policy recommendations involve longer-term oriented reforms. This is in particular the case for promotion of competition, harmonizing standards and reducing price regulation (a relatively short-term reform would be to simplify price changes for regulated products). Finally, as pointed out in the report, comprehensive labour market reforms would increase wage flexibility and, consequently, the flexibility of prices, especially service prices. The importance of these reforms will be increasing over time as the role of services rises in the Euro-area countries.

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Appendix A: Computation of the Price Rigidity Indicators

A1. Correspondence Table between COICOP and NACE Classifications

Table A1. Correspondence Table Between the COICOP and NACE Classifications

COICOP	Weight	Share	Main corresponding NACE sector	
01 Food and non-alcoholic beverages	**166,8**			
01.1. Food	151,8	91,0	15	Manufacture of food products and beverages
01.2. Non-alcoholic beverages	15	9,0		
02. Alcoholic beverages and tobacco	**41,7**			
02.1 Alcoholic beverages	18,9	45,3	15(91 to 97)	Manufacture of food products and beverages
02.2. Tobacco	22,8	54,7	16	Manufacture of tobacco products
03. Clothing and footwear	**80,4**			
03.1. Clothing	64,7	80,5	18	Manufacture of wearing apparel; dressing and dyeing of fur
03.2. Footwear including repair	15,7	19,5	19(3)	Manufacture of footwear
04. Housing, water, electricity, gas and other fuels	**157,7**			
04.1. Actual rentals for housing	63	39,9		
04.3. Maintenance and repair of the dwelling	18,3	11,6	21(24)	Manufacture of wallpaper
04.4. Water supply and miscellaneous services relating to the dwelling	26,7	16,9	41	Collection, purification and distribution of water
04.5. Electricity, gas and other fuels	49,7	31,5	40	Electricity, gas, steam and hot water supply
05. Furnishings, household equipment and routine maintenance of the house	**81,2**			
05.1. Furniture and furnishings, carpets and other floor coverings	33,2	40,9	36(1)	Manufacture of furniture
05.2. Household textiles	6,9	8,5		
05.3. Household appliances	11,9	14,7	29(7)	Manufacture of domestic appliances n.e.c.
05.4. Glassware, tableware and household utensils	5,8	7,1		
05.5. Tools and equipment for house and garden	5,1	6,3		
05.6. Goods and services for routine household maintenance	18,3	22,5	36	Manufacture of brooms and brushes
06. Health	**31,8**			
06.1. Medical products, appliances and equipment	15,5	48,7	24(4)	Manufacture of pharmaceuticals, medicinal chemicals and botanical products
06.2. Out-patient services	16,3	51,3		
06.3. Hospital services	0	0,0		
07. Transport	**156,5**			
07.1. Purchase of vehicles	48,9	31,2	34(1)	Manufacture of motor vehicles
07.2. Operation of personal transport equipment	85,8	54,8	23(2)	Manufacture of refined petroleum products
07.3. Transport services	21,8	13,9		

COICOP	Weight	Share	Main corresponding NACE sector	
08. Communications	**23,3**			
08.1. Postal services	2,4			
08.2. Telephone and telefax equipment	2,5			
08.3. Telephone and telefax services	19,2			
09. Recreation and culture	**97,1**			
09.1. Audio-visual, photographic and information processing equipment	16,5	17,0	32(3)	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods
09.2. Other major durables for recreation and culture	2,3	2,4	36(3)	Manufacture of musical instruments
09.3. Other recreational items and equipment, gardens and pets	18,7	19,3	36(4)	Manufacture of sports goods
09.4. Recreational and cultural services	26	26,8		
09.5. Newspapers, books and stationery	21,6	22,2	22(1)	Publishing
09.6. Package holidays	12	12,4		
10. Education	**8,8**			
11. Restaurants and hotels	**85,3**			
11.1. Catering services	70,1	82,2		
11.2. Accommodation services	15,2	17,8		
12. Miscellaneous goods and services	**69,9**			
12.1. Personal care	28,6	40,9	24(52)	Manufacture of perfumes and toilet preparations
12.3. Personal effects n.e.c.	10,6	15,7	33(5)	Manufacture of watches and clocks
12.4. Social protection	2,3	3,3		
12.5. Insurance	16,1	23,0		
12.6. Financial services n.e.c.	3,9	5,6		
12.7. Other services n.e.c.	8,4	12,0		
Total Weight	**1000,5**			

Notes
02.3 Narcotics and 12.2 Prostitution are unobserved
04.2 Imputed rentals for housing are not included in the computation of the HICP

A2. Some Statistics Used in the Computations

Table A2 : Country Weights (MUICP Weights)

Country	Weight
Belgium	39.9
Germany	346.51
Spain	90.83
France	209.07
Ireland	9.8
Italy	183.08
Luxembourg	1.99
Netherlands	56.54
Austria	29.1
Portugal	18.13
Finland	15.07

Source : Eurostat

Table A3: - Frequency of Consumer Price Changes (% per month)

