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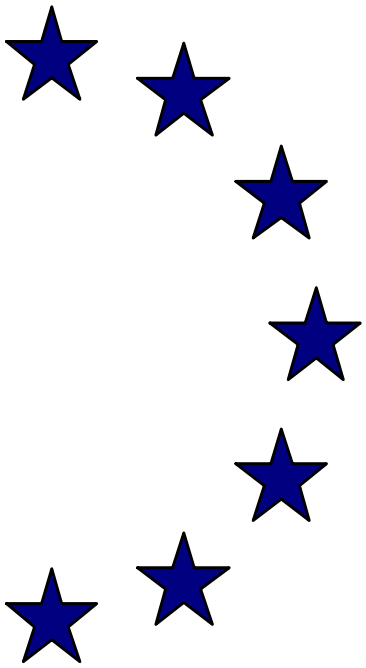

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The macroeconomic effects of a pandemic in Europe - A model-based assessment

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The macroeconomic effects of a pandemic in Europe. A model-based assessment

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Abstract: This report estimates possible macroeconomic effects of a pandemic taking place in the EU in 2006, using a quarterly macroeconomic model. The macroeconomic costs of a pandemic, that is the cost in terms of production lost due to illness and death measured as reductions in GDP growth and/or declines in the level of GDP, are quantified in various pandemic scenarios. We focus on two sectors of the European economy that are expected to be particularly severely hit, tourism and trade. The results are compared with those obtained in similar studies. Our basic conclusion is that, although a pandemic would take a huge toll in human suffering, it would most likely not be a severe threat to the European macroeconomy.

Key words: Pandemics, avian flu, Spanish influenza, Europe, EU.

JEL classification: C5, E13 and I12.

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1. Introduction[1]

The spread of avian flu has led to fears of a worldwide pandemic. This fear is based on the view that the H5N1 bird flu virus may mutate into a disease that will easily and rapidly spread from human to human and that no effective vaccine will exist to counter such an outbreak. In response to this possible health catastrophe, several reports on the economic consequences of a major epidemic have been produced recently. So far there has been no study of the potential consequences of a pandemic on the economies of the EU Member States.

The purpose of this report is to fill this gap by estimating the likely macroeconomic effects of a pandemic using a quarterly macro-model constructed and calibrated for the EU-25 as one single economic entity. The use of such a macro-model has several advantages.

First of all, it covers a number of substitution and interaction effects that previous quantitative work on pandemics has tended to either ignore or be unable to quantify. Models based on simple "mechanical" assumptions may disregard the major feature of a modern economy, namely its flexibility and adaptability when exposed to shocks. A pandemic is a truly negative exogenous shock propagating its effects through the economic system and should be modelled as such.

Second, by adopting a quarterly macro-model, we are able to quantify the economic effects of a health catastrophe in both the short run and the long run as well as in the transition path between these two stages. Studies based on annual models are less suited as pandemics usually occur over a period of a few months, making a quarter a suitable observation period.

Third, a large macro-model facilitates the study of various assumptions concerning the severity of a pandemic. Finally, using a macro-model for the whole of the EU makes it easier for us to compare our results with those derived for the United States.

At this stage, we would like to make two qualifications. First, our aim is to quantify the *macroeconomic* costs of an exogenous shock of a pandemic, that is the cost in terms of production lost due to illness and death measured as reductions in GDP growth and/or declines in the level of GDP. We are not estimating the economic costs which occur in terms of loss of health and of life, neither are we able to describe the human suffering and tragedies associated with a pandemic.

Second, before presenting our estimates, we want to stress the great uncertainties involved in all steps necessary in arriving at the results in our scenarios. The uncertainty is particularly

[1] We have benefited from constructive comments by Bob Arnold, Tommy Bengtsson, Helen Chan, Steven James, Magnus Johannesson, Bengt Jönsson, Roman Kräussel and Svenn-Erik Mamelund. We would like to thank Sophie Bland for linguistic guidance.

great as the world has not experienced a major pandemic in recent times. We do not know if, when and where it will happen and how it will evolve. There have been considerable advances in medical technology since the last major worldwide pandemic, the Spanish influenza in 1918-19, making it extremely difficult to forecast and estimate the impact of a future pandemic.

This report is organized as follows. First, we briefly consider some studies on the economic effects of large epidemics, focusing on the assumptions concerning the characteristics of a future pandemic, as these assumptions are extremely crucial for the results obtained. Second, we perform a number of simulations using a macro-model developed within DG ECFIN, the QUEST model, to study various pandemic scenarios; first a baseline scenario, then the same scenario modified by the introduction of new assumptions. Here, we compare our results with those obtained for the United States. Third, we examine the impact on tourism and trade, two sectors of the European economy that are assumed to be severely hit.

2. Background

Fear of a massive outbreak of the avian flu, reaching pandemic proportions, has led to an interest in other pandemics in history, particularly the two major catastrophes of the bubonic plague or Black Death in the mid-14th century and the Spanish influenza in 1918-19. However, there have also been many pandemics of lesser magnitude. Potter (2001) identifies about 10 pandemics in the past 300 years, arguing that there is a recurrent although not regular periodic pattern, so that we should not rule out the possibility of new medical disasters of this type in the future. According to Kilbourne (2005), the world was hit by three pandemics in the 20th century: the Spanish influenza in 1918, the Asian influenza in 1957 and the Hong Kong influenza in 1968. Of these the Spanish flu was by far the most severe, killing between 30 and 60 million.

