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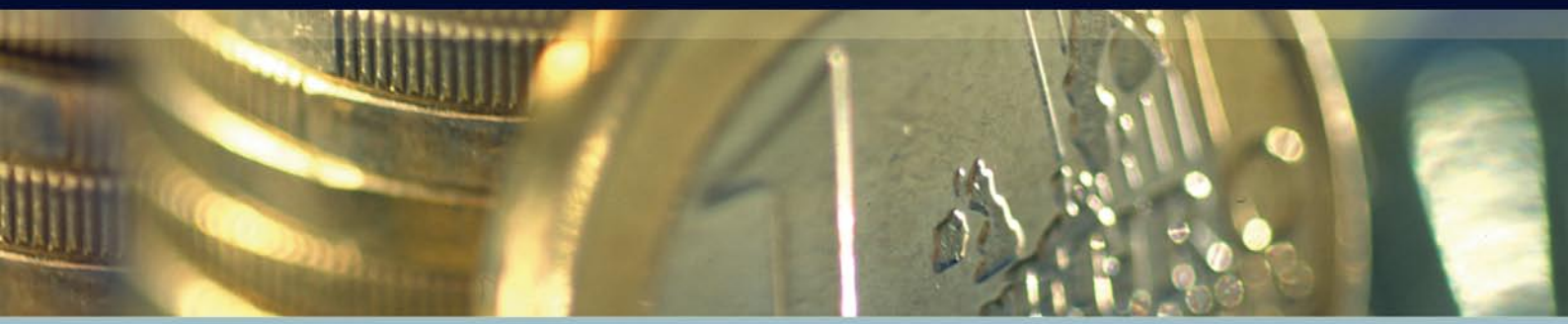

The Great Moderation in the euro area: What role have macroeconomic policies played?

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The Great Moderation in the euro area: What role have macroeconomic policies played?

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Abstract:

Most OECD countries have experienced a sharp reduction in the volatility of output and inflation over the past three decades. Although this Great Moderation process has stirred considerable interest in economic and policy circles, research on its causes has so far tended to focus on the US economy and has produced relatively little empirical evidence on the euro area or other non-US OECD countries. This paper contributes to fill in the gap by providing a euro-area view of the Great Moderation process and by assessing the euro-area experience against developments in other OECD countries. Its main focus is on the possible role of macroeconomic policies. After reviewing a set of key stylised facts of the fall in output growth volatility in the euro area, the paper discusses the possible channels through which economic policies may have contributed to the Great Moderation and presents the results of an econometric panel analysis of the determinants of output growth volatility. Its main conclusion is that the Great Moderation is not just the result of a long period of luck in the form of milder shocks but can also partly be ascribed to changes in economic policies, in particular improvements in the conduct of monetary policy and, to a lesser extent, more powerful automatic fiscal stabilisers. In particular, reflecting considerably worse starting positions, improvements in the conduct of monetary policies have been much larger in several Member States than in the US over the past three decades, bringing larger gains in terms of output stability. To a lesser degree, stronger automatic stabilisers also seem to have contributed to the moderation of output fluctuations in some euro-area countries.

Keywords: macroeconomic volatility, Great Moderation, euro area

JEL classification codes: E32, E52, E62

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1. INTRODUCTION

Over the past three decades, most OECD countries experienced a sharp reduction in the volatility of both output growth and inflation. As it has become more and more firmly established empirically, the so-called 'Great Moderation'[1] has begun to generate considerable interest in academic and policy circles, largely because of its potentially important policy implications. A key issue at stake is whether the Great Moderation reflects a long period of luck in the form of milder shocks and could therefore be reversed rapidly or is attributable to changes in the structures of the economies concerned and could be of a more permanent nature.

Most of the available empirical work on the sources of the Great Moderation has focused on the US economy. A clear consensus still has to emerge but a review of the US literature already suggests two conclusions. First, the decline in output volatility probably reflects a multiplicity of factors. Second, within this range of factors, several prominent scholars have tended to ascribe a dominant role to the good luck hypothesis while leaving relatively little room for changes in economic policies, particularly monetary policy.[2]

This paper looks further into the issue by providing a euro-area view of the Great Moderation process and by quantifying the role of various possible factors in a panel analysis of OECD countries. Its main conclusion is that, although reduced shocks have probably played an important role, the contribution of economic policies should not be overlooked. In particular, changes in macroeconomic policies seem to have helped significantly to reduce output instability in the euro area. Reflecting considerably worse starting positions, improvements in the conduct of monetary policies have been much larger in several Member States than in the US over the past three decades, bringing larger gains in terms of output stability. To a lesser degree, stronger automatic stabilisers also seem to have contributed to the moderation of output fluctuations in some euro-area countries. In addition, the econometric analysis also lends some support to a possible output stabilising role of increased financial-market deepness and reduced oil exposure but these results appear to be statistically weaker and the two variables only emerge as meaningful explanatory variables of the volatility of, respectively, investment and private consumption.

Section 2 recapitulates a number of stylised facts in relation with the Great Moderation process in the euro area. Section 3 reviews the main possible channels though which economic policy may have contributed to reduce output growth volatility. Section 4 discusses the results of a panel analysis of the determinants of output growth volatility. Section 5 concludes.

2. THE GREAT MODERATION IN THE EURO AREA – SOME STYLISED FACTS

This section presents the main stylised facts of the Great Moderation process in the euro area, comparing developments in the euro area with other OECD countries and looking at the contribution of GDP components and industrial sectors.[3]

The volatility of output growth declined substantially in the euro area over the past three decades. Volatility, as measured by the standard deviation of y-o-y GDP growth, fell from over 2% in the 1970s to 1.1% in the most recent decade (1998Q1-2007Q3) (Graph 1). The decline was particularly pronounced in the late 1970s and early 1980s. Since then, output growth volatility has followed a cyclical pattern marked by temporary increases coinciding with periods of cyclical peaks or early phases of downturn. These temporary phases were observed

[1] The expression 'Great Moderation' was first coined by Stock and Watson in a 2002 paper. The paper originally focused on the US economy but the reduction in volatility has taken place to various degrees in all advanced economies. Throughout his note, the expression 'Great Moderation' is used in the broader context of OECD countries.

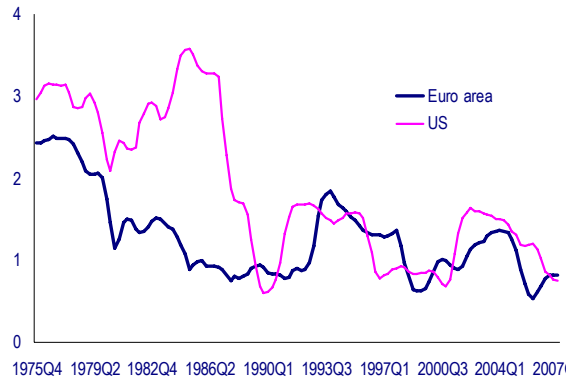
[2] See for instance Stock and Watson (2002, 2003a and 2003b) and Gordon (2005). This research acknowledges the instrumental role played by monetary policy in the moderation of inflation instability but generally only reports a modest contribution of monetary policy to the reduction of output volatility.

[3] For a more detailed discussion of some of these stylised facts see European Commission (2007a).

both in the early 1990s and early 2000s. Volatility remained quite low by historical standards in the past few years.

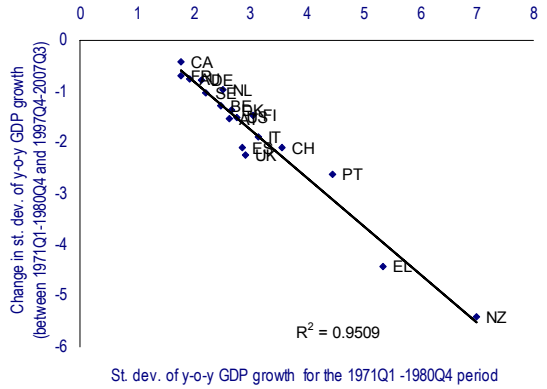
A comparison with the US shows both similarities and differences in the moderation process. The decline in output growth volatility was somewhat sharper in the US than in the euro area, although starting from a much higher level. The process also seems to have begun later in the US. On the other hand, the temporary bouts of higher volatility in the 1990s and 2000s were relatively similar in both regions, although they took place slightly earlier in the US, in line with that country's cyclical lead relative to the euro area.

Graph 1: **The volatility of GDP growth, euro area and US** (standard deviation of y-o-y growth in % – 5-year window – 1975 Q4 to 2007 Q3)



Source: Commission services and ECB.

Graph 2: **Correlation between the levels and changes in GDP growth volatility, selected OECD countries** (1)



(1) Volatility is calculated as the standard deviation of y-o-y GDP growth.

Source: Commission services and ECB.

The decline in output growth volatility is a common feature to all euro-area Member States but also to virtually all industrialised countries. Table 1 displays the standard deviation of output growth for euro-area Member States as well as a selection of non-euro-area OECD countries for the 1971-2007 period. While there is clear evidence of a reduction in output growth volatility everywhere, the magnitudes and timings differ substantially across countries. Some countries experienced a much stronger decrease than the euro area (e.g. New Zealand, Switzerland, the UK and the US) and others a more moderate one (e.g. Canada). The general decline in output volatility was actually associated with a convergence in volatility levels across countries. The countries which experienced the strongest moderation process are also those which posted the highest volatility level in the 1970s (Graph 2).

Regarding timing, the moderation process started in the early1980s in some countries (e.g. most euro-area Member States), while it only began in the second half of the 1980s in others (e.g. most anglo-saxon countries but also the Netherlands). In a number of cases, the moderation process was relatively continuous and may have pursued its course in recent years (e.g. Denmark, Greece, Austria and New Zealand) while in others the decline in output volatility took place mostly in the 1980s (e.g. Belgium, Switzerland and Italy) or was temporary reversed in the early 1990s (e.g. Finland and Sweden).

The substantial degree of cross-country heterogeneity in the Great Moderation process casts some doubt on explanations of the reduction in output volatility focusing exclusively on common shocks. Somehow, both changes in shocks and changes in economic policies and structures must have been at play.