COICOP	**AUS**	**BEL**	**GER**	**FRA**	**FIN**	**ITA**	**LUX**	**NED**	**POR**	**SPA**
01. Food and non alcoholic beverages	18.0	20.4	18.4	19.0	20.4	14.6	19.0	23.2	37.2	32.2
02. Alcoholic beverages. tobacco and narcotics	14.8	14.0	8.4	21.0	12.6	10.0	14.0	19.2	14.4	17.5
03. Clothing and footwear	12.7	3.8	6.7	17.0	19.8	5.4	20.0	20.5	27.5	5.1
04. Housing. water. electricity. gas and other fuels	11.8	25.1	5.9[1] / 29.6[2]	24.0	20.4	21.8	29.0	18.9	8.0	6.1
05. Furnishing. household equipment and routine household maintenance	7.3	5.2	6.3	16.0	12.0	4.4	18.0	7.9	10.9	8.7
06. Health	5.0	6.4	n.a.	8.0	10.0	n.a	3.0	n.a.	4.6	4.5
07. Transport	35.8	46.0	34.4	36.0	36.5	24.8	21.0	88.0	25.7	8.3
08. Communications	10.1	12.3	n.a.	23.0	38.5	n.a	4.0	n.a.	11.3	n.a
09. Recreation and culture	25.1	10.3	5.3	13.0	15.4	7.7	13.0	7.9	12.0	9.5
10. Education	5.0	n.a	n.a.	6.0	2.6	n.a	5.0	n.a.	7.7	7.9
11. Restaurants and hotels	9.2	3.3	4.7	8.0	10.2	5.8	5.0	7.8	18.6	4.2
12. Miscellaneous goods and services	7.7	6.7	7.0	12.0	11.0	4.3	11.0	10.4	11.1	7.4
00. Consumer Price Index	**15.8**	**15.3**	**10.8[1] / 13.6[2]**	**19**	**17.8**	**10**	**17**	**16.5**	**22**	**14.4**

Sources : Glatzer, Rumler (2007), Dhyne, Konieczny (2007), Hoffmann, Kurz-Kim (2006), Baudry *et al.* (2006), Laakonen, Vilmunen (2004), Veronese *et al.* (2005), Lünneman, Mathä (2005), Jonker *et al.* (2005), [9] Dias, Dias, Neves (2004), Alvarez, Hernando (2004)

Notes : [1] Including housing rents [2] Excluding housing rents

Table A4: - Frequency of Consumer Price Increases (% per month)

COICOP	AUS	BEL	GER	FRA	FIN	ITA	LUX	NED	POR	SPA
01. Food and non alcoholic beverages	9.5	11.3	9.3	11.0	n.a	8.5	11.0	13.5	19.2	17.7
02. Alcoholic beverages. tobacco and narcotics	7.6	9.9	4.9	11.0	n.a	7.3	11.0	13.8	10.0	11.2
03. Clothing and footwear	6.4	2.6	3.8	4.0	n.a	4.9	11.0	11.9	12.2	4.4
04. Housing. water. electricity. gas and other fuels	7.5	14.7	3.9[1] / 18.0[2]	15.0	n.a	13.3	18.0	10.0	5.8	5.3
05. Furnishing. household equipment and routine household maintenance	4.3	3.4	4.4	6.0	n.a	4.1	11.0	6.1	7.0	5.8
06. Health	4.0	5.8	n.a.	5.0	n.a	n.a	3.0	n.a.	4.1	3.6
07. Transport	19.7	24.3	19.4	21.0	n.a	14.2	14.0	44.9	19.8	7.3
08. Communications	2.7	5.0	n.a.	2.0	n.a	n.a	2.0	n.a.	4.9	n.a
09. Recreation and culture	13.0	5.3	2.8	4.0	n.a	5.2	7.0	4.6	7.4	5.3
10. Education	4.3	n.a	n.a.	5.0	n.a	n.a	4.0	n.a.	6.6	7.6
11. Restaurants and hotels	5.9	2.9	3.4	5.0	n.a	4.9	4.0	6.7	9.3	4.0
12. Miscellaneous goods and services	5.5	4.5	4.3	6.0	n.a	3.9	8.0	8.0	7.7	6.0
00. Consumer Price Index	**8.8**	**8.8**	**6.3[1] / 7.9[2]**	**10**	**n.a**	**6.8**	**11**	**10.4**	**12.7**	**9**

Sources : Glatzer, Rumler (2007), Dhyne, Konieczny (2007), Hoffmann, Kurz-Kim (2006), Baudry *et al.* (2006), Laakonen, Vilmunen (2004), Veronese *et al.* (2005), Lünneman, Mathä (2005), Jonker *et al.* (2005), [9] Dias, Dias, Neves (2004), Alvarez, Hernando (2004)

Notes : [1] Including housing rents [2] Excluding housing rents

Table A5: - Frequency of Consumer Price Decreases (% per month)