Studies of the macroeconomic impact in the past of pandemics and of other major diseases such as SARS and HIV/AIDS have attempted to quantify the consequences in terms of lost output and growth. However, there is little consensus. The results depend crucially on the models used and on the availability of data. Although the literature on the Black Death is substantial, researchers have not reached firm conclusions concerning its long-run effects, according to Bell and Lewis (2004, p. 159).

A study by Brainerd and Siegler (2003), one of the few on the economic effects of the Spanish influenza, suggests that the 1918-19 pandemic in the US actually increased economic growth in the 1920s.[2] Similarly, using a theoretical economic model, Young (2004) argues that the AIDS epidemic in South Africa will increase net future per capita consumption – while Bell and Gersbach (2004) find strong negative effects. Still, studies of the past give us valuable information about the proper assumptions to make when "guesstimating" the macroeconomic impact of future pandemics.

[2] In contrast, Almond and Mazumder (2005) argue that the Spanish influenza had very long-term negative effects, even as late as 65-80 years after the pandemic, through its impact on fetal health.

As mentioned above, the outbreak of avian flu has led to a flow of reports on the possible economic consequences of a future worldwide health disaster.[3] Admittedly these reports are very variable in quality, some being rather speculative, lacking a solid analytical base, presenting lists of possible effects, and calculating the costs solely in pecuniary terms. However, a few reports assess the potential macroeconomic effects of a new pandemic using economic models, like the study by the US Congressional Budget Office from December 2005 "A Potential Influenza Pandemic: Possible Macroeconomic Effects and Policy Issues".[4] Similarly, James and Sargent (2006) at the Economic Analysis and Forecasting Division of the Canadian Department of Finance have calculated the economic impact of a pandemic for Canada. McKibbin and Sidorenko (2006) estimate the global economic consequences of a pandemic using a 20-country model of Asia. These are excellent up-to-date summaries and useful as benchmark cases for this study of Europe.

Any estimate of the effects of a pandemic must, as is the case in the above-mentioned reports, combine two sets of assumptions or "models". The first set concerns the spread and impact of the pandemic from a medical/health perspective, while the second considers the choice of economic model and techniques to adopt to estimate the economic effects, once the medical assumptions are given. Of course, the final result depends on the initial choice of both the medical and the economic "model".

Three medical variables related to the pandemic are crucial for the estimation of its economic effects: the *morbidity rate* (the percentage of the population infected), the *number of work weeks lost*, and the *mortality rate* (the percentage of those infected that die). Data on these key numbers can be taken from studies of past pandemics.

A major impression of the reports on the future effects of a pandemic on the economy is the uncertainty surrounding any attempt to quantify its impact *ex ante*. So many uncertainties are involved that some observers argue that publishing scenarios dealing with the impact of a future pandemic on the scale of the 1918-1919 Spanish influenza – which may not happen – entails a serious risk of creating undue alarm, which may ultimately prove to be counterproductive.

The optimists suggest that progress in medical science since the Spanish influenza will prevent any future pandemic having major repercussions, that today's health systems are well prepared to respond quickly and efficiently, that progress in vaccine technology means that we can rapidly develop new vaccines, etc.[5] Thus we should not expect any disasters, nor create pessimistic scenarios that will engender unnecessary fear and thus costs to society.

More cautious commentators argue that the risks are real and that we should plan accordingly. The pattern of pandemics in the past suggests that we can expect more in the future although

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[3] See Bell and Lewis (2004) for a short survey of the economic consequences of pandemics.

[4] At the request of the US Senate, the CBO turned to both medical and economic expertise to assess the macroeconomic effects on the US economy. The perspective is a domestic one. The worldwide consequences are not considered, nor are the trade effects on the US economy. The report is also careful not to make any policy recommendations – concerning either public health or macroeconomic policies.

[5] The role of governments and markets in the production of vaccine in the event of a future avian flu pandemic has been much debated recently. See Forslid (2005) for one policy proposal.

there is no strict pandemic periodicity.[6] In our view, history shows that the risks are real. Hence, we believe there is a need for policy-makers to have estimates of the possible – although not likely or certain – economic effects of a future pandemic in Europe.

3. The macroeconomic effects of a pandemic in Europe

In this section we use the quarterly QUEST model developed within DG ECFIN. This is a standard New Keynesian macro-model of the world economy as described by Roeger and in 't Veld (2004). Production is modelled with a neoclassical production function using capital and labour as input. The life-cycle hypothesis is used to model consumption. A fraction of households are liquidity-constrained. Firms operate under monopolistic competition in the goods market and form their price, labour demand and investment decisions by maximising the present value of their cash flow, taking into account technological constraints and demand conditions for their respective products. Firms also face adjustment costs for prices, employment and capital. Wages are determined on an imperfectly competitive labour market. Nominal rigidities prevent a rapid response of nominal wages and prices to economic shocks. The regions of the world are linked through trade and international financial flows.

We first derive a set of baseline projections using the QUEST model. Next we extend the simulations in a number of steps.

3.1 The baseline simulation

For our baseline scenario, we adopt the medical assumptions used in the study by the US Congressional Budget Office (2005) concerning a future pandemic and feed them into our model for the European economy.