Table 1: VOLATILITY OF GDP GROWTH, SELECTED OECD COUNTRIES (1)

(Standard deviation of y-o-y GDP growth – in %)

	1971Q1-1980Q4	1981Q1-1990Q4	1991Q1-2000Q4	1997Q4-2007Q3	Difference between 1971Q1-1980Q4 and 1997Q4-2007Q3
BE	2.48	1.56	1.54	1.20	-1.28
DE	2.14	1.83	1.71	1.37	-0.77
EL	5.34	3.31	2.34	0.92	-4.42
ES	2.87	1.99	1.75	0.77	-2.10
FR	1.78	1.25	1.35	1.08	-0.70
IT	3.14	1.47	1.45	1.26	-1.88
NL	2.53	2.16	1.53	1.56	-0.97
AT	2.64	1.51	1.10	1.11	-1.53
PT	4.45	3.00	2.01	1.83	-2.62
FI	3.06	1.94	3.61	1.60	-1.46
EA	**1.94**	**1.34**	**1.33**	**1.07**	**-0.87**
DK	2.67	2.24	1.71	1.30	-1.37
SE	2.22	1.64	2.26	1.20	-1.02
UK	2.91	2.03	1.50	0.66	-2.25
US	2.76	2.43	1.51	1.26	-1.50
JP	N.A.	1.70	1.75	1.70	0
CA	1.78	2.74	2.12	1.36	-0.42
CH	3.56	1.86	1.52	1.46	-2.10
AU	1.93	2.67	1.78	1.17	-0.76
NZ	6.99	3.52	2.37	1.57	-5.42

(1) IE and LU are not included due to lack of quarterly data.
Source: Commission services and OECD.

Table 2 displays the standard deviation of the contributions of GDP components to y-o-y GDP growth in the euro area for the 1971-2007 period. The decline in volatility was broad-based, affecting most components. The fall was larger for the most volatile GDP components, particularly inventories and investment.[4] In contrast, both government consumption and net trade do not seem to have played a major role in the moderation process. In the case of government consumption, this reflects both the sector's relatively small weight in GDP and its intrinsic stability. As to trade, a sharp reduction in the volatility of exports and imports over the past three decades was offset by increasing trade openness and the associated rise in the importance the two variables for GDP growth. As a result the volatility of the contribution of exports and imports increased significantly over the period although the volatility of the contribution of net trade increased more modestly due to the strong degree of comovement between exports and imports.

In addition to the fall in the volatility of its individual components, two other possible sources of moderation in GDP fluctuations should be considered, namely compositional effects and changes in comovements between components. Regarding the first one, increased GDP growth stability could be partly explained by shifts in composition towards more stable GDP components. Graph 3 shows the effect of changes in the composition of GDP by comparing the actual standard deviation of GDP growth to the standard deviation which would have been obtained if the shares of the various GDP components had been held constant at their average value of the first half of the 1970s.[5] The two curves are very close, suggesting that composition effects have remained marginal.

[4] Caution is however needed when interpreting the role of inventories to the great moderation process in the euro area. Inventories being still used as a residual in the GDP accounting identity in some Member States, the fluctuations in the contribution of inventories to GDP may be a genuine economic phenomenon but also, partly, a statistical artefact.

[5] The fixed-weight GDP is calculated as the sum of the y-o-y growth rates of the GDP components weighted by their average shares in the level of GDP for the first half of the 1970s. In the case of inventories, for which the share in GDP is not subject to any drift and is close to 0, the actual contribution to GDP growth is used.

Table 2: VOLATILITY OF THE GDP COMPONENTS, EURO AREA

(standard deviation of the contributions of components to y-o-y GDP growth – in %)

	1971Q1-1980Q4	1981Q1-1990Q4	1991Q1-2000Q4	1997Q4-2007Q3	Difference between 1971Q1-1980Q4 and 1997Q4-2007Q3
Private consumption	0.77	0.79	0.70	0.50	-0.27
Government cons.	0.12	0.13	0.22	0.10	-0.02
Investment	0.86	0.81	0.77	0.56	-0.30
Inventories	1.24	0.55	0.49	0.36	-0.89
Exports	0.71	0.82	1.30	1.34	0.64
Imports	0.96	0.86	1.37	1.25	0.29
Net exports	0.57	0.86	0.64	0.63	0.06

Source: Commission services and ECB.

The other possible source of moderation relates to the fact that the volatility of GDP growth depends on the volatility of its individual components but also on their comovements.[6] Ceteris paribus, a decrease in the comovements between GDP components will entail a decrease in the volatility of GDP. To check the magnitude of this correlation effect, Graph 4 displays an estimated measure of the volatility of GDP growth assuming that all pairwise correlation coefficients between GDP components are held constant at their value of the first half of the 1970s.[7] The distance between the recalculated measure of volatility and the actual one gives an indication of the size of the correlation effect. The graph does not point to any systematic effect although reduced correlation between components helped to curb GDP volatility temporarily but significantly in the 1980s and again in the late 1990s. On both occasions, these dampening effects were, however, subsequently reversed.

This does not mean, however, that the pairwise correlations of GDP components remained unchanged over the past three decades. In particular, inventories which tended to move in tandem with other GDP components in the 1970s, thereby amplifying cyclical fluctuations, now seem to be acting more as a buffer of demand shocks. This positive contribution of the inventories-related correlations to the moderation of output volatility probably reflects improvements in the management of inventories. It has, nevertheless, been offset by movements in the opposite direction of the correlations between other GDP components. In particular, although the correlation of imports with GDP is subject to large swings, it seems that imports now tend to dampen fluctuations in domestic demand shocks less than in the past. The reasons for the latter change would deserve to be further explored.

Overall, the moderation of the volatility of GDP growth can be mostly traced back to the decline in the volatility of individual GDP components with relatively little additional effects of changes in composition or in correlations. Inventories seem to have played a key role in the process (both due to their reduced volatility and to their increasing role in absorbing demand fluctuations) followed by investment and consumption. Based on the decomposition of the variance of GDP into the sum of the covariance of GDP with its individual components, the fall in volatility between the first half of the 1970s and the most recent 5-year period (2002-07) can be ascribed to the components according to the following proportions: inventories (49%), investment (41%), consumption (30%), net trade (-20%).[8]

[6] The variance of GDP growth is the sum of the variance of its components (measured in contributions to GDP growth) and of all the pairwise covariances between these components (again measured in contributions to GDP growth and multiplied by 2).
Formally, if GDP = $\Sigma_i Y_i$ then:
VAR (GDP) = $\Sigma_{i,j}$ COVAR(Y_i, Y_j) = Σ_i VAR(Y_i) + $\Sigma_{i,j \text{ with } i \neq j}$ COVAR(Y_i, Y_j)

[7] The covariance between two GDP components depends on their correlation but also on their respective standard deviations. Formally: Covar(x, y) = Correl(x, y) × σ_x × σ_y (where the σ variables stand for the standard deviations). The variance of GDP is recalculated by holding all the pairwise Correl(x, y) coefficients constant.

[8] See formula in footnote (5).

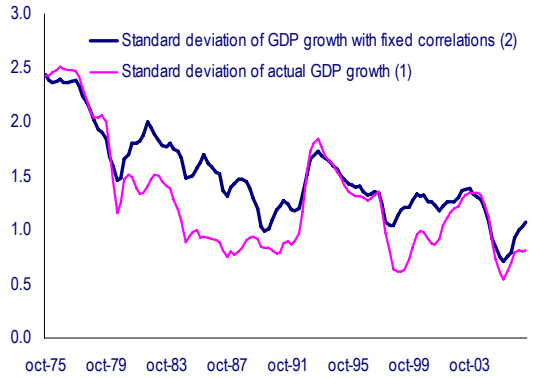
Graph 3: **Effects of changes in the shares of GDP components on the volatility of GDP growth, euro area** (in % – 5-year window – 1975 Q4 to 2007 Q3)

(1) Standard deviation of y-o-y GDP growth.

(2) Standard deviation of the sum of the y-o-y growth rates of the GDP components weighted by their average share in the level of GDP during the first half of the 1970s.

Source: Commission services and ECB.

Graph 4: **Effect of changes in the correlations between GDP components on the volatility of GDP growth, euro area** (in % – 5-year window – 1975 Q4 to 2007 Q3)



(1) Standard deviation of y-o-y GDP growth.

(2) The standard deviation with fixed correlations is calculated by holding the correlations between individual GDP components constant at their level of the first half of the 1970s.

Source: Commission services.

An analysis of the decomposition of GDP into industrial sectors paints a relatively similar picture. Table 3 displays the standard deviations of the contributions of industrial sectors to y-o-y growth in the euro-area's total gross value added over the 1971-2007 period. As in the case of GDP components, the drop in volatility appears broad-based, affecting all sectors but agriculture. It is also more pronounced for the more volatile sectors (mostly industry). Changes in the sectoral composition of value added, with the rising importance of the more stable service sector, helped to stabilise output growth but the effect was small, accounting for less than 10% of the overall fall in the standard deviation of growth in valued added since the 1970s (Graph 5).[9] Hence, composition effects were only slightly stronger than in the case of GDP components. Regarding the impact of comovements, most pairwise correlation coefficients between growth in individual sectors decreased but only modestly and the overall effect on GDP growth volatility remained marginal (Graph 6).

Table 3: VOLATILITY OF THE SECTORAL COMPONENTS OF VALUE ADDED, EURO AREA

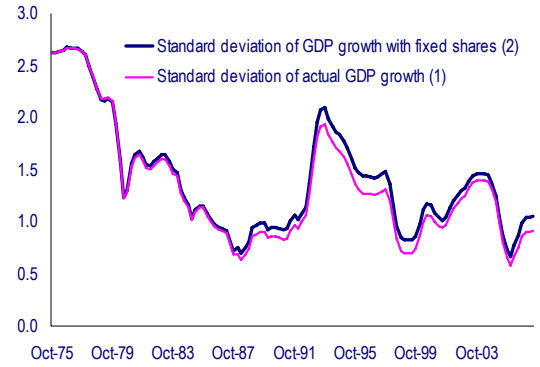
(Standard deviation of the contributions of components to y-o-y growth in total value added in %)

	1971Q1-1980Q4	1981Q1-1990Q4	1991Q1-2000Q4	1997Q4-2007Q3	Difference between 1971Q1-1980Q4 and 1997Q4-2007Q3
Agriculture	3.38	3.40	3.13	6.51	3.13
Manufacturing	3.87	2.53	3.23	2.16	-1.70
Construction	3.22	3.10	3.01	1.55	-1.67
Services	1.43	0.92	0.81	0.92	-0.52

Source: Commission services.

[9] As in the case of GDP components, fixed-weight value-added is calculated as the sum of the y-o-y growth rates of the value added of individual sectors weighted by their average shares in total value added during the first half of the 1970s.

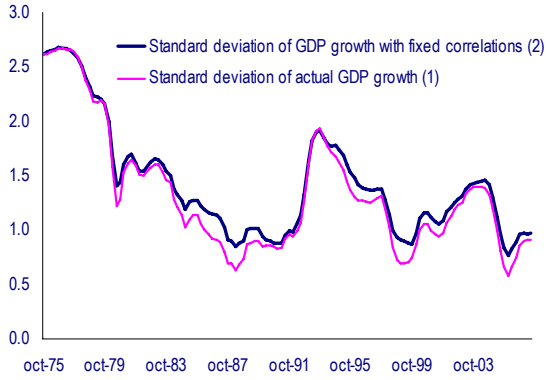
Graph 5: **Effects of changes in the shares of industrial sectors on the volatility of growth in total value added, euro area**
(in % – 5-year window – 1975 Q4 to 2007 Q3)



(1) Standard deviation of y-o-y growth in total gross value added.
(2) The fixed-weight value added is calculated as the sum of the y-o-y growth rates of the value added of individual sectors (4 sector decomposition) weighted by their average share in total value added during the first half of the 1970s.