COICOP	AUS	BEL	GER	FRA	FIN	ITA	LUX	NED	POR	SPA
01. Food and non alcoholic beverages	8.5	9.1	9.1	8.0	n.a	6.1	8.0	9.8	17.1	14.6
02. Alcoholic beverages. tobacco and narcotics	7.2	4.1	3.5	10.0	n.a	2.7	3.0	5.4	4.3	6.3
03. Clothing and footwear	6.3	1.2	2.9	13.0	n.a	0.5	9.0	8.6	16.3	0.7
04. Housing. water. electricity. gas and other fuels	4.3	10.4	2.0[1] / 11.6[2]	9.0	n.a	8.5	11.0	8.9	2.9	0.8
05. Furnishing. household equipment and routine household maintenance	3.0	1.8	1.9	10.0	n.a	0.3	7.0	1.7	4.7	2.9
06. Health	1.0	0.6	n.a	3.0	n.a	n.a	0.0	n.a	0.8	0.9
07. Transport	16.1	21.7	15.0	15.0	n.a	10.6	7.0	43.1	6.0	1.1
08. Communications	7.4	7.3	n.a	21.0	n.a	n.a	2.0	n.a	7.3	n.a
09. Recreation and culture	12.1	5.0	2.5	9.0	n.a	2.5	6.0	3.3	6.8	4.2
10. Education	0.7	n.a	n.a	1.0	n.a	n.a	1.0	n.a	1.1	0.3
11. Restaurants and hotels	3.3	0.4	1.3	3.0	n.a	0.9	1.0	1.1	5.4	0.2
12. Miscellaneous goods and services	2.2	2.2	2.7	6.0	n.a	0.4	3.0	2.4	3.6	1.5
00. Consumer Price Index	**7**	**6.5**	**4.5[1] / 5.7[2]**	**9**	**n.a**	**3.2**	**6**	**6.1**	**8.6**	**5.4**

Sources : Glatzer, Rumler (2007), Dhyne, Konieczny (2007), Hoffmann, Kurz-Kim (2006), Baudry et al. (2006), Laakonen, Vilmunen (2004), Veronese et al. (2005), Lünneman, Mathä (2005), Jonker et al. (2005), 9 Dias, Dias, Neves (2004), Alvarez, Hernando (2004)

Notes : [1] Including housing rents [2] Excluding housing rents

Table A6: - Average Size of Consumer Price Increases (in %)

COICOP	AUS	BEL	GER	FRA	FIN	ITA	LUX	NED	POR	SPA
01. Food and non alcoholic beverages	17.2	11.7	12.8	17.3	n.a	6.4	11.0	13.9	12.2	10.8
02. Alcoholic beverages. tobacco and narcotics	15.3	5.0	8.0	5.0	n.a	7.9	6.0	6.3	4.2	6.0
03. Clothing and footwear	22.2	5.7	12.9	38.6	n.a	6.6	11.0	19.4	6.1	5.7
04. Housing. water. electricity. gas and other fuels	6.6	5.6	7.4[1] / 5.5[2]	7.1	n.a	4.8	6.0	9.5	2.4	6.6
05. Furnishing. household equipment and routine household maintenance	9.6	6.0	6.5	10.5	n.a	5.3	8.0	9.9	3.5	6.7
06. Health	4.0	5.7	n.a.	5.3	n.a	n.a	10.0	n.a.	3.0	11.2
07. Transport	9.6	5.0	4.8	4.3	n.a	6.4	4.0	3.4	2.2	5.1
08. Communications	14.8	10.7	n.a.	11.5	n.a	n.a	12.0	n.a.	3.0	n.a
09. Recreation and culture	11.0	9.3	10.6	10.3	n.a	6.8	10.0	16.3	3.4	6.9
10. Education	4.7	n.a	n.a.	3.7	n.a	n.a	14.0	n.a.	3.2	5.8
11. Restaurants and hotels	7.1	6.2	7.1	6.1	n.a	9.5	6.0	8.4	7.7	9.2
12. Miscellaneous goods and services	7.1	7.1	10.0	8.6	n.a	7.8	7.0	7.9	3.3	6.6
00. Consumer Price Index	**11.3**	**7.8**	**8.6[1]/ 8.8[2]**	**12.5**	**n.a**	**7.1**	**8**	**11.6**	**5.7**	**8.2**

Sources : Glatzer, Rumler (2007), Dhyne, Konieczny (2007), Hoffmann, Kurz-Kim (2006), Baudry et al. (2006), Laakonen, Vilmunen (2004), Veronese et al. (2005), Lünneman, Mathä (2005), Jonker et al. (2005), 9 Dias, Dias, Neves (2004), Alvarez, Hernando (2004)

Notes : 1 Including housing rents 2 Excluding housing rents

Table A7: - Average Size of Consumer Price Decreases (in %)