We do this for two reasons. First, the key assumptions concerning the morbidity rate, the mortality rate, etc. for a future pandemic in the US are derived from past pandemics and appear as well-founded, even if they are still guesses. Second, the estimates pertaining to the US economy in the CBO projections should serve as a useful comparison with the results of our study concerning the European economy as there are a number of similarities between the US and EU economies.

The CBO report presents two scenarios – a severe and a mild one. In the severe scenario, 90 million Americans are infected – corresponding to a morbidity or gross attack rate of 30 per cent – and of these about 2 million are assumed to die – corresponding to a mortality rate (case fatality rate) of 2.5 per cent. In the mild scenario, the attack rate is set at 25 per cent and the fatality rate 1.14 per cent. A number of additional assumptions are made concerning weeks off work across various sectors, etc. These numbers are derived from studies of past pandemics.

[6] See for example Dowdle (2006), who concludes that there is no predictable pattern of occurrence of pandemics.

To calculate the economic effects on the EU of a future pandemic, we adopt the severe scenario from the CBO report. Thus, we assume a pandemic in Europe to have a morbidity rate of 30 per cent and a mortality rate of 2.5 per cent. We also assume that the number of weeks off work due to the pandemic is on average 3 weeks. This holds for both those who are infected and those who choose to stay at home to care for the sick. Sickness and mortality rates are assumed to be uniformly distributed over age cohorts.

Applying these figures on sickness and mortality rates to the EU-25 suggests that about 150 million Europeans will become sick for three weeks and 2.5 per cent of those, in other words 0.75 per cent of the total population, will die.

These assumptions concerning overall population mortality are on the high side compared to the evidence from the Spanish influenza of 1918-1910, for which Patterson and Pyle (1991, table 1) estimate an average mortality rate in Europe of about 0.5 per cent. They suggest roughly the same number for Canada and the United States. Johnson and Mueller (2002) arrive at almost identical mortality rates for Europe and North America.[7] Thus, our baseline projection presented below founded on a total population mortality rate of 7.5 deaths per thousand represents a more pessimistic flu scenario than the Spanish influenza, which was the worst pandemic anywhere in the world during the 20th century.

Our assumption of an average of three weeks off due to the pandemic is also higher than the pattern from the past. Kilbourne (2006) notes that during the Spanish influenza those infected typically were only ill with a fever for 3-5 days, so that the total period of disease was shorter.

From past evidence we know that pandemics do not extend over long periods of time. Most of the effect is confined to a period of about three to four months. Thus, we assume that the pandemic will only last for one quarter. In this scenario the pandemic has an identical health impact on the rest of the world outside Europe. Concerning the timing of the pandemic we allow it to start in the first quarter of 2006. This is done only for technical reasons since it makes it easier to demonstrate the annual impact and compare it with studies based on annual models.

Supply and demand effects: When calculating the economic effects, we distinguish between supply and demand effects. The supply effects arise from a loss in hours worked, while the demand effects or psychological effects result mainly from precautionary measures taken by the population to avoid infection. It is likely that certain activities, like travelling and meeting and socializing with other people in restaurants, bars, cinemas, etc. will be substantially reduced. This is clearly illustrated by the experience from the SARS epidemic in Hong Kong in the second quarter of 2003, when tourism fell by 90 per cent in two months.

In our baseline QUEST simulations, sickness is captured via a temporary decline in the efficiency of the persons employed. In addition, we assume a permanent negative shock to the population level of 0.75 per cent. This is the fundamental supply shock associated with the pandemic.

It is instructive to isolate the supply from the demand effects. Therefore we simulate in a first step the effect of the pandemic under the assumption that there are no demand effects and consider supply and demand effects jointly in a second step. We arrive at a total supply effect

[7] The incidence of the Spanish flu also varied considerably across countries and within countries. See for example Mamelund (2003) on the experience of Norway.

for 2006 of -1.1 per cent as a fall in the GDP level from the baseline projection as reported in column (i) in Table 1.

Demand effects are important as well. The pandemic is likely to affect specific sectors related to tourism and entertainment (bars, restaurants, etc.) In 2004, the value added in these sectors accounted for 4.4 per cent of GDP in the EU-25, comparable to the CBO estimate for the US. Using the assumption that demand would decline by 80 per cent (in line with the CBO's estimate), this amounts to a demand shock of 3.5 per cent of GDP in one quarter.[8] The demand effect amounts to -0.5 per cent of GDP in 2006 – see column (ii) in Table 1.

Under the assumption that the epidemic breaks out in the first quarter of 2006, and combining the supply and demand effect, we arrive at a drop in EU GDP growth in 2006 of 1.6 percentage points according to our calculations. See column (iii) in Table 1. Instead of growing at 2.1 per cent in 2006, as projected in DG ECFIN's autumn 2005 forecast, the EU-25 economy would grow by only 0.5 per cent.

In absolute terms, the output loss in 2006 would amount to about 180 billion euros. However, for 2007 a recovery is projected and GDP growth would be one percentage point higher than the baseline projection. Eventually, the GDP of EU-25 would approach a level which is 0.75 per cent below the baseline because of the permanent decline of the population and thus of the labour force in Europe. Obviously, this is an average EU effect. However, it is likely that the Mediterranean countries would be more heavily affected because of their larger tourist industry.