Source: Commission services.

Graph 6: **Effect of changes in the correlations between industrial sectors on the volatility of growth in total value added, euro area**
(in % – 5-year window – 1975 Q4 to 2007 Q3)



(1) Standard deviation of y-o-y growth in total gross value added.
(2) The standard deviation with fixed correlations is calculated by holding the correlations between individual sectors (4 sector decomposition) constant at their level of the first half of the 1970s.

Source: Commission services.

Two additional stylised facts of the Great Moderation are worth stressing which suggest that both changes in the conduct of monetary policy and in the functioning of labour markets may have helped to dampen output volatility.

First, the moderation of output growth volatility was accompanied by a decline in the level of inflation and its volatility in the euro area (Graph 7) as well as in most OECD countries. Explanations for the moderation of inflation tend to centre around changes in monetary institutions (central bank independence, inflation targeting etc..).[10] It is tempting to interpret the parallel decline in nominal and real volatility as evidence of the effect of improved monetary policy on output stability.[11]

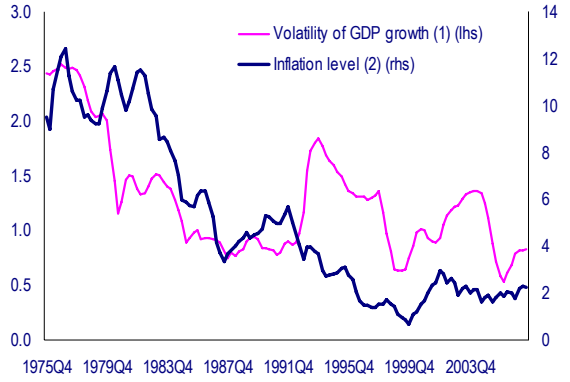
Second, looking at the supply side, a decomposition of the variance of GDP into its employment and productivity components gives a prominent role to a drop in the volatility of productivity in the Great Moderation process in the euro area (Graph 8). The volatility of growth in productivity decreased sharply in the 1980s and dropped again in the 2000s to hit a three-decade low. In contrast, the volatility of employment increased temporarily in the 1990s before falling back in recent years. It is currently low but it occasionally reached equally low levels in the past. An additional source of moderation was a decrease in the correlation between employment and productivity. As shown in Graph 8, the correlation turned from clearly positive in the 1970s to moderately negative or null during much of the 1980s and of the 1990s before increasing again in the year 2000s. While a broad range of factors can affect the comovements between employment and productivity - including changes in the nature of shocks that hit the economy - some economists have tended to interpret changes in comovements as reflecting mostly changes in the functioning of labour markets.[12]

[10] See European Commission (2007c).

[11] See for example Blanchard and Simon (2001).

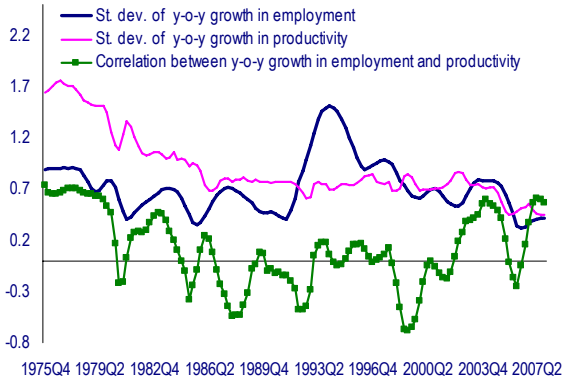
[12] For instance, Stiroh (2006) reports a similar drop in correlation between employment and productivity in the US and concludes that part of the increased stability of the U.S. economy can be traced to changes in the U.S. labour markets.

Graph 7: **The moderation of GDP growth and inflation, euro area**
(in % – 5-year window – 1975 Q4 to 2007 Q3)



(1) Standard deviation of y-o-y GDP growth.
(2) y-o-y changes in the GDP deflator.
Source: Commission services and ECB.

Graph 8: **Volatility of growth in GDP, employment and productivity, euro area**
(in % – 5-year window – 1975 Q4 to 2007 Q3)



Source: Commission services and ECB.

Overall, the stylised facts reviewed above offer a number of clues regarding the possible causes of the fall in output volatility. First, cross-country differences in the timing and the size of the fall make it unlikely that the process as purely driven by a reduction in the size or frequency of common shocks. Second, changes in economic structures such as better inventory management or, to a lesser degree, the shift of production towards services must have played a role. Third, there are some indirect indications that changes in macroeconomic policies, particularly monetary policy, may have contributed to stabilise output. More speculatively, some data also call for a further analysis of the possible role of structural policies (labour and product market reforms).

Finally, it is worth stressing an issue which has been largely overlooked in the literature on the Great Moderation. The above stylised facts are basically valid for measures of volatility based on the standard deviation (or variance) of year-on-year changes in the variables considered. Other types of indicators could, however, be constructed and, as discussed further in Box 1, stylised facts are not fully robust to the choice of the volatility indicator.

Box 1: HOW ROBUST IS THE ANALYSIS TO DIFFERENT MEASURES OF OUTPUT VOLATILITY?

The issue of the measurement of volatility has received relatively little attention in the empirical literature on the fall in output volatility. The analysis presented in this paper is based on what is probably the most widely used indicator in the existing empirical research on the Great Moderation, i.e. the standard deviation of the y-o-y GDP growth rates. However, a number of other measures could be considered as well. To illustrate the possible sensitivity of the analysis to measurement issues, the present box discusses two alternative measures. The first one is an obvious simple variation of the basic measure, namely the standard deviation of the q-o-q GDP growth rates. The second one is the absolute value of the output gap. It is meant to capture the idea that a long period of stable but sluggish growth away from potential (a rather frequent occurrence in the euro area) is not necessarily a sign of low volatility although it will be associated with a low standard deviation of growth.

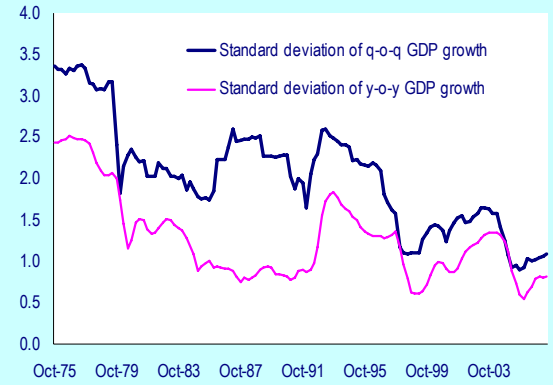
The two alternative measures of volatility do not necessarily paint the same picture than the basic one.

The left panel of the next graph displays the standard deviation of both y-o-y and q-o-q GDP growth in the euro area. The two measures both point to a large drop in volatility and are relatively closely correlated (with a correlation coefficient of 76%). They nevertheless suggest different time patterns with the moderation process taking place in the 1980s as well in the 1990s/early 2000s in the case of the q-o-q measure, against mostly in the 1980s in the case of the y-o-y measure. Differences between the two measures are quite large in some euro-area countries. Their correlation is only around 50% in Germany and Finland against 95% in Austria and Italy.

The right panel of the graph displays the standard deviation of the y-o-y GDP growth together with the average of the absolute value of the output gap. The two measures are somewhat more correlated than in the previous

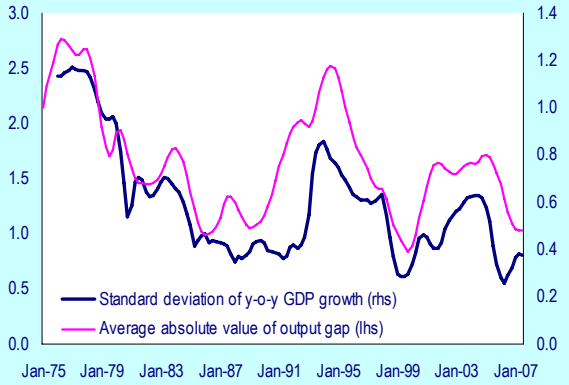
case (83% against 76%). Again, however, the time patterns of the moderation process differ somewhat with the measure of volatility based on the output-gap returning close to its peak of the 1970s during the first half of the 1990s. Differences between the two measures are quite significant in some euro-area countries with a correlation of only 44% in the Netherlands against about 95% in Greece and Italy.

Standard deviations of q-o-q and y-o-y GDP growth, euro area (1)
(in % – 5-year window – 1975 Q1 to 2007 Q3)



(1)The standard deviation of q-o-q GDP growth rate is annualised.
Source: Commission services and ECB.

Average absolute value of the output gap and standard deviation of y-o-y GDP growth, euro area
(in % – 5-year window – 1975 Q1 to 2007 Q3)



Source: Commission services and ECB.

The three different measures of volatility also paint somewhat different pictures when analysing the contributions of GDP components to overall GDP volatility. For each of the three measures, the table below displays the changes in the volatility of the contributions of individual GDP components between 1997Q4-2007Q3 and 1971Q1-1979Q4. Inventories appear to play a comparatively more important role in the moderation process in the case of the y-o-y measure and, to a lesser extent, in the output gap measure. Conversely, consumption emerges as a more critical component in the case of the q-o-q measure.

Volatility of GDP components

Measures based on:	Standard deviation of the contributions of components to: y-o-y GDP growth	Standard deviation of the contributions of components to: q-o-q GDP growth (1)	Average absolute value of the contributions of components to the output gap
Private consumption	-0.27	-0.70	-0.18
Government consumption	-0.02	-0.07	0.02
Investment	-0.30	-0.55	-0.18
Inventories	-0.89	-0.85	-0.44
Net exports	0.06	-0.15	-0.02

(1) The standard deviation of q-o-q growth rate is annualised.
Source: Commission services

Not very surprisingly, tests also show that results of panel regressions are also partly sensitive to the choice of the volatility measure. The main econometric specification presented in Section 4 hereafter is based on the y-o-y measure on the ground that it is the most commonly used in the empirical literature on the Great Moderation. Tests carried out with the two alternative measures presented here indicate that results remain broadly similar when using the absolute value of the output gap. However, they change substantially when using the q-o-q measure with most of the explanatory variables becoming insignificant. This could be an indication that q-o-q growth data are excessively noisy and that high frequency fluctuations in GDP are difficult to explain in the Great Moderation context.