COICOP	AUS	BEL	GER	FRA	FIN	ITA	LUX	NED	POR	SPA
01. Food and non alcoholic beverages	18.9	13.4	12.7	10.3	n.a	6.5	14.0	17.5	9.0	11.7
02. Alcoholic beverages. tobacco and narcotics	16.0	5.8	8.4	5.2	n.a	7.6	10.0	10.9	2.6	6.9
03. Clothing and footwear	33.4	6.8	15.7	25.8	n.a	8.1	10.0	22.8	6.2	7.6
04. Housing. water. electricity. gas and other fuels	7.7	5.0	6.1[1] / 6.4[2]	6.7	n.a	4.6	5.0	3.2	1.0	8.1
05. Furnishing. household equipment and routine household maintenance	14.2	6.2	10.3	11.3	n.a	4.8	8.0	11.0	2.7	8.0
06. Health	7.7	5.8	n.a.	5.6	n.a	n.a	13.0	n.a.	1.0	12.2
07. Transport	8.4	3.3	7.7	4.7	n.a	5.7	3.0	3.8	0.9	7.6
08. Communications	8.8	11.5	n.a.	10.9	n.a	n.a	26.0	n.a.	6.8	n.a
09. Recreation and culture	12.1	10.7	11.5	10.6	n.a	8.0	9.0	25.5	2.3	9.4
10. Education	1.7	n.a	n.a.	4.6	n.a	n.a	17.0	n.a.	1.2	27.1
11. Restaurants and hotels	6.9	5.1	8.9	6.6	n.a	11.8	5.0	11.8	4.0	11.7
12. Miscellaneous goods and services	11.2	6.6	11.4	9.1	n.a	9.4	5.0	9.0	1.7	9.2
00. Consumer Price Index	**13.9**	**8.3**	**9.6[1]/ 10.7[2]**	**10**	**n.a**	**7.8**	**8**	**15.1**	**3.97**	**10.3**

Sources : Glatzer, Rumler (2007), Dhyne, Konieczny (2007), Hoffmann, Kurz-Kim (2006), Baudry et al. (2006), Laakonen, Vilmunen (2004), Veronese et al. (2005), Lünneman, Mathä (2005), Jonker et al. (2005), 9 Dias, Dias, Neves (2004), Alvarez, Hernando (2004)

Notes : 1 Including housing rents 2 Excluding housing rents

Table A8 - Frequency of Producer Price Changes (% per month)

NACE 2 digit code	BEL	GER	FRA	ITA	POR	SPA
10. Mining of coal and lignite. extraction of peat	n.a	n.a	4.3	n.a	n.a	74.5
11. Extrac. of crude petroleum & natural gas; rsa excl. survey	n.a	n.a	n.a	n.a	n.a	n.a
12. Mining of uranium & thorium ores	n.a	n.a	n.a	n.a	n.a	n.a
13. Mining of metal ores	10.0	n.a	n.a	n.a	n.a	n.a
14. Other mining and quarrying	10.4	n.a	15.8	n.a	n.a	17.2
15. Manuf. of food products and beverages	20.6	27.7	31.3	26.5	20.7	26.8
16. Manuf. of tobacco products	12.0	n.a	14.5	n.a	9.3	27.1
17. Manuf. of textiles	14.6	18.4	11.3	13.6	9.0	11.1
18. Manuf. of wearing apparel. dressing. dyeing of fur	9.0	8.3	6.9	n.a	5.0	10.0
19. Tanning & dressing of leather. manufacture of luggage. etc	3.8	8.6	7.9	14.1	n.a	13.1
20. Manuf. of wood & wood products except furniture	9.4	20.4	11.3	8.9	12.2	10.2
21. Manuf. of paper & paper products	26.3	29.7	19.1	23.8	n.a	32.7
22. Publishing. printing & reproduction of recorded media	10.3	17.0	12.0	0.8	n.a	12.5
23. Manuf. of coke. refined petroleum products. nuclear fuel	89.0	94.2	85.0	n.a	66.5	93.1
24. Manuf. of chemicals & chemical products	35.8	30.9	23.2	16.7	11.1	29.5
25. Manuf. of rubber & plastic products	24.2	14.8	12.5	6.8	7.1	15.4
26. Manuf. of other non-metallic mineral products	15.8	24.0	22.9	21.9	4.0	15.8
27. Manuf. of basic metals	77.7	48.6	52.4	27.2	24.3	55.2
28. Manuf. of fabricated metal products. exc. Machinery	18.2	13.8	11.5	3.8	3.2	11.1
29. Manuf. of machinery & equipment n.e.c	6.6	8.3	9.5	10.8	n.a	7.8
30. Manuf. of office. accounting & computing machinery	50.0	29.9	16.7	5.5	n.a	16.6
31. Manuf. of electrical machinery & apparatus n.e.c	8.9	18.1	13.7	24.1	16.6	15.0
32. Manuf. of radio. TV. communication equipment	18.1	13.8	14.7	6.0	n.a	9.0
33. Manuf. of medical. precision & optical instruments. watches	6.0	8.9	8.7	1.5	n.a	8.6
34. Manuf. of motor vehicles. trailers & semi-trailers	30.5	7.9	15.6	2.8	n.a	13.4
35. Manuf. of other transport equipment	4.0	5.9	8.9	8.5	n.a	10.3
36. Manuf. of furniture; manufacturing n.e.c.	6.0	8.9	10.0	3.3	17.9	8.8
37. Recycling	4.0	n.a	n.a	n.a	n.a	n.a
40. Electricity. gas. steam and hot water supply	63.5	n.a	21.5	n.a	n.a	7.9
41. Collection. purification. distribution of water	14.0	n.a	20.6	n.a	n.a	n.a
Producer price index	**24.0**	**22.0**	**24.8**	**15.4**	**23.1**	**22.4**