About two thirds of the total effect is supply-induced while one third is demand-induced. There are two reasons why the annual demand effect is smaller than the direct or immediate impact effect. First, we assume a monetary policy reaction. According to the Taylor rule, built into the QUEST model, the ECB would lower interest rates in 2006 (by close to 100 basis points) to offset the fall in economic activity. This reduces the negative effect on consumption spending and slightly raises investment.[9] Second, the negative consumption shock in the first quarter is in fact a positive shock on savings. These additional savings are partly spent in the quarters following the pandemic. Both effects also explain why the demand effects in the years following the pandemic will be slightly positive.

When interpreting these numbers, it must be kept in mind that they are also based on the assumption that automatic stabilisers in the form of health insurance and government transfers are in place, covering medical costs and providing income support, thus dampening the economic impact of the pandemic.[10]

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[8] The effect on tourism by a pandemic is likely to depend strongly on the date at which the pandemic occurs. Since most tourist activities occur in the summer months, the GDP effect of a pandemic would be larger if it occurred in the third quarter. There is also a wide variation across EU countries: Mediterranean countries would be hit relatively hard during a pandemic, since the tourist sector in, for example, Greece and Spain accounts for 8 to 9 per cent of GDP.

[9] Investment actually slightly declines in the first year because the supply effect on investment predominates over the demand effect.

[10] It is assumed that government expenditure stays constant.

The recovery: How fast and strong will the recovery be after the pandemic? Figure 1 provides the quarterly growth profile of GDP in the EU, that is the deviation of growth rates under alternative assumptions from the baseline growth rate. Figure 1 demonstrates that in terms of growth rates, there will be a rapid recovery in the quarter following the pandemic.

The pandemic itself is assumed to last for only about one quarter. On the supply side, people resume work and consumers return to their previous consumption habits quickly. This adjustment pattern is known from previous pandemics. See Figure 2 showing GDP growth in Hong Kong around the SARS epidemic in the second quarter of 2003. In the case of SARS, GDP rose rapidly in the third quarter of 2003 after declining in the second quarter. This rapid increase in growth was primarily due to tourists and visitors from mainland China returning and Hong Kong citizens not immediately resuming foreign travel.

A similar pattern emerges from the Spanish influenza. The Canadian study by James and Sargent (2006) shows monthly real US retail sales figures for the years 1918 and 1919 from the NBER Macro History Database. The pandemic, which started in September 1918 and lasted until December 1918, led to negative retail sales growth of about -2 per cent in November and -6 per cent in December. However, after the pandemic in January 1919, retail sales growth jumped to 8 per cent. Reallocation of consumption from one quarter to another is also known from other disasters. For example, the 9/11 terrorist attack also led to a substantial reallocation of consumption from the third to the fourth quarter in 2001.

3.2. Alternative scenarios

We must be aware that more pessimistic scenarios are possible, even if we stick to the morbidity and mortality assumptions adopted above for our severe scenario. There exist downside risks on both the supply and the demand side. On the supply side, the fear of being infected may prevent healthy people from going to work. Also, important trade linkages could break down, interrupting the flow of intermediate inputs in production. On the demand side, the psychological effects could also be larger than in the scenario above, and sometimes there is a worry that stock markets and other financial markets will be negatively affected. We comment below on these qualifications.

Rate of absenteeism: Our simulations assume that those who are not infected actually go to work. There is of course the risk that healthy people may stay at home as well because they are afraid of infection. In this case the disruption of production could be more severe. However, the extent to which this would happen is a matter of speculation. The evidence from previous pandemics does not show a large decline in labour input. James and Sargent (2006), looking at the 1918, 1957 and 1968 pandemics, do not find significant increases in the rate of absenteeism.

Trade effects during a pandemic: The baseline simulation assumes no bottleneck effects from trade. Such bottleneck effects could arise in cases where the EU is heavily dependent on specific intermediate inputs from certain regions in the world. Appendix A lists the 50 products (using a 3-digit classification) on which the EU is most dependent on one (out of 8) regions in the rest of the world.

Only for energy does the EU seem to have a genuine strategic dependence on specific intermediates. Obviously, for oil, the EU is strongly dependent on the Middle East (from where about 95 per cent of all extra-EU oil imports originate). There is also some dependence on the US for products such as engines and parts, aircraft and pharmaceutical products. But

these are products with a high intra-EU trade share as well. It is likely that they could be substituted by domestic production in the EU. The EU does not depend strongly on South-East Asia or China for intermediate products. To sum up, the data in Appendix A on intermediate goods trade suggests that a pandemic is not likely to cause major problems for the EU via production bottlenecks.

It can be argued that trade effects should play a larger role today than during previous epidemics. There is certainly some truth to this view. However, the empirical evidence suggests that it is mostly tourism/personal travel that is affected, not trade in goods. It has also been argued that past pandemics may have caused larger disruptions because of the then prevailing on-site assembly-line mode of production, in contrast to the vertically integrated production that currently predominates, which can avail itself of a variety of supply sources.

Additional demand effects: Though we consider tourism and entertainment as sectors which are likely to be negatively affected, there are studies which also explore demand shortfalls for other sectors as well. Psychological effects are important; this was the case in the SARS epidemic. There was only a small supply-side effect, but consumption was strongly affected.