Overall, these examples indicate that caution should be exercised when analysing the Great Moderation process as, to some extent, conclusions reached may not be fully robust to the type of volatility indicator used.

3. ECONOMIC POLICIES AND OUTPUT STABILITY: A REVIEW OF THE POSSIBLE CHANNELS

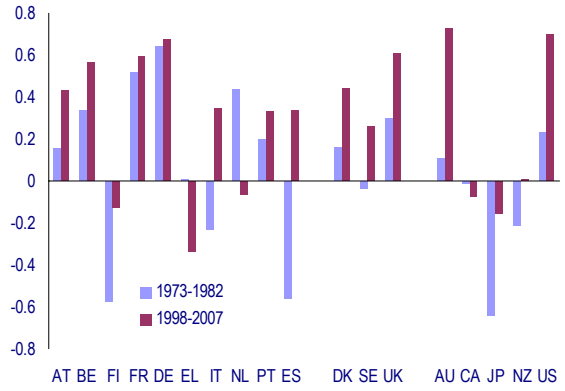
The large differences in the timing and scope of the reduction in output growth volatility across OECD countries suggest that the process cannot be solely ascribed to a reduction in the size or frequency of common shocks. Over the past three decades, economies policies have been altered significantly, resulting in far-reaching changes in the macroeconomic framework and the functioning of product, labour and financial markets. Critically, these changes have been put in place to varying degrees and paces across countries and therefore constitute good candidates for explaining country differences in the pattern of the drop in output volatility. This section reviews the possible channels through which these policy changes may have affected output growth stability.

3.1. IMPROVEMENTS IN THE MACROECONOMIC FRAMEWORK

Improvements in the conduct of macroeconomic policies have been most visible in the area of monetary policy. Far-reaching institutional changes involving the widespread recognition of the costs of inflation, increasing focus on inflation stability, central bank independence and inflation targeting have significantly transformed monetary policy. The associated improvement in the efficiency of monetary policy is measurable against a broad range of indicators, including more counter-cyclical interest rates, an increased stability of inflation expectations or an improved trade-off between output and inflation volatility.

Graph 9: **Correlation between short-term real interest rates and output gaps, selected OECD countries**

(in % –1973-1982 and 1998-2007)(1)

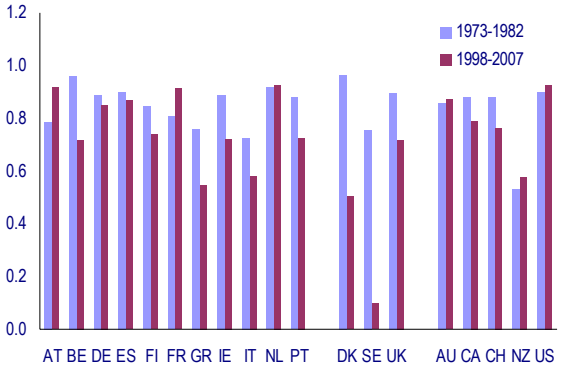


(1) The first period is: 1980-89 for AT, FI, EL and JP, 1977–86 for ES, 1982-91 for SE, 1974-83 for NZ.

Source: Commission services and OECD

Graph 10: **Autocorrelation coefficient of inflation, selected OECD countries**

(1973-1982 and 1998-2007)(1)



(1) First order autocorrelation coefficients of y-o-y changes in the GDP deflator.

Source: Commission services and OECD.

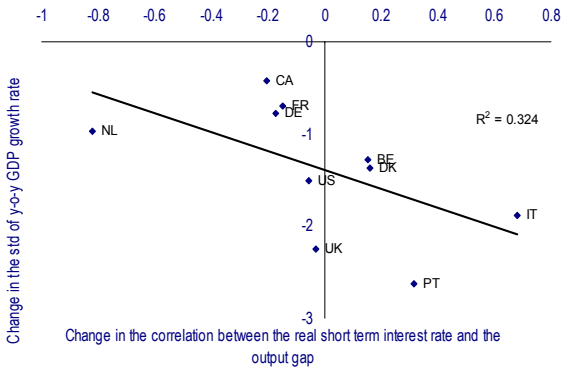
Graph 9 shows the correlation between real short-term interest rates and the output gap for a range of OECD countries. For nearly all the countries, the correlation was significantly higher in recent years than during the 1970s-80s, suggesting large improvements in the counter-cyclicality of monetary policy. Graph 10 presents another piece of evidence pointing in the same direction of better monetary policy. The disinflation process registered in most OECD countries since the 1980s has been accompanied by a drop in the persistence of inflation. Inflation's autocorrelation coefficient has decreased markedly, suggesting that the drop in inflation volatility was not solely attributable to smaller inflation shocks but also to changes in the transmission of those shocks.[13] Likely explanations include reduced inflation indexation and a shift from backward- to forward-looking inflation expectations in relation with a strengthening of the credibility of monetary policy. Interestingly,

[13] Assuming that inflation follows a first-order autoregressive process, the variance of inflation is equal to $\sigma^2 / (1-\rho^2)$ where σ^2 is the variance of inflation shocks and ρ the autoregressive coefficient. In this setting, a decrease of the variance of inflation can be explained either by a decrease in the variance of inflation shocks (lower σ^2) or by a reduction in the persistence of inflation (lower ρ).

improvements in monetary policy are correlated with the moderation of output volatility. For instance, countries which have shown comparatively larger drops in the counter-cyclicality of interest rates have also tended to register larger falls in output volatility (Graph 11).

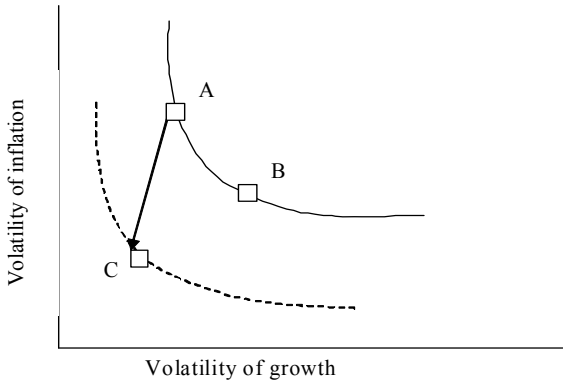
Graph 11: **Changes in output volatility and in the counter-cyclicality of interest rates, selected OECD countries**

(changes between 1973-1982 and 1998-2007 in pp)



Source: Commission services.

Graph 12: **The efficiency frontier of monetary policy**



Source: Commission services.

As discussed in the previous section, a central feature of the great moderation has been a joint decline in inflation and output volatility. In modern macroeconomic theory, monetary authorities face a trade-off between inflation and output volatility. The trade-off results from the existence of supply shocks which push inflation and output in opposite directions and which force monetary authorities to choose (temporarily) between price and output stabilisation objectives. It can be illustrated by a downward sloping curve relating inflation volatility to growth volatility (Graph 11). The location of an economy on the curve depends on the relative importance attached by its monetary authorities to the objectives of price and output stability.

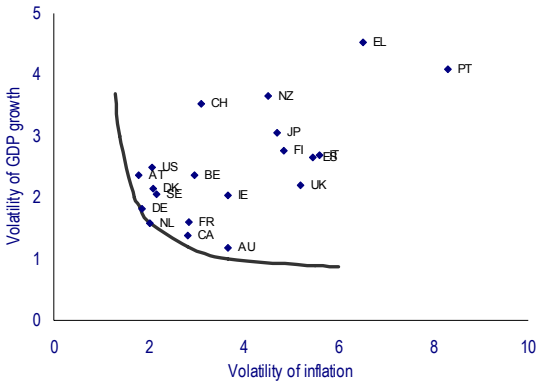
In such a setting, the simultaneous decline of output and inflation volatility that characterises the great moderation cannot be exclusively explained by a move along the efficiency curve (e.g. from points A to B in Graph 12) but must also translate an inward shift of the efficiency curve (e.g. from points A to C). Two sets of factors can lead to a shift in the curve: either changes in the frequency and size of supply shocks or changes in the functioning of the economy. The latter include structural changes in the economy (e.g. a shift of production from manufacturing to services, a lower oil dependency, better consumption smoothing through financial markets) and changes in the efficiency of macroeconomic policies (e.g. more credible monetary policies or more counter-cyclical fiscal policies). Box 2 describes a small analytical model which illustrates the impact of various forms of structural changes on the output and inflation volatility. It highlights the potentially important contribution of changes in inflation expectations to the Great Moderation.

In an attempt to give some empirical content to the efficiency-curve framework presented above, Graphs 13 and 14 display estimates of inflation and output volatility in a number of OECD countries for, respectively, the 1970s and the last ten years.

- In the earlier period (Graph 13), cross-country differences in the volatility performance were remarkably large. Some countries (e.g. Germany and the US) seem to have been located on broadly similar curves characterised by a combination of relatively low inflation volatility and low output volatility. Other countries (many of them now belonging to the euro area, including Italy, Spain, Greece, Portugal and Finland) were located in the North-East part of the chart with much higher combinations of inflation and output volatility.
- In the most recent past (Graph 14), all countries shifted markedly inwards and are clustered in a much smaller area. The inward shift was obviously much larger for those countries located in the North-East part of Graph 13. This could partly reflect a reduction in asymmetric shocks in the latter group but it is also (and more likely) an indication of larger improvements in economic policies and structures.

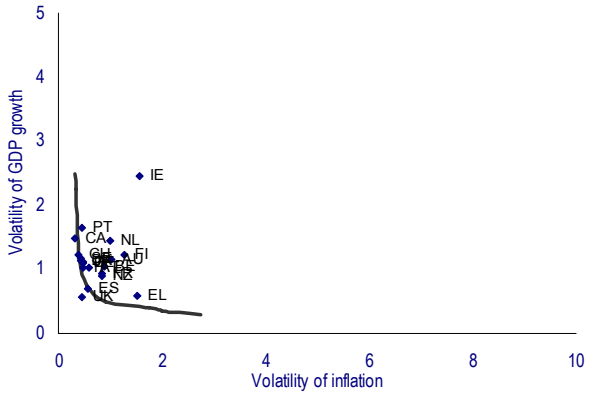
- Finally, it is interesting to note that those countries which experienced the largest inward shift from Graph 13 to 14 are also those which registered the largest changes in the monetary policy indicators reviewed above, suggesting a key role of monetary policy in the reduction of output volatility in this group.[14]

Graph 13: **Inflation and output growth volatility, selected OECD countries**
(standard deviation for the period 1970-1979– in %)



Source: Commission services.

Graph 14: **Inflation and output growth volatility, selected OECD countries**
(standard deviation for the period 1998-2007– in %)



Source: Commission services.