Sources: Cornille, Doosche (2006), Stahl (2006), Gautier (2006), Sabbatini *et al.* (2005), Dias, Dias, Neves (2004), Alvarez *et al.* (2005)

Table A9 - Frequency of Producer Price Increases (% per month)

NACE 2 digit code	BEL	GER	FRA	ITA	POR	SPA
10. Mining of coal and lignite. extraction of peat	n.a	n.a	2.9	n.a	n.a	38.1
11. Extrac. of crude petroleum & natural gas; rsa excl. survey	n.a	n.a	n.a	n.a	n.a	n.a
12. Mining of uranium & thorium ores	n.a	n.a	n.a	n.a	n.a	n.a
13. Mining of metal ores	7.0	n.a	n.a	n.a	n.a	n.a
14. Other mining and quarrying	7.0	n.a	11.1	n.a	n.a	9.9
15. Manuf. of food products and beverages	11.1	14.4	17.0	13.5	n.a	15
16. Manuf. of tobacco products	11.0	n.a	11.0	n.a	n.a	18.1
17. Manuf. of textiles	7.8	9.7	5.9	7.9	n.a	6.6
18. Manuf. of wearing apparel. dressing. dyeing of fur	4.1	5.0	3.7	n.a	n.a	6.3
19. Tanning & dressing of leather. manufacture of luggage. etc	3.8	6.2	5.6	8.2	n.a	8.9
20. Manuf. of wood & wood products except furniture	5.2	9.5	6.5	7.4	n.a	6.7
21. Manuf. of paper & paper products	12.7	16.1	10.4	13.4	n.a	17
22. Publishing. printing & reproduction of recorded media	6.6	9.4	6.7	0.8	n.a	8.1
23. Manuf. of coke. refined petroleum products. nuclear fuel	51.0	46.5	46.1	n.a	n.a	49.5
24. Manuf. of chemicals & chemical products	18.8	15.8	13.0	9.8	n.a	15.9
25. Manuf. of rubber & plastic products	12.5	7.6	6.5	3.9	n.a	8.7
26. Manuf. of other non-metallic mineral products	9.3	11.5	13.0	12.0	n.a	9.4
27. Manuf. of basic metals	37.5	26.8	30.1	13.4	n.a	29.3
28. Manuf. of fabricated metal products. exc. Machinery	10.3	7.7	6.8	3.0	n.a	7.2
29. Manuf. of machinery & equipment n.e.c	3.9	5.9	6.1	7.2	n.a	5.5
30. Manuf. of office. accounting & computing machinery	31.0	8.3	7.4	2.8	n.a	8.4
31. Manuf. of electrical machinery & apparatus n.e.c	4.2	9.3	7.8	7.1	n.a	8.7
32. Manuf. of radio. TV. communication equipment	6.8	4.7	4.5	1.7	n.a	4.6
33. Manuf. of medical. precision & optical instruments. watches	3.7	5.5	6.0	0.9	n.a	5.2
34. Manuf. of motor vehicles. trailers & semi-trailers	17.5	6.3	8.6	2.7	n.a	9.2
35. Manuf. of other transport equipment	4.0	4.4	6.1	5.4	n.a	7.6
36. Manuf. of furniture; manufacturing n.e.c.	4.0	6.4	6.7	2.9	n.a	6.5
37. Recycling	3.0	n.a	n.a	n.a	n.a	n.a
40. Electricity. gas. steam and hot water supply	42.2	n.a	11.8	n.a	n.a	4.4
41. Collection. purification. distribution of water	10.0	n.a	16.8	n.a	n.a	n.a
Producer price index	**21.1**	**12.0**	**13.8**	**8.5**	**13.6**	**12.7**

Sources: Cornille, Doosche (2006), Stahl (2006), Gautier (2006), Sabbatini *et al.* (2005), Dias, Dias, Neves (2004), Alvarez *et al.* (2005)

Table A10 – Frequency of Producer Price Decreases (% per month)