We therefore also study a scenario with a more severe psychological effect. The CBO, for example, fears strong negative effects for all types of transport, community, social and personal services, retail and wholesale and also a decline in demand for manufacturing products of around 10 per cent. Table 2 shows how these demand effects are distributed across sectors of the US economy according to the CBO estimates. Using the same assumptions and applying EU weights, we arrive at a negative demand effect of 11 per cent in the quarter in which the pandemic occurs.

Taking these more serious demand effects into account, the demand shortfall in the quarter in which the pandemic strikes would be about 11 per cent in the EU and the GDP loss in 2006 could be about 3.3 per cent (See column (iv) in Table 1.)

Stock market effects: The historical evidence suggests that the effects on stock markets of pandemics are insignificant. If they occurred, we do not know by how much or for how long stock prices would fall. In the case of a prolonged fall in share prices of 10 per cent, the QUEST model gives an additional negative output effect in the range of between -0.2 and -0.8 per cent, depending on the monetary policy response and how the stock market affects investment and consumption. However, since it is likely that the decline in stock prices would be only temporary, the effect would be much smaller and below -0.1 per cent in the first year.

Length of the pandemic: In our simulations it is assumed that the pandemic would be rather short-lived and would be over within one quarter. This was the case with the Spanish influenza. Of course, if it were to drag on for longer, then both the negative demand and supply effects would be larger. Under the assumption that 60 per cent of the population would fall sick over a period of two quarters (but keeping the mortality rate as before) and extending the demand effects over two quarters, we arrive at a first-year effect of -2.6 per cent.

Annual growth effect depends on the timing of the pandemic: Given the fact that the economic effects of a pandemic are rather short-lived, it is also interesting to see how the effects would be distributed over the two years depending on when the pandemic strikes during the year. Results are shown in Table 3, which demonstrates the dynamics of the pandemic. Essentially,

the later the pandemic occurs in the year, the smaller the effect in 2006 and the less of a recovery in 2007.

4. Comparisons with other studies

The QUEST simulation results are neither at the lower nor the upper end of the set of available estimates, as shown in Table 4 where we compare our estimates with those from other studies covering the United States, Canada and the world. The numbers in Table 4 are not fully comparable as they are based on different medical and economic assumptions. Still they give a fairly uniform picture.

We have adopted many assumptions from the CBO report in order to facilitate comparisons with the United States. In the severe scenario in the CBO report, the impact on the US economy would be "slightly larger" than during a typical recession in the post-World War II period – the level of GDP will decline by 5 per cent during the year of the pandemic. The 5 per cent is the sum of a 3 per cent supply-side effect and 2 per cent demand effect.

In the mild scenario, US economic growth will slow, but the level of GDP will not decline. In short, a mild influenza pandemic will not have a major macroeconomic impact. The focus of the CBO study is on the short-run effects. The reports simply states that "there is little evidence available to use" to analyse the long-run and the very long-run effects.

It is instructive to compare our results to the CBO study in more detail. In our view the following factors explain the differences:

1. Labour productivity assumption: The CBO does not use a macro-model to calculate the effects. Instead the output loss is simply calculated by taking average labour productivity and estimating the output loss by applying average labour productivity to the decline in employment. In other words, the CBO assumes an output elasticity of employment equal to one. In the QUEST model we use a production function for calculating output, using capital and labour. Here the (short-run) output elasticity of labour is around 0.6. This explains a large part of the difference in the supply effect.

2. Overtime and capacity utilisation. In the QUEST model, there is a temporary increase in the work effort (increase in hours worked) of the still-healthy employees during the pandemic. Consequently, instead of declining by 7.5 per cent in the second quarter of 2006, actual labour input (hours worked) only declines by about 6.6 per cent. Without an increase in labour effort, the supply-induced GDP decline in the first year could increase in absolute terms to -1.3 per cent.

3. Demand effects. The CBO study assumes an extra consumption demand effect of around 2/3 of the supply effect. This demand effect corresponds to our extreme scenario. However, because of the stabilisation brought about by monetary policy and an endogenous response of consumption and investment the total demand effect for the whole year is smaller than the initial shock.

The study for Canada by James and Sargent (2006) estimates that the hypothetical impact of a 1918-type pandemic (25 per cent sickness rate and 5 per cent mortality rate) would have a negative impact of -0.75 per cent in the year of the outbreak, assuming there is no panic among the population. The total impact of a hypothetical 1957-type influenza pandemic (with a sickness rate of less than 10 per cent) is estimated to be -0.3 per cent. These numbers are close to our estimates. See Table 4.

The German RWI institute estimates the costs of a pandemic to be between 1.1 and 3.3 per cent of GDP for Germany (see *Financial Times Deutschland* 17/1/06)). This range is close to our estimates for the EU economy.[11]

5. Summary

We have estimated the costs of a pandemic using a macro-model for the EU-25. We report GDP losses under various assumptions. In our baseline scenario we find for the first year of a pandemic, that is for 2006, a supply effect of - 1.1 per cent of GDP and a demand effect of - 0.5 per cent, totalling a fall in GDP of - 1.6 per cent. These effects diminish sharply for 2007 and 2008 but a long-run negative effect of - 0.6 per cent remains due to the reduction in the labour force caused by the pandemic. Additional effects can be added to this scenario. If we do so, we end up with an estimate of the GDP loss ranging between 2 and 4 per cent. Our results are in line with those of recent studies that explore the macroeconomic effects of a pandemic for other countries and regions.