Whereas the case for a significant contribution of monetary policy to the decline in output volatility seems reasonably straightforward (at least for the euro area), the available evidence appears less compelling for fiscal policy. There have been some improvements in fiscal policies as shown, for instance, by a reduction in the ratio of public deficits to GDP across a majority of OECD countries since the mid-1990s (Graph 15). This suggests that, over the past decade, fiscal authorities have enjoyed more room for manoeuvre to smooth cyclical fluctuations. However, these improvements having occurred mainly since the 1990s can, at best, account only for a fraction of the observed decline in output volatility. Overall, two opposite arguments can be developed.

- On the one hand, although the propensity to 'stop and go' has been considerably reduced, there are indications that discretionary fiscal policy retains pro-cyclical features in many OECD countries (see for instance European Commission 2006).
- On the other hand, automatic stabilisers stand out as a possibly more promising candidate for a role in the Great Moderation. Empirical evidence for OECD countries points to a negative link between government size and GDP volatility (see also Graph 16).[15] Assuming that government size and the smoothing power of automatic stabilisers go hand in hand, the result can be interpreted as an evidence of a positive effect of automatic stabilisers on macroeconomic stability. Since the size of the government – as measured by the ratio of general government expenditures to GDP – increased in most OECD countries in the 1970s and 1980s, a rise in the size of the stabilisers may be one of the explanatory factors for the Great Moderation, at least for that period. As discussed further in the next section, there is also some evidence that the relation between government size and volatility may be non-linear.[16]

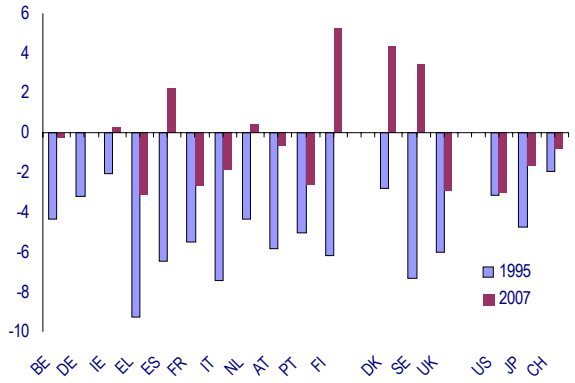
[14] The efficiency curves displayed on the charts are purely illustrative. For an interesting attempt to estimate these curves see Cecchetti, et al. (2006).

[15] Fatás and Mihov (2001).

[16] Debrun et al. (2008).

Graph 15: **Budget balance, selected OECD countries**

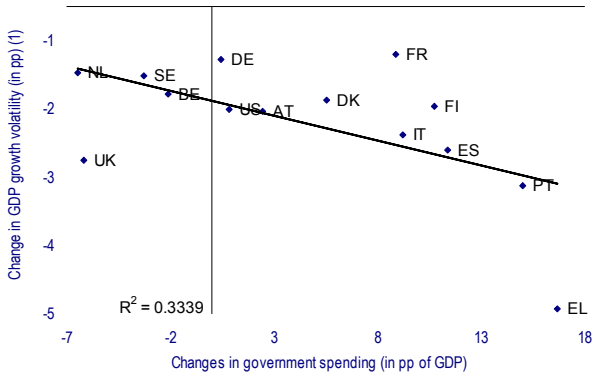
(% of GDP – 1995-2007)



Source: Commission services.

Graph 16: **Changes in government spending and GDP growth volatility, selected OECD countries**

(between 1973-82 and 1998-07)



(1) Volatility is measured by the standard dev. of y-o-y GDP growth.
Source: Commission services.

Box 2: THE RELATION BETWEEN INFLATION AND OUTPUT VOLATILITY SOME INSIGHTS FROM A SIMPLE MODEL OF MONETARY POLICY

Following De Gregorio (2007), the relation between inflation and output volatility can be better understood with a very simple model combining a monetary policy loss function (equation (1) below) and a Phillips curve (equation (2)). Monetary authorities have an inflation target and minimise a loss function which depends both on the size of inflation and the output gap.

(1) $L = \mu \times y_t^2 + (\pi_t - \pi^*)^2$
(2) $\pi_t = \alpha \times \pi_{t-1} + (1- \alpha) \times E_{t-1}(\pi_t) + \beta \times y_t + \varepsilon_t$

where:
y_t output gap,
π_t Inflation rate
π^* Inflation target
ε_t Inflation shocks

The table below summarises the relations between the volatility of output and inflation and the structural parameters of the model.

The impact of model parameters on inflation and output volatility

	Output volatility	Inflation volatility
The loss function parameter for output (μ)	-	+
The inflation autoregressive coefficient (α)	+	+
The Phillips curve's slope (β)	?	-
The variance of the inflationary shock (σ_ε)	+	+

An increase in the value of the parameter μ, as happens when monetary authorities shift their priority from inflation to output, entails a reduction in the volatility of output but at the expense of an increase in the volatility of inflation. This is an illustration of the standard inflation volatility / output volatility trade-off.

However, changes in some parameters of the model will bring a simultaneous decline in output and inflation volatility. Obviously, a decrease in the size of inflation shocks will be associated with a drop in the variances of

both inflation and the output gap. A similar result will be obtained with a reduction in the coefficient α, i.e. the extent to which current inflation depends on past inflation. A reduction in α may be the result of a weakening of wage indexation schemes or of increased credibility in the inflation target of the monetary authorities.

Finally, it is worth noting that changes in the slope of the Phillips curve (i.e. the β coefficient capturing the direct response of inflation to the output gap in the Phillips curve equation) have well-defined effects on inflation volatility but not on output volatility. Hence, the well-documented flattening of the Phillips curve observed in recent years in many industrialised countries (likely due to several factors including globalisation and increased international competition) is, in the simple framework presented here, a source of higher inflation volatility but its effect on output volatility depends on the model parameters. However, simulations with a model calibrated on UK data suggest that the flattening of the Phillips curve could lead to a reduction of output volatility (Iakova 2007).

Overall, this model suggests that a joint decline in inflation and output volatility may be an indication of smaller shocks or of structural changes in the economy affecting the autoregressive component of inflation. The latter can be a sign of increased credibility in monetary policy but can also result from reduced wage indexation. In contrast, structural changes bringing a flattening of the Phillips curve (e.g. increased trade, competition or capital mobility) tend to be associated with increased inflation volatility and are not necessarily conducive to reduced output volatility.

3.2. CHANGES IN STRUCTURAL POLICIES

OECD countries have been going through various degrees of ***product and labour market reforms*** since the 1980s and it is tempting to try to establish a link between these structural changes and increased output stability. Unfortunately, economic theory does not provide clear guidance as to the effects of product or labour market rigidities on output stability. Some forms of rigidities may dampen the initial impact of a shock but lengthen the ensuing adjustment phase with the net effect on output volatility remaining theoretically undetermined. For example, strict employment protection legislation may delay the response of employment to a shock, thereby mitigating the initial impact of the shock on consumption while delaying the necessary adjustment process.[17] The available empirical literature on the link between market rigidities and output volatility is particularly sparse. To the best of our knowledge, only one panel study has explored the issue, reporting a positive link between product market regulations and output volatility.[18]

Trade integration can affect output volatility via several and sometimes conflicting channels. Increased trade integration means that a larger part of country-specific shocks are smoothed by being transferred to trading partners.[19] This would a priori suggest a negative link between trade integration and volatility. However, trade integration may also foster production specialisation and therefore the occurrence of country-specific shocks. Furthermore, as shown in Box 2, trade integration and globalisation may entail a flattening of the Phillips curve that will bring a deterioration of the inflation/output volatility trade-off with a likely increase in inflation volatility and a possible rise in output volatility (the latter depending on model parameters). Overall, the link between output volatility and trade is therefore essentially an empirical matter but evidence for industrialised countries is relatively sparse and has so far failed to establish a significant relationship.[20]

The theoretical effect of ***financial liberalisation / integration*** on output stability is equally ambiguous. By improving opportunities to diversify and share risks, financial liberalisation allows better consumption smoothing and should thereby contribute to curb output volatility. Nevertheless, in an argument that looks very similar to the one developed for trade, financial liberalisation – by severing the link between output fluctuations and consumption – may also facilitate production specialisation and therefore the risk of sectoral shocks, leading simultaneously to an increase in output volatility and a reduction in consumption volatility. Finally, historical

[17] Duval et al. (2007).

[18] Kent et al. (2005).

[19] More precisely, demand shocks are partly transferred to trading partners while supply shocks are likely to be blunted by increased competition (i.e. firms will have less leeway to raise their prices).

[20] See Cecchetti et al. (2006); Kent et al. (2005) and Buch at al. (2002).

evidence also shows that phases of financial liberalisation may be associated with temporary spells of increased volatility as economic agents take time to come to grip with the full implications of the new financial environment. The overall impact of increased financial integration will depend on which of these three channels dominates. The few studies which have explored the question empirically have generally reported a positive link between financial development and output stability.[21]

4. ESTIMATING THE DETERMINANTS OF OUTPUT VOLATILITY IN A PANEL REGRESSION

4.1. THE ESTIMATION FRAMEWORK

This section provides quantitative substance to the discussion of the previous section by presenting the results of an econometric analysis of the determinants of output growth volatility in a panel of 20 OECD countries. GDP growth volatility is regressed on a set of structural and macro-economic policy variables for the period 1973 to 2007. Additional regressions are also tested using consumption growth volatility and investment growth volatility as endogenous variables.

As regards structural changes, the main variables tested are: (i) the sectoral shift in production towards services (ii) the degree of openness to international trade and (iii) changes in the exposure to oil prices. Economic policy variables include measures of changes in macroeconomic policies, both (iii) monetary policy and (iv) fiscal policy, as well as indicators aimed at capturing changes in structural policies in terms of (v) financial markets and (vi) regulation in the product markets.[22]

More formally, the following equation is estimated on a panel composed of the former EU15 Member States – except Luxembourg – together with the US, Japan, Canada, Australia, Switzerland and New Zealand:

$$\sigma_{it} = \alpha_t + \alpha_i + \beta_1 X_{1,it} + \beta_2 X_{2,it} + \ldots + \beta_n X_{n,it} + \varepsilon_{it} \qquad \forall\, i = 1,..,\ 20\ \forall\, t = 1,..,\ 7$$

where σ_{it} is the volatility of output growth as measured by the standard deviation of year-on-year quarterly GDP growth (or consumption and investment growth in alternative estimations) and the X variables represent a set of regressors. Time- and country-fixed effects are added when statistically appropriate.

To obtain reasonably meaningful estimates of volatility, the 1973-2007 estimation period is broken down into 7 sub-periods of 5 years each (1973Q1-1977Q4, 1978Q1-1982Q4, etc..). This entails a panel size of approximately 140 data points (actually somewhat less as the panel is imbalanced and all variable are not available for the full sample in all countries). Regressors which are available as quarterly or annual time series are averaged over the 5-year blocks.