NACE 2 digit code	BEL	GER	FRA	ITA	POR	SPA
10. Mining of coal and lignite. extraction of peat	n.a	n.a	1.4	n.a	n.a	36.4
11. Extrac. Of crude petroleum & natural gas; rsa excl. survey	n.a	n.a	n.a	n.a	n.a	n.a
12. Mining of uranium & thorium ores	n.a	n.a	n.a	n.a	n.a	n.a
13. Mining of metal ores	2.0	n.a	n.a	n.a	n.a	n.a
14. Other mining and quarrying	3.5	n.a	2.8	n.a	n.a	7.3
15. Manuf. Of food products and beverages	9.2	13.4	12.8	12.9	n.a	11.8
16. Manuf. Of tobacco products	1.0	n.a	3.4	n.a	n.a	9
17. Manuf. Of textiles	6.9	8.7	5.4	5.7	n.a	4.5
18. Manuf. Of wearing apparel. dressing. dyeing of fur	4.9	3.3	2.9	n.a	n.a	3.8
19. Tanning & dressing of leather. manufacture of luggage. etc	0.0	2.3	3.0	5.9	n.a	4.2
20. Manuf. Of wood & wood products except furniture	4.3	10.9	4.6	1.5	n.a	3.5
21. Manuf. Of paper & paper products	14.3	13.6	8.8	10.4	n.a	15.7
22. Publishing. printing & reproduction of recorded media	4.7	7.7	3.9	0.0	n.a	4.4
23. Manuf. Of coke. refined petroleum products. nuclear fuel	38.0	47.7	38.9	n.a	n.a	43.6
24. Manuf. Of chemicals & chemical products	17.0	15.1	11.5	6.9	n.a	13.6
25. Manuf. Of rubber & plastic products	11.6	7.2	6.0	2.9	n.a	6.8
26. Manuf. Of other non-metallic mineral products	6.4	12.6	12.2	9.9	n.a	6.5
27. Manuf. Of basic metals	39.7	21.8	18.2	13.8	n.a	25.8
28. Manuf. Of fabricated metal products. exc. Machinery	7.9	6.1	4.6	0.8	n.a	3.8
29. Manuf. Of machinery & equipment n.e.c	2.6	2.4	3.1	3.7	n.a	2.4
30. Manuf. Of office. accounting & computing machinery	19.0	21.6	9.3	2.7	n.a	8.1
31. Manuf. Of electrical machinery & apparatus n.e.c	4.2	8.8	7.4	17.0	n.a	6.3
32. Manuf. Of radio. TV. communication equipment	11.3	9.2	9.3	4.3	n.a	4.4
33. Manuf. Of medical. precision & optical instruments. watches	2.6	3.3	2.5	0.6	n.a	3.4
34. Manuf. Of motor vehicles. trailers & semi-trailers	13.5	1.6	6.5	0.1	n.a	4.1
35. Manuf. Of other transport equipment	0.0	1.5	4.2	3.1	n.a	2.7
36. Manuf. Of furniture; manufacturing n.e.c.	1.9	2.5	3.4	0.4	n.a	2.3
37. Recycling	1.0	n.a	n.a	n.a	n.a	n.a
40. Electricity. gas. steam and hot water supply	21.5	n.a	3.8	n.a	n.a	3.5
41. Collection. purification. distribution of water	5.0	n.a	3.8	n.a	n.a	n.a
Producer price index	**13.6**	**10.0**	**11.0**	**6.9**	**9.5**	**9.6**

Sources: Cornille, Doosche (2006), Stahl (2006), Gautier (2006), Sabbatini *et al.* (2005), Dias, Dias, Neves (2004), Alvarez *et al.* (2005)

Table A11 – Average Size of Producer Price Increases (in%)