Our estimate of the macroeconomic cost of a pandemic in Europe is high, as we have investigated a rather severe medical scenario with a mortality rate higher than that of the Spanish influenza in Europe in 1918-1920. Still, such a pandemic does not have to spell economic disaster for Europe. The macroeconomic effects of a future pandemic as estimated here are roughly of the same size as those of a major recession.

[11] The impact of the SARS epidemic in Hong Kong is estimated to amount to a decline in annual GDP growth of 1.8 per cent. Data supplied by Helen Chan, principal economist of Central Government Offices, Hong Kong.

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Table 1: The baseline scenario. QUEST-simulation results: Deviations of GDP levels from the baseline projection. Per cent

Year	Supply and Demand Effects			Supply and demand (with additional demand effects) (extreme case)
	Supply (i)	Demand (ii)	Total (iii)	Total (iv)
2006	-1.1	-0.5	-1.6	-3.3
2007	-0.6	+0.1	-0.5	-0.8
2008	-0.6	+0.1	-0.5	-0.5

Table 2: Assumed declines in demand by industry in the event of a pandemic in EU-25

Agriculture	-10
Forestry	-10
Fishing	-10
Mining and quarrying	-10
Manufacturing	-10
Electricity, gas and water supply	0
Construction	-10
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel	-10
Wholesale trade and commission trade, except of motor vehicles and motorcycles	-10
Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	-10
Hotels & catering	-80
Inland transport	-67
Water transport	-67
Air transport	-67
Supporting and auxiliary transport activities; activities of travel agencies	-67
Communications	0
Financial intermediation, except insurance and pension funding	0
Insurance and pension funding, except compulsory social security	0
Activities auxiliary to financial intermediation	0
Real estate activities	-5
Renting of machinery and equipment	0
Computer and related activities	0
Research and development	0
Legal, technical and advertising	0
Other business activities	-5
Public administration and defence; compulsory social security	0
Education	0
Health and social work	15
Other community, social and personal services	-80
Private households with employed persons	0
Total	-11.3

Note: We apply the same assumptions as the CBO study for the decline of demand in individual sectors.

Source: EU KLEMS

Table 3: Annual growth effects and the start of a pandemic

(Deviation of growth rates relative to the baseline scenario)

	2006	2007
1st Quarter	-1.6	1.0
2nd Quarter	-1.4	0.9
3rd Quarter	-1.2	0.7
4th Quarter	-1.1	0.4

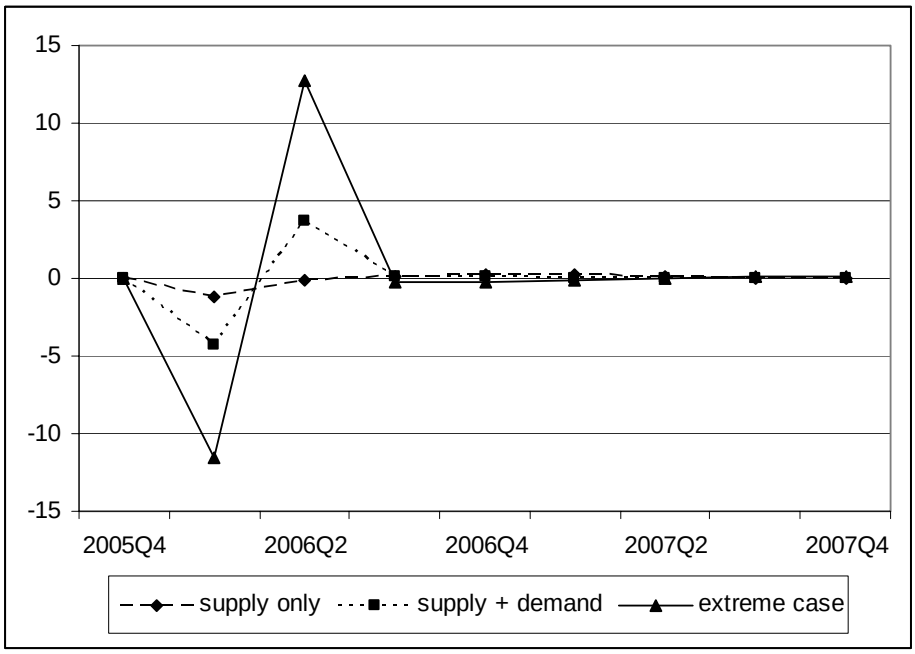
Comment: The second and third column give the annual average growth rates for 2006 and 2007.

Table 4: Estimated output losses due to a future pandemic. Some recent estimates. Per cent of GDP

Country/Region	*Author*	*Range of estimates (min. to max)*
EU-25	This report	1.6 – 4.1
USA	Congressional Budget Office (2005)	1.5 -5.0
Canada	James and Sargent (2006)	0.2 – 1.0
Germany	FT Deutschland 17/1, 2006	1.1 – 3.3
World	McKibbin and Sidorenko (2006)	0.8 – 12.6

Figure 1: Growth effects on EU-25 of a pandemic starting in the second quarter of 2006. Baseline scenario