4.2. REGRESSORS TESTED

A first measure of ***structural changes*** aims at capturing sectoral shifts in production. For each country, it is calculated as the share of value added in the service sector in total value added. A second structural measure is designed to test the idea that a higher exposure to trade may bring additional output volatility in periods of large swings in world trade. The indicator is constructed as the product of the degree of openness to international trade of the country considered (i.e. the ratio of its trade to its GDP) and an indicator of the volatility of quarterly world trade growth (common to all countries). A similar indicator is used to assess the effect of changes in the exposure to oil prices. It is calculated as the oil intensity (the ratio of oil consumption to real GDP) multiplied by an estimate of the volatility of real oil prices.

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[21] See for instance Cecchetti et al. (2006), op. cit. and Buch, C., J. Döpke. and C. Pierdzioch (2002).

[22] Due to the lack of appropriate time series, a measure of labour market regulations could not be included in the regressions.

As regards ***monetary policy***, a range of indicators can be tested. As the idea is to try to capture the possible output stabilising effect of improvements in the monetary policy framework and in the conduct of monetary policy, an obvious indicator is the degree of counter-cyclicality of real short-term interest rates as measured by the correlation between interest rates and the output gap. Simple correlation is, however, probably a relatively poor measure of the stabilisation efficiency of monetary policy in the sense that real rates may move in close tandem with the cycle (i.e. measured correlation is high) while remaining grossly inadequate in terms of level.[23]

We have therefore constructed an alternative monetary-policy indicator which seeks to takes such level effects into account. It is calculated as the distance between the real interest rate gap (i.e. the actual real short-term interest rate minus the equilibrium real interest rate) and a weighted sum of the deviations of GDP and inflation from their respective trends.

Formally, the indicator is calculated (for country j and time t) as:

$$(1) \quad MPI_{jt} = [ri_{jt} - (ri^{e}_{j} + \alpha \times (\Pi_{jt} - \Pi^{trend}_{jt}) + \beta \times (og_{jt}))]^2$$

where: ri_{jt} is the real short-term interest rate,

ri^{e}_{j} is the equilibrium interest rate,

og_{jt} is the output gap,

Π_{jt} is the inflation rate,

and Π^{trend}_{jt} is the trend inflation rate (as derived from an HP filter).

Model simulations indicate that monetary policy rules which set policy rates (in deviation from their equilibrium level) close to a weighted sum of the output gap and deviations of inflation from a target generally offer the best macroeconomic stabilisation properties.[24] Assuming that inflation targets can be proxied by the inflation trend, the monetary-policy indicator described in equation (1) measures the extent to which interest rates deviate from such stabilising monetary policy rules. It is expected to be positively correlated with output growth volatility, i.e. a high level of the indicator will be suggestive of developments in real rates that do little to stabilise output and will therefore be associated with higher output growth volatility.

To calculate the monetary-policy indicator, a number of practical assumptions have to be made about the weights and equilibrium rates.[25] Arguably, these assumptions about the indicator's parameters are not carved in marble and alternative specifications have been tested to assess the robustness of the regression results. These tests show that key econometric results regarding the impact of the monetary-policy indicator on output growth stability are generally robust to changes in the parameters. [26]

In addition to the monetary policy indicators discussed above, the possible impact of participation in the ERM or the euro is also directly tested with various dummies equal to 1 when a Member State belongs to ERM and adopts the euro.[27] It is important to stress that effects of the dummies come on top of the possible stabilising role achieved by the euro via monetary policy and the monetary-policy indicator.

Regarding ***fiscal policy*** indicators, our tests relate both to discretionary fiscal policy and automatic stabilisers. Fiscal activism is captured by various measures of the correlation between the cyclically adjusted primary balance (CAPB) and the business cycle. A major drawback of these measures is, however, the very small size of

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[23] This was observed in a number of OECD countries in the 1970s and early 1980s.

[24] See Taylor (1993).

[25] In particular, trend growth is taken as a proxy for the equilibrium real interest rate. The respective weights on the inflation and the output gap are set at 0.5 as originally suggested in Taylor (1993).

[26] More specifically, econometrics results appear quite robust to the choice of the weights on the output gap and inflation but are somewhat more sensitive to alternative specifications of the inflation target. For instance, specifications where the inflation target is set constant both across countries and across time tend to produce somewhat weaker econometric results. This is probably not very surprising insofar as, in most OECD countries, it seems difficult to argue that monetary authorities were pursuing (even implicitly) the same inflation target in the 1970s as now.

[27] The only dummy which comes out as statistically significant in some specification is one which captures both participation in ERM and in the euro. Independent ERM and euro dummies were been tested but not found to be meaningful.

the samples over which they are constructed: CAPB are only available at annual frequency and the sample being decomposed into 5-year blocks, correlation coefficients are therefore calculated with only 5 data points in each block. As a result, the indicators tend to display an excessive level of variability. The possible role of automatic fiscal stabilisers is captured via the average size of government expenditure as a share of GDP. This regressor is based on the assumption of a close link between the size of government expenditure and the power of automatic stabilisers.

Finally, two indicators of changes in structural policies are also tested. (i) The effect of financial liberalisation is proxied by the ratio of domestic credit to the private sector GDP. This is admittedly a very rudimentary indicator of the relative deepness of financial markets but it is frequently used in empirical studies on volatility of growth in the absence of more satisfactory alternatives. (ii) The second structural-policy measure considered in the regression is an index of product market regulation (PMR) published by the OECD. The index is a weighted average of the degree of regulation in 5 service industries (airlines, telecom, electricity, gas, post, rail and road). The higher the index, the more competition is inhibited by regulations.

4.3. REGRESSION RESULTS – MAIN SPECIFICATIONS

Regression results for the main estimated specifications are presented in Table 4. Column (1) displays the full specification while Column (2) shows the specification restricted to the significant regressors. In both cases, the estimations are carried with fixed time effects but no fixed country effects as the latter were found to be statistically insignificant.

One of the most critical findings of the regression work is that it brings support to the idea of a significant impact of macro-economic policies on output volatility. Both monetary policy and fiscal policy – the latter via automatic stabilisers rather than discretionary policy – can help explain country differences in volatility developments over the past three decades.

In line with priors, the estimated coefficient for **monetary policy** is both positive and statistically significant, suggesting that changes in monetary policy have contributed to the Great Moderation process in most OECD countries included in the panel. The estimated contribution is rather large in some euro-area Member States (e.g. Greece, Spain, Italy, Portugal and Finland) where monetary policy mismanagement was particularly acute in the 1970s. In these countries improvements in monetary policy may account for about 20 to 70% of the drop in output volatility registered over the past 30 years.[28] In contrast, the estimated contribution of monetary policy is small for most 'core' euro-area countries such as Austria, Belgium, the Netherlands or France and, in particular, almost negligible for Germany. It is worth stressing that the model also points to a strong role for monetary policy in some countries outside the euro area (e.g. Australia, New Zealand and the United Kingdom) but not in the US. The results are therefore in line with available research on the US which has tended to report only a small effect of monetary policy to the Great Moderation in that country.

It is also interesting to note that the monetary-policy indicator performs better than inflation as an explanatory variable of output-growth volatility. Inflation volatility is often used as a regressor in the empirical literature on output volatility. The correlation between the two variables is high and inflation volatility therefore tends to be a highly meaningful regressor which is generally interpreted as a proxy for changes in the conduct of monetary policy. However, including this variable in the regression poses a simultaneity problem as GDP and inflation can be both driven by common demand and supply shocks (e.g. oil shocks). The relative strength of the explanatory power of inflation volatility and the monetary-policy indicator can be tested by including the inflation volatility in the regressions of Column (1) and (2). Results show that inflation volatility is not significant when associated with the monetary-policy indicator. This suggests that the relatively strong correlation between inflation volatility and output volatility observed in most OECD countries is not just the reflection of common shocks affecting the two variables but also the genuine effect of changes in monetary policies.

[28] The estimates are obtained by multiplying the estimated coefficient for the monetary policy indicator (Column 2 in Table 4) by the change in the monetary policy indicator between the beginning and the end of the estimation sample in the country considered. The result is then compared with the overall decrease in output growth volatility in the country considered. For further details on the contributions of the various explanatory variables see Annexes 1 and 2. The two tables in these annexes display the estimated contributions of the various regressors to the overall change in output volatility between 1973-77 and 2003-07. The calculations are based on the estimated coefficients in Columns (2) and (3) of Table 4.

TABLE 4: THE SOURCES OF GROWTH VOLATILITY – RESULTS OF A PANEL ANALYSIS
MAIN SPECIFICATIONS
(endogenous variable: standard deviation of y-o-y GDP growth)

	Full specification (1)	Specification (1) restricted to the significant variables (2)	Specification (2) with country fixed effects (3)
Constant	7.307	7.931	9.265
	(3.58)***	(5.59)***	(4.50)***
Monetary policy indicator	0.008	0.008	0.007
	(3.47)***	(5.86)***	(3.88)***
Government expenditure	-0.180	-0.200	-0.139
	(-2.61)***	(-4.11)***	(-1.87)**
(Government expenditure) ²	0.002	0.002	0.001
	(2.45)**	(3.74)***	(1.92)**
Share of services in total value added	-0.021	-0.025	-0.046
	(-2.06)**	(-2.57)**	(-2.30)**
(World trade volatility) x (trade intensity)	0.039	0.040	
	(1.88)*	(2.03)**	
ERM / euro dummy	-0.053		
	(-0.37)		
Financial market development	-0.002		
	(-1.15)		
Product Market Regulation	-0.014		-0.341
	(0.15)		(-3.02)***
Cyclicality of primary budget balances	0.073		
	(0.96)		
(Oil intensity) x (volatility of oil prices)	2.483		
	(0.71)		
Country fixed effects	No	No	Yes
Period fixed effects	Yes	Yes	Yes
R-squared	0.673	0.768	0.804
Number of observations.	113	125	125

Notes – Estimation method: panel OLS regressions. GDP growth volatility is measured by the standard deviation of y-o-y GDP growth. Absolute value of t tests reported in parentheses. ***, **, * denote, respectively, statistical significance at 1, 5, and 10% level. Heteroskedasticity robust estimates of standard deviations (White).
Regressions (1) and (2) include two dummies to cater for, respectively, the high level of growth volatility generally registered in Greece and the extreme volatility brought by the recession of the early 1990s in Finland. The latter dummy is also included in regression (3).

Tests with various dummies for **participation in the ERM and/or the euro** generally indicate a positive but non-significant effect of monetary integration on the stability of GDP growth but, as already emphasised this comes in addition to the euro effect possibly captured by the monetary policy indicator. Regarding the latter point, it is noteworthy that, within our sample of OECD countries, the largest improvements in the calculated monetary policy indicator are to be found in some euro-area Member States. In these Member States, the largest improvements in the indicator were registered in the 1980s but further, more modest, gains also took place in the 1990s pointing to a possible role for the euro.[29]

[29] It is of course difficult to say to what extent good monetary policy practices would have persisted in these countries in the past 10 years in the absence of the euro. In the absence of such a counterfactual, the impact of the euro on the volatility of GDP growth is difficult to assess in the econometric setting used here.