NACE 2 digit code	BEL	GER	FRA	ITA	POR	SPA
10. Mining of coal and lignite. extraction of peat	n.a	n.a	3.4	n.a	n.a	4.9
11. Extrac. of crude petroleum & natural gas; rsa excl. survey	n.a	n.a	n.a	n.a	n.a	n.a
12. Mining of uranium & thorium ores	n.a	n.a	n.a	n.a	n.a	n.a
13. Mining of metal ores	21.0	n.a	n.a	n.a	n.a	n.a
14. Other mining and quarrying	5.0	n.a	3.7	n.a	n.a	5.8
15. Manuf. of food products and beverages	4.0	3.4	3.6	n.a	n.a	5.3
16. Manuf. of tobacco products	3.0	n.a	7.2	n.a	n.a	5.9
17. Manuf. of textiles	3.6	2.5	4.6	n.a	n.a	5
18. Manuf. of wearing apparel. dressing. dyeing of fur	4.9	2.5	7.0	n.a	n.a	5.4
19. Tanning & dressing of leather. manufacture of luggage. etc	2.6	1.9	6.0	n.a	n.a	4.6
20. Manuf. of wood & wood products except furniture	4.2	3.1	3.6	n.a	n.a	5.5
21. Manuf. of paper & paper products	3.3	3.4	5.1	n.a	n.a	5.3
22. Publishing. printing & reproduction of recorded media	1.1	3.1	4.4	n.a	n.a	5.7
23. Manuf. of coke. refined petroleum products. nuclear fuel	5.0	3.7	6.4	n.a	n.a	6.3
24. Manuf. of chemicals & chemical products	6.2	4.4	4.3	n.a	n.a	5.1
25. Manuf. of rubber & plastic products	6.0	4.3	4.2	n.a	n.a	5.4
26. Manuf. of other non-metallic mineral products	5.0	3.3	3.5	n.a	n.a	4.6
27. Manuf. of basic metals	5.5	2.8	3.4	n.a	n.a	3.9
28. Manuf. of fabricated metal products. exc. Machinery	5.6	3.2	4.1	n.a	n.a	5
29. Manuf. of machinery & equipment n.e.c	4.6	2.8	3.9	n.a	n.a	4.7
30. Manuf. of office. accounting & computing machinery	3.0	4.9	8.0	n.a	n.a	4.8
31. Manuf. of electrical machinery & apparatus n.e.c	6.7	3.4	4.0	n.a	n.a	4.6
32. Manuf. of radio. TV. communication equipment	6.5	4.9	5.6	n.a	n.a	4.8
33. Manuf. of medical. precision & optical instruments. watches	1.7	4.3	3.7	n.a	n.a	4.7
34. Manuf. of motor vehicles. trailers & semi-trailers	2.1	1.8	2.1	n.a	n.a	3
35. Manuf. of other transport equipment	3.0	2.3	5.3	n.a	n.a	4.6
36. Manuf. of furniture; manufacturing n.e.c.	3.9	3.4	4.7	n.a	n.a	5.4
37. Recycling	13.0	n.a	n.a	n.a	n.a	n.a
40. Electricity. gas. steam and hot water supply	1.9	n.a	5.9	n.a	n.a	2.7
41. Collection. purification. distribution of water	3.0	n.a	1.6	n.a	n.a	n.a
Producer price index	**3.6**	**2.0**	**4.1**	**4.2**	**4.6**	**4.7**

Sources: Cornille, Doosche (2006), Stahl (2006), Gautier (2006), Sabbatini *et al.* (2005), Dias, Dias, Neves (2004), Alvarez *et al.* (2005)

Table A12 – Average Size of Producer Price Decreases (in %)

NACE 2 digit code	BEL	GER	FRA	ITA	POR	SPA
10. Mining of coal and lignite. extraction of peat	n.a	n.a	3.8	n.a	n.a	5
11. Extrac. Of crude petroleum & natural gas; rsa excl. survey	n.a	n.a	n.a	n.a	n.a	n.a
12. Mining of uranium & thorium ores	n.a	n.a	n.a	n.a	n.a	n.a
13. Mining of metal ores	29.0	n.a	n.a	n.a	n.a	n.a
14. Other mining and quarrying	3.6	n.a	4.1	n.a	n.a	5.7
15. Manuf. Of food products and beverages	4.0	3.4	3.3	n.a	n.a	5
16. Manuf. Of tobacco products	3.0	n.a	3.1	n.a	n.a	3.3
17. Manuf. Of textiles	4.5	2.6	4.8	n.a	n.a	5
18. Manuf. Of wearing apparel. dressing. dyeing of fur	3.4	3.2	8.6	n.a	n.a	6.8
19. Tanning & dressing of leather. manufacture of luggage. etc	0.0	4.4	7.3	n.a	n.a	5.3
20. Manuf. Of wood & wood products except furniture	4.1	2.8	3.5	n.a	n.a	5.4
21. Manuf. Of paper & paper products	4.0	2.8	4.4	n.a	n.a	4.6
22. Publishing. printing & reproduction of recorded media	2.1	4.5	5.0	n.a	n.a	4.8
23. Manuf. Of coke. refined petroleum products. nuclear fuel	7.0	2.8	5.5	n.a	n.a	6.2
24. Manuf. Of chemicals & chemical products	7.1	4.2	4.3	n.a	n.a	4.5
25. Manuf. Of rubber & plastic products	5.1	4.3	3.5	n.a	n.a	5.1
26. Manuf. Of other non-metallic mineral products	4.2	3.7	3.7	n.a	n.a	4.5
27. Manuf. Of basic metals	5.3	2.9	2.7	n.a	n.a	3.8
28. Manuf. Of fabricated metal products. exc. Machinery	8.2	3.2	3.6	n.a	n.a	4.7
29. Manuf. Of machinery & equipment n.e.c	6.8	3.8	4.2	n.a	n.a	4.1
30. Manuf. Of office. accounting & computing machinery	8.0	4.5	9.8	n.a	n.a	8.3
31. Manuf. Of electrical machinery & apparatus n.e.c	8.4	3.7	4.2	n.a	n.a	4.5
32. Manuf. Of radio. TV. communication equipment	6.7	5.2	5.7	n.a	n.a	5
33. Manuf. Of medical. precision & optical instruments. watches	2.9	5.0	4.8	n.a	n.a	4.5
34. Manuf. Of motor vehicles. trailers & semi-trailers	1.9	2.3	1.9	n.a	n.a	3.2
35. Manuf. Of other transport equipment	0.0	3.6	4.6	n.a	n.a	3.7
36. Manuf. Of furniture; manufacturing n.e.c.	3.9	3.2	5.2	n.a	n.a	5.4
37. Recycling	6.0	n.a	n.a	n.a	n.a	n.a
40. Electricity. gas. steam and hot water supply	3.6	n.a	3.9	n.a	n.a	3.2
41. Collection. purification. distribution of water	4.0	n.a	1.6	n.a	n.a	n.a
Producer price index	**4.5**	**2.0**	**3.9**	**4.2**	**4.8**	**4.5**