Deviation from baseline growth in per cent



Deviation from baseline levels in per cent

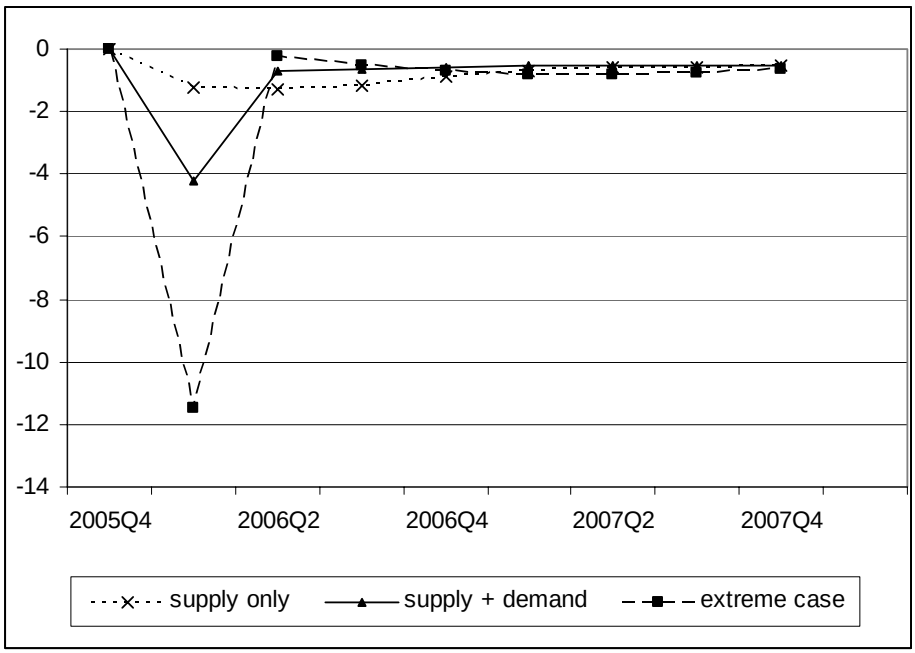
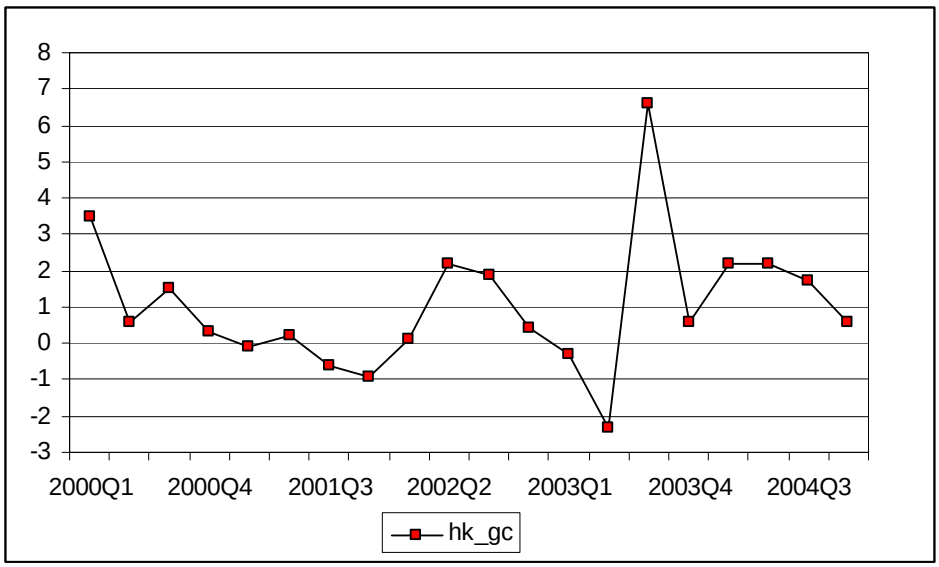


Figure 2: The impact of SARS in Hong Kong during the second quarter of 2003. Quarterly GDP growth per cent



Appendix A. EU25 imports from Extra-EU25 of the 50 SITC rev.3 -3 digit- products with the biggest shares for 1 partner/-zone, 2004