As regards **budgetary policy**, output growth volatility is found to be negatively correlated with the ratio of government expenditure to GDP, in line with the results reported in Fatas and Mihov (2001). Provided that the size of government and the smoothing power of automatic stabilisers go hand in hand, this can be interpreted as evidence of a role of automatic stabilisers in the Great Moderation process. However, the relationship between government size and output stability appears to be non-linear. As first suggested in Debrun et al. (2007), the fit of the regression can be strongly improved by adding the squared ratio of expenditure to GDP as a regressor. As a result, according to our point estimates, the effect of government size on stability is positive up to a ratio of 50% (with a 95% confidence interval of 46 to 54%) and turns negative above this threshold. It is interesting to note that this non-linearity is not just an empirical regularity but also has theoretical underpinnings. Buti et al. (2002 and 2003) have shown that in a standard AD/AS model, an increase in the tax rate may entail lower stabilisation in the face of supply shocks when a threshold tax burden is reached.

Overall, given the magnitude of the estimated elasticity, the contribution of government expenditure/automatic stabilisers to the drop in GDP volatility over the past three decades is found to be large only in a few countries, mostly located in the euro area (e.g. Greece, Spain, and Portugal and, to a lesser degree, Italy and Finland). As in the case of the monetary policy indicator, the contribution is small in most 'core' euro-area countries and, in particular, almost negligible in Germany. The fiscal policy variables also seem to have played only a minor role in the US.

Tests with a range of alternative public finance variables have proved to be unsuccessful. In particular, changes in the debt level are not found to have a statistically significant effect on output growth volatility. Maybe more critically, measures of discretionary fiscal policy, such as the degree of correlation of the CAPB with the output gap, do not appear to be significantly correlated with output volatility. Hence, the regression results do not point to a major role for fiscal activism in the Great Moderation process.

Regression results provide only moderate support for the idea that the Great Moderation has been partly driven by changes in economic structures (apart from those pertaining to monetary policy). The **shift of production to services** comes out as a significant regressor with a negative sign. A higher share of services in GDP has therefore a moderating role on output volatility. However, the estimated order of magnitude is small and the contribution of the variable to the fall in output volatility since the 1970s does not exceed 10-15% in most cases. The only exception is Germany where the contribution reaches 30% due to both a larger shift towards services and an overall smaller decrease in output growth volatility.

In contrast with most of the literature on this subject, **openness to trade** is found to be significantly and positively correlated with output volatility. Nevertheless, the magnitude of the effect is very small. According to the estimated coefficients, highly trade intensive euro-area Member States such as Belgium or the Netherlands would face a trade induced loss in output stability of a few decimals of a percentage point compared with their less trade-open counterparts. Overall, it seems that the negative and positive effects of trade on output stability largely cancel each other out.

Whereas conventional wisdom tends to give a prominent role **to oil shocks** in explanations of the high macroeconomic volatility of the 1970s and early 1980s, this hypothesis finds only mixed support in our panel regressions. Higher oil intensity tends to be associated with higher output growth volatility in periods of large swings in oil price volatility but the effect is not statistically significant in our main specifications (although it is found to be meaningful in some of the alternative specifications presented in the next section).

Finally, the two variables aimed at capturing changes in **structural policies**, i.e. the ratio of private-sector credit to GDP or the indicator of product market regulations, are both found to be statistically insignificant.

Overall, the variables included in the regression in Column (2) explain about 50% of the decline in output volatility since the 1970s, the rest being accounted for by time fixed effects. Most of the share is attributable to macroeconomic policy variables with monetary policy playing a leading role. The explanatory power of the model is somewhat higher for the euro area – particularly southern Member States – than for the rest of the OECD, and is rather weak for the US.

It is also worth stressing that estimation results suggest that it is difficult to interpret time fixed effects in terms of shocks (good luck hypothesis). The estimated time effects show a clear and steady downward trend suggesting that they capture both common shocks and some missing explanatory variable. An obvious potential candidate

for the latter would be the improvement in the management of inventories. There is indeed some correlation between the estimated time fixed effects and the reduction of the contribution of inventories to GDP volatility as computed on the basis of the GDP accounting identity. Another potential candidate is financial market development which, due to lack of proper data, has only been crudely captured in the estimations.

Finally, a discussion of the importance of fixed country effects is necessary. The rejection of fixed country effects in Columns (1) and (2) is not statistically very strong (at the 10% level but not at the 15% level). Column (3) therefore displays the variant of column (2) obtained with fixed country effects. The picture remains broadly the same except for trade openness and the indicator of product market regulation. Trade becomes non-significant (it is therefore omitted from the column) while **product market regulation** turns strongly significant. The estimated coefficient for PMR in Column 3 is negative, i.e. more stringent product market regulations are associated with lower output growth volatility. This is not in line with the (only) other econometric study on the issue (Kent et al. (2005)) which reports a positive coefficient. It is also somewhat surprising given that most OECD countries have experienced a joint decrease in the level of regulation and in output volatility over the past two decades, an observation which would a priori have suggested a positive correlation between the two variables. There are nevertheless reasons to consider the estimated coefficient for the PMR variable with prudence. It is indeed not significant in our preferred specification, which excludes fixed country effects, and only becomes significant when fixed country effects are added. So it appears less statistically robust than some other variables listed above. In addition, the indicator of product market regulation, compiled by the OECD, only covers some service sectors (utilities, transport, telecom and post). Broader measures also covering manufacturing sectors could produce difference results but such measures are unfortunately not available for a time span sufficiently long to allow meaningful regressions. Further work would clearly be useful here.

4.4. REGRESSION RESULTS – ALTERNATIVE SPECIFICATIONS

Additional regressions were also tested to check the sensitivity of the regression to changes in the specification of the endogenous variable. Columns (1) and (2) in Table 5 display estimations results obtained when GDP volatility is replaced by consumption and investment volatility (both measured in terms of standard deviation of y-o-y growth). Columns (3) and (4) give an idea of the sensitivity of the model to alternative measures of GDP volatility.

Regression results obtained with consumption and investment volatility are generally weaker than those obtained with the main specifications in Table 4. As regards **consumption volatility**, only the monetary policy indicator, the ERM/euro dummy and oil exposure come out as statistically meaningful regressors (Column (1)). The monetary policy indicator displays the expected positive sign and an estimated coefficient that is close to that of the main specification. In contrast to the results obtained for GDP volatility, participation in the ERM and/or the euro is associated with reduced consumption volatility and the size of the estimated effect is far from negligible. The oil exposure variable, which is not meaningful in the case of the main specifications, becomes significant in the consumption equation. A possible interpretation is that swings in oil prices are a key source of volatility for private consumption while their overall impact on GDP volatility depends on a range of parameters, such as the response of wages to terms of trade losses. As these parameters have evolved substantially over the past three decades, the regressions fail to find a mechanical effect of oil intensity on GDP volatility.

The results for **investment volatility** are disappointing (Column (2)). Only, the ERM/euro dummy and the credit variable emerge as statistically significant. The coefficient for the ERM/euro dummy is substantially higher than in the case of consumption, pointing to a potentially stronger stabilising role of the variable for the corporate sector than for the household side. However, this could also be a consequence of the fact that the stabilising role of changes in monetary policy is not properly captured by the monetary policy variable (which is not significant). In contrast to GDP and consumption, there is some evidence that financial market deepening has played a role in the reduction of investment growth volatility. This result should however be interpreted with caution for several reasons. First, the proxy used for financial market deepening (the ratio of private-sector credit to GDP) is very rudimentary. Second, the significance level is only 10%. Third, the regression only includes two meaningful regressors and the estimated coefficient for credit is quite high: for the sample as a whole, the credit variable could explain as much as half of the decline in investment volatility between the 1970s and the most recent period (the share would however be lower in the case of the euro area, at about one third).

Table 5: The sources of growth volatility – Results of a panel analysis
Alternative specifications

Endogenous variable:	Consumption volatility	Investment volatility	GDP volatility	
	(standard dev. of y-o-y changes)	(standard dev. of y-o-y changes)	(standard dev. of q-o-q changes)	(average absolute value of the output gap)
	(1)	(2)	(3)	(4)
Constant	1.332	8.377	5.177	5.778
	(5.66)***	(6.64)***	(3.17)***	(4.04)***
Monetary policy indicator	0.009		-3.24E-05	0.003
	(2.07)**		(-0.02)	(2.38)**
Government expenditure			-0.101	-0.091
			(-1.88)*	(-1.76)*
(Government expenditure) ^{2}			0.001	0.001
			(2.07)**	(1.58)
Share of services in total value added			-0.024	-0.022
			(-1.59)	(-1.67)*
(World trade volatility) x (trade intensity)				
ERM / euro	-0.630	-1.901		
	(-1.86)*	(-1.94)*		
Financial market development		-0.022	-0.001	-0.002
		(-1.88)*	(-0.49)	(-0.86)
Product Market Regulation			-0.093	-0.204
			(-1.32)	(-2.36)**
(Oil intensity) x (volatility of oil prices)	8.511			
	(2.07)**			
Country fixed effects	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes
R-squared	0.625	0.511	0.868	0.741
Number of observations.	113	121	125	125

Notes – Estimation method: panel OLS regressions.
Absolute value of t tests reported in parentheses. ***, **, * denote, respectively, statistical significance at 1, 5, and 10% level. Heteroskedasticity robust estimates of standard deviations (White).

Overall, the consumption and investment regressions allow to identify a sizeable ERM/euro effect and, possibly, a financial market effect not present in the GDP equations. Statistically speaking these regression are, however, less satisfactory than in the case of GDP volatility. This could reflect the fact that GDP volatility is not just the sum of the volatility of its components but also depends on the comovements between these components. Such changes in comovements can clearly not be captured in the individual consumption or investment regressions.

Finally, in order to illustrate the sensitivity of the analysis to the type of volatility indicator used (see also discussion in Box 1), Columns (3) and (4) display variants of the main specification where the standard deviation of y-o-y growth in GDP is replaced by the two alternatives measures discussed in Box 1, namely, the standard deviation of q-o-q GDP growth and the average absolute value of the output gap. These two equations are estimated with fixed country effects as tests show a clear need for them.

- Regression results are particularly disappointing when **volatility is measured in q-o-q growth**. Only government spending remains clearly significant while services become borderline significant. Two

possible explanations come to mind. First, quarterly GDP data are still fraught with statistical problems in some euro-area countries and this could create statistical noise that reduces the power of the regression. Second, with q-o-q changes, the volatility indicator also captures very short-term volatility that may be poorly explained by our economic-policy or structural variables.