Sources: Cornille, Doosche (2006), Stahl (2006), Gautier (2006), Sabbatini *et al.* (2005), Dias, Dias, Neves (2004), Alvarez *et al.* (2005)

Appendix B. Further Estimation Results

Rigid A2 Indicator for Price Increases

NACE	BEL	GER	FRA	SPA
15	0.874	1.515	1.789	0.428
16	0.261	NA	0.130	0.222
18	0.223	1.899	1.927	0.129
19	0.699	2.440	2.248	0.504
21	0.288	0.235	0.239	1.149
22	2.534	2.369	0.899	0.211
23	0.503	0.743	0.714	2.252
24	1.362	1.914	0.908	1.260
29	0.089	0.718	0.841	0.126
32	0.187	0.798	0.363	0.149
33	1.544	0.696	0.635	0.133
34	0.773	1.866	1.175	0.322
36	0.317	0.825	0.620	0.069
41	1.908	NA	0.091	0.738
40	0.510	NA	1.611	NA

Source : Own computation

Rigid A2 Indicator for Price Decreases

NACE	BEL	GER	FRA	SPA
15	1.081	1.478	1.173	0.611
16	1.883	NA	1.226	0.623
18	1.916	1.766	2.614	1.911
19	8.000	1.317	2.812	2.168
21	0.149	0.638	0.172	3.566
22	1.809	1.805	1.141	0.422
23	0.814	1.959	0.811	3.657
24	2.731	2.793	0.980	3.343
29	0.141	0.904	1.949	0.451
32	0.809	1.881	0.363	0.376
33	0.635	0.649	1.061	1.072
34	0.507	3.773	1.345	1.995
36	0.527	1.192	1.450	0.312
41	0.590	NA	0.939	2.329
40	0.541	NA	2.170	NA

Source : Own computation

Rigid B Indicator for Price Changes

NACE	BEL	GER	FRA	SPA
15	NA	0.437	0.146	0.166
16	NA	-0.055	-0.001	-0.125
18	0.999	0.683	0.742	0.772
19	1.018	0.775	NA	0.854
21	-0.242	0.477	0.419	NA
22	0.527	0.789	0.349	0.532
23	0.246	0.012	0.102	0.091
24	0.655	0.396	0.484	0.673
29	0.697	-0.494	0.574	NA
32	0.733	0.701	0.684	NA
33	0.761	0.279	0.609	0.441
34	-0.101	-0.146	0.037	-0.159
36	0.795	-0.187	0.448	0.097
41	-0.202	-0.120	NA	NA
40	-0.261	0.282	0.013	-0.257

Source : Own computation, based on Eurostat
Notes: Rigid B cannot be calculated for increases and decreases separately because it uses index data.

Rigid B Indicator for Price Changes (Continued)

NACE	AUS	FIN	ITA	NED
15	0.461	NA	0.483	0.060
16	0.169	NA	-0.008	0.005
18	0.654	0.533	0.220	1.221
19	0.557	0.876	NA	0.973
21	0.114	NA	NA	0.852
22	0.588	0.439	0.378	0.011
23	-0.059	NA	0.221	0.193
24	0.393	0.512	0.053	0.700
29	0.158	0.452	NA	-0.245
32	0.884	NA	NA	0.202
33	0.173	0.539	NA	0.862
34	-0.229	NA	NA	0.131
36	0.328	0.318	0.523	-0.326
41	0.004	NA	NA	1.091
40	0.184	NA	0.101	1.091

Source : Own computation, based on Eurostat

Rigid B Indicator for Price Changes (Continued)

NACE	IRE	GRE	SLO	CYP
15	0.303	0.543	NA	-0.221
16	-0.054	0.198	NA	-0.002
18	1.028	0.841	0.392	0.705
19	0.914	0.845	0.752	0.994
21	NA	0.072	0.013	-0.142
22	0.172	0.440	0.429	0.102
23	0.035	0.246	0.320	0.132
24	0.498	0.462	0.030	0.091
29	0.858	0.796	-0.095	0.843
32	0.381	0.525	0.626	0.122
33	0.527	0.805	0.111	-0.087
34	0.111	0.237	0.086	-0.283
36	0.580	0.748	0.069	0.497
41	NA	-0.158	NA	-0.683
40	NA	-0.117	-0.411	-0.674

Source : Own computation, based on Eurostat