SITC rev.3 (total 260 codes)	Description	Share inTotal EU25 Imports from Extra-EU25	Americas (excl USA)	China	EU neighbours	India	Japan	South East Asia (excl China)	USA
	Total Imports	**100**	7.1	12.4	**31.5**	1.6	7.7	11.9	15.2
344	Petroleum Gases	0.04	0.0	0.0	**96.7**	0.0	0.0	0.0	1.0
023	Butter	0.02	1.7	0.0	0.8	0.0	0.0	**93.2**	0.1
272	Fertilizers Crude	0.04	2.7	0.1	**92.9**	0.1	0.0	0.1	0.3
043	Barley Unmilled	0.01	4.3	0.0	**92.8**	0.0	0.0	0.0	1.6
333	Petroleum Oils	10.93	2.3	0.0	**92.5**	0.0	0.0	0.0	0.0
342	Liquefied Propane And Butane	0.21	1.1	0.0	**90.8**	0.0	0.0	0.1	0.7
562	Fertilizers (Other Than Those Of Group 272)	0.19	2.7	0.2	**90.0**	0.0	0.0	0.0	1.1
345	Coal Gas Water Gas Producer Gas And Similar Gases	0.00	0.0	0.0	5.6	0.0	0.0	0.0	**89.8**
672	Ingots And Other Primary Forms Of Iron Or Steel	0.20	6.5	0.9	**89.0**	0.6	0.1	0.1	0.9
783	Road Motor Vehicles	0.04	1.0	0.2	**88.3**	0.0	0.3	0.1	3.7
244	Cork Natural Raw And Waste	0.00	0.1	10.6	**87.8**	0.0	0.1	0.0	1.4
011	Meat Of Bovine Animals	0.10	**87.0**	0.0	0.2	0.0	0.0	4.6	0.2
792	Aircraft	1.55	5.8	0.3	4.5	0.1	1.0	1.0	**83.4**
334	Petroleum Oils	2.15	4.5	0.0	**81.9**	1.6	0.0	1.3	3.9
261	Silk	0.01	4.1	**80.4**	12.0	2.7	0.5	0.1	0.1
422	Fixed Vegetable Fats And Oils Crude Refined Or Fractionated Other Than	0.21	3.2	0.3	0.7	4.4	0.1	**80.3**	1.0
231	Natural Rubber	0.14	0.1	0.0	0.2	0.7	0.0	**79.2**	0.2
282	Ferrous Waste And Scrap	0.23	5.4	0.1	**79.0**	0.2	0.0	0.6	9.0
579	Waste Parings And Scrap Of Plastics	0.00	2.6	1.2	**78.3**	0.1	1.5	1.0	7.0
073	Chocolate	0.03	5.4	0.6	**77.5**	0.0	0.2	0.7	4.4
812	Sanitary Plumbing And Heating Fixtures	0.08	1.3	10.6	**77.2**	0.2	0.6	3.7	1.8
676	Iron And Steel Bars Rods Angles Shapes And Sections	0.27	4.1	1.4	**77.1**	1.9	1.2	2.5	2.6
081	Feeding Stuff For Animals	0.58	**75.8**	0.5	8.0	0.2	0.1	4.4	9.3
351	Electric Current	0.22	0.0	0.0	**75.2**	0.0	0.0	0.0	0.0
283	Copper Ores And Concentrates	0.16	**75.0**	0.0	5.1	0.0	0.0	14.0	0.0
035	Fish Dried Salted Or In Brine; Smoked Fish	0.06	5.8	1.4	**74.9**	0.0	0.0	0.5	2.8
813	Lighting Fixtures And Fittings	0.27	0.3	**73.8**	7.7	2.2	0.7	6.1	4.8
016	Meat And Edible Meat Offal Salted In Brine	0.00	10.0	0.0	**72.8**	0.0	0.1	0.7	0.8
831	Travel Goods Handbags And Similar Containers	0.43	0.3	**72.6**	6.4	5.8	0.3	10.8	1.4
971	Gold Non-Monetary (Excluding Gold Ores And Concentrates)	0.34	4.6	0.1	**72.0**	0.1	0.1	1.8	0.5
421	Fixed Vegetable Fats And Oils	0.10	17.1	0.2	**71.3**	4.1	0.0	0.5	2.0
961	Coin (Other Than Gold Coin) Not Being Legal Tender	0.00	4.2	2.8	**71.2**	0.0	0.3	4.4	9.6
044	Maize (Not Including Sweet Corn) Unmilled	0.07	**69.9**	0.6	15.0	0.0	0.0	0.3	10.9
894	Baby Carriages Toys Games And Sporting Goods	1.11	1.3	**69.5**	4.7	0.5	3.8	7.7	7.1
597	Prepared Additives For Mineral Oils And The Like	0.05	3.5	0.2	16.7	0.3	4.6	1.0	**68.6**
791	Railway Vehicles	0.08	2.9	0.6	**68.2**	0.2	0.5	17.4	7.9
673	Flat-Rolled Products Of Iron Or Non-Alloy Steel Not Clad Plated Or Coated	0.34	8.7	5.7	**67.8**	7.4	0.5	3.5	0.3
714	Engines And Motors Non-Electric	1.32	7.2	2.0	7.6	0.4	3.0	3.2	**67.7**
684	Aluminium	0.87	9.7	0.7	**66.1**	0.2	0.4	1.0	3.4
017	Meat And Edible Meat Offal Prepared Or Preserved N.E.S.	0.07	**66.0**	0.0	4.3	0.0	0.0	26.3	0.2
059	Fruit Juices	0.13	**65.8**	2.8	15.2	0.2	0.0	6.1	6.2
686	Zinc	0.04	11.2	1.0	**65.6**	0.0	0.2	11.7	4.9
223	Oil Seeds And Oleaginous Fruits	0.02	**64.3**	10.1	8.0	0.8	0.1	2.7	2.9
325	Coke And Semi-Coke	0.18	1.4	**64.1**	17.3	0.0	1.8	7.9	1.6
024	Cheese And Curd	0.04	4.7	0.0	**63.1**	0.0	0.0	29.0	0.1
633	Cork Manufactures	0.01	4.0	10.6	**62.6**	0.3	0.2	9.0	4.9
222	Oil Seeds And Oleaginous Fruits.	0.45	**62.2**	3.6	6.3	1.8	0.0	1.3	23.4
274	Sulphur And Unroasted Iron Pyrites	0.00	6.4	1.0	**61.8**	0.3	0.2	11.3	0.2
883	Cinematograph Film Exposed And Developed	0.00	7.4	0.2	9.0	2.6	1.4	9.3	**61.7**
247	Wood In The Rough Or Roughly Squared	0.14	2.9	0.0	**61.6**	0.0	0.1	1.3	6.8

Source: Comtrade