- Regression results appear closer to the main specification, although slightly weaker, when **the absolute value of the output gap** is used. In particular, the government expenditure variables become borderline significant (at the 15% level).

5. SUMMARY AND CONCLUSION

Over the past three decades, most OECD countries have experienced a sharp reduction in the volatility of output and inflation. Although this Great Moderation process has stirred considerable interest in economic and policy circles, research on its causes has so far tended to focus on the US economy and has produced relatively little empirical evidence on the euro area or other non-US OECD countries. This paper contributes to fill in the gap by providing a euro-area view of the Great Moderation process and by assessing the euro-area experience against developments in other OECD countries. Its main focus is on the possible role of economic policies. After reviewing a set of key stylised facts of the fall in output growth volatility in the euro area, the paper discusses the possible channels through which economic policies may have contributed to the Great Moderation process and presents the main results of an econometric panel analysis of the determinants of output growth volatility.

The review of a set of GDP data suggests a number of broad stylised facts on the Great Moderation in the euro area. First, the fall in the volatility of growth has been pervasive in the sense that it cannot be traced back to specific sectors of the economy. It is visible for most GDP components and in most industries. Although there is some evidence that a drop in the correlation between demand components or industries has contributed to raise GDP stability, this effect appears small. Second, the rise in output stability is geographically broad-based, having taken place in all Member States and, more generally, in most OECD countries. Third, it seems to be, at least partly, rooted in changes in economic structures. For instance, the shift of production towards services, a reduced correlation between employment and productivity and better inventory management all seem to have played a role although estimates of the contributions of these changes appear low except in the case of inventories. Finally and critically, the magnitude and the timing of the fall in volatility have varied substantially across Member States and, more generally, across OECD countries, casting doubts on a simple explanation of the Great Moderation based exclusively on reduced common shocks.

There are basically two policy areas which have undergone deep changes over the past two or three decades and therefore make natural candidates for explaining the Great Moderation: improvements in the macroeconomic framework and the liberalisation of product, labour and financial markets. Our econometric panel analysis finds a substantial role for the former but only weak evidence in support of the latter.

As to macroeconomic policies, the panel analysis points to a significant correlation between output volatility and an indicator measuring changes in the conduct of monetary policy. The volatility-dampening effect of monetary policy appears to have been particularly large in some euro-area Member States – those where monetary policy mismanagement was particularly acute in the 1970s – and some other OECD countries but not in the US. The regressions also find a stabilising role for the participation in the ERM/euro (on top of any ERM/euro effect indirectly captured by the monetary policy variable), but only for some GDP components and not for GDP as a whole. Fiscal policy is found to have a positive impact on output stability via the size of government and automatic stabilisers but changes in discretionary policy are not found to be a meaningful explanatory variable. The relation between government size and output stability presents strongly non-linear features in the sense that size is positively associated with stability up to a certain level of government spending in GDP and becomes negatively correlated with GDP beyond that level.

Regarding structural policies, the regressions suggest a positive and sizeable impact of financial deepening on volatility via its impact on investment and a sizeable and negative impact of product market deregulation. These two effects, however, appear less robust from a statistical standpoint than the effects of the macroeconomic policy variables.

Finally, the regressions lend only limited support to the idea that changes in economic structures have contributed to dampen output fluctuations. The estimated effects of the variables measuring changes in economic structures (including the share of services in GDP, trade openness and oil exposure) are generally either small or not significant. An exception is the decline in oil exposure which seems to have helped significantly to stabilise consumption growth although not GDP growth.

Overall, the estimation work does a reasonably good job at substantiating the contribution of macroeconomic policies to the Great Moderation and provides evidence that changes in macroeconomic policies have played a bigger role in the euro area (with Germany emerging as a major exception) than in the US. These results are therefore in line with available research on the US which has tended to report only a small effect of monetary policy to the Great Moderation in that country. The case for the contribution of structural changes and market liberalisation appears somewhat less convincing either because the estimated impacts are small or because they do not appear to be very robust statistically. Altogether, the regressors tested in the model (i.e. changes in economic policies and structures) accounts for about 50% of the reduction in output growth volatility in the OECD over the past three decades, most of this being attributable to changes in macroeconomic policies. In theory, this means that reductions in common shocks (as opposed to changes in policies and structure) could account for as much as 50% of the Great Moderation. In practice, however, the contribution of shocks in the model is probably overestimated as some structural explanatory variables are improperly measured. Hence, this paper lends support to the idea that the Great Moderation is not just the result of a long period of luck in the form of milder shocks but is also partly rooted in changes in economic policies and structures and could therefore be a rather persistent feature of the euro-area economic landscape.

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Annex 1: ESTIMATED CONTRIBUTIONS OF THE EXPLANATORY VARIABLES TO THE CHANGES IN GDP GROWTH VOLATILITY BETWEEN 1973-77 AND 2003-07

(based on the estimated equation in Column (2) of Table 4 p 19 – equation without fixed country effects)

Changes in volatility between 1973-77 and 2003-07 due to changes in:

	Monetary policy	Government expenditure	Share of services in total value added	World trade volatility x trade intensity	Total explanatory variables (excl. fixed time effects)	Fixed time effects	Not explained	Actual change in GDP volatility
BE	-0.33	-0.02	-0.07	-0.07	-0.49	-1.32	-0.58	-2.39
DK	-0.28	-0.07	-0.06	-0.07	-0.48	-1.32	0.12	-1.69
DE	-0.03	-0.01	-0.35	-0.05	-0.43	-1.32	0.61	-1.14
EL	-1.03	-1.12	-0.49	-0.02	-2.66	-1.32	-1.70	-5.67
ES	-1.54	-1.13	-0.01	-0.02	-2.70	-1.32	1.77	-2.25
FR	-0.22	-0.14	-0.18	-0.02	-0.56	-1.32	0.35	-1.53
IT	-0.79	-0.42	-0.11	-0.02	-1.34	-1.32	-0.62	-3.28
NL	-0.29	0.03	-0.24	-0.07	-0.58	-1.32	0.34	-1.56
AT	-0.18	-0.04	-0.08	-0.07	-0.37	-1.32	0.04	-1.65
PT	-2.14	-1.16	-0.19	-0.05	-3.55	-1.32	0.10	-4.77
FI	-0.72	-0.37	0.08	-0.05	-1.06	-1.32	0.92	-1.45
SE	-0.24	0.02	0.03	0.03	-0.16	-1.32	0.07	-1.41
UK	-1.24	0.06	-0.28	-0.05	-1.51	-1.32	0.11	-2.71
US	-0.10	-0.13	-0.07	-0.02	-0.32	-1.32	-0.66	-2.30
JP (1)	-0.01	-0.32	-0.15	-0.02	-0.50	-0.51	0.55	-0.47
CA	-0.37	0.01	-0.12	-0.05	-0.53	-1.32	0.65	-1.20
CH (2)	-0.02	-0.23	-0.05	-0.01	-0.32	-0.83	0.13	-1.02
AU	-0.65	-0.02	-0.21	-0.02	-0.90	-1.32	0.93	-1.29
NZ (2)	-0.50	0.19	-0.07	-0.01	-0.39	-0.83	0.52	-0.70
				Averages (3)				
Euro area	-0.73	-0.44	-0.16	-0.05	-1.37	-1.32	0.12	-2.57
Other OECD	-0.34	-0.05	-0.10	-0.02	-0.51	-1.01	0.24	-1.28
Other OECD excl JP, CH, NZ	-0.48	-0.02	-0.12	-0.03	-0.65	-1.32	0.20	-1.77

(1) Difference between 1983-87 and 2003-07
(2) Difference between 1988-92 and 2003-07
(3) Simple arithmetic averages

Annex 2: ESTIMATED CONTRIBUTIONS OF EXPLANATORY VARIABLES TO THE CHANGES IN GDP GROWTH VOLATILITY BETWEEN 1973-77 AND 2003-07

(based on the estimated equation in Column (3) of Table 4 p 19 – equation with fixed country effects)

Changes in volatility between 1973-77 and 2003-07 due to changes in:

	Monetary policy		Gov. expenditure		Share of services in total value added			Product market regulations	Not explained
	Total explanatory variables (excl. fixed time effects)					Fixed time effect			
	Actual change in GDP volatility								
BE	-0.31	0.01	-0.13	1.14	0.70	-2.35	-0.74	-2.39	
DK	-0.27	0.03	-0.11	1.33	0.98	-2.35	-0.31	-1.69	
DE	-0.03	0.00	-0.64	1.20	0.53	-2.35	0.68	-1.14	
EL	-0.98	-0.67	-0.89	0.52	-2.02	-2.35	-1.30	-5.67	
ES	-1.47	-0.70	-0.02	1.03	-1.16	-2.35	1.27	-2.25	
FR	-0.21	0.00	-0.32	1.01	0.47	-2.35	0.35	-1.53	
IT	-0.75	-0.20	-0.20	1.11	-0.04	-2.35	-0.89	-3.28	
NL	-0.28	0.00	-0.44	1.35	0.63	-2.35	0.17	-1.56	
AT	-0.18	0.01	-0.14	0.96	0.64	-2.35	0.05	-1.65	
PT	-2.04	-0.68	-0.36	1.14	-1.94	-2.35	-0.48	-4.77	
FI	-0.69	-0.16	0.15	1.06	0.36	-2.35	0.54	-1.45	
SE	-0.23	0.03	0.05	0.91	0.76	-2.35	0.18	-1.41	
UK	-1.19	0.02	-0.51	1.26	-0.42	-2.35	0.06	-2.71	
US	-0.09	-0.08	-0.13	0.67	0.37	-2.35	-0.32	-2.30	
JP (1)	-0.01	-0.18	-0.28	0.92	0.45	-1.43	0.52	-0.47	
CA	-0.35	0.00	-0.21	0.83	0.27	-2.35	0.89	-1.20	
CH (2)	-0.02	-0.14	-0.10	0.47	0.21	-1.55	0.32	-1.02	
AU	-0.62	-0.01	-0.39	0.86	-0.16	-2.35	1.23	-1.29	
NZ (2)	-0.48	0.05	-0.13	0.53	-0.02	-1.55	0.88	-0.70	
Averages (3)									
Euro area	-0.69	-0.24	-0.30	1.05	-0.18	-2.35	-0.03	-2.57	
Other OECD	-0.33	-0.03	-0.18	0.78	0.24	-1.86	0.34	-1.28	
Other OECD excl JP, CH, NZ			-0.46	0.00	-0.22	0.98	0.30	-2.35	
	0.29	-1.77							

(1) Difference between 1983-87 and 2003-07
(2) Difference between 1988-927 and 2003-07
(3) Simple arithmetic averages