Potential Output Growth in Several Industrialised Countries : a Comparison*

Christophe Cahn Arthur Saint-Guilhem

April 11, 2006

PRELIMINARY VERSION – COMMENTS ARE MORE THAN WELCOME

Abstract

In this paper, we present international comparisons of potential output growth among several economies – Canada, the euro area, France, Germany, Italy, Japan, the Netherlands, United Kingdom, and the United States– based on a set of various techniques. The main estimates rely on a structural approach where output of the whole economy is described by a Cobb-Douglas function. This framework allows distinguishing for temporal considerations depending on the assumed volatility of potential output. Moreover, this study presents two originalities, say, the construction of consistent and homogenous capital stock series, and long run estimates including capital deepening effects based on a stable capital/output ratio in value terms, whereas standard estimations assumed a stable ratio in volume. Lastly, we use univariate methods as a benchmark. Even if the final estimates are obviously sensitive to each method and the assumptions made for each of them, this paper might help to understand why some economies stood below its potential during the recent period by identifying the sources of the long run potential growth.

Keywords: potential growth, production function, total factor productivity, age of equipments.
JEL classification: C51, E32, O11, O47.

*Banque de France, DAMEP, 31 rue Croix des Petits Champs, 75049 Paris Cedex, France. The authors are very grateful to Anne-Christèle Chavy-Martin, Valérie Vogel, and Béatrice Rouvreau for research assistance. The authors thank G. Cette, O. Vigna, and J.-P. Villetelle for helpful comments and suggestions. They also are indebted to F. Lequiller and A. Sylvain for providing valuable data, as well as H. le Bihan for providing its routines, but the authors retain sole responsability for any remaining errors. The views expressed herein are those of the authors and do not necessarily reflect those of the Banque de France. Corresponding author: `christophe.cahn@banque-france.fr`.

1 Introduction

For a central banker, potential growth estimates are of major concern since it provides the monetary authority with assessments of the inflationary pressures on goods and labour markets at a global level. Indeed measurements of output gap, defined as the difference between actual and potential output, may be used for such an assessment. Besides, for monitoring purpose, quarterly measurements of output gap stand for a composite and simple indicator of the economy's position in the business cycle. Potential growth estimates may also be used for macroeconomic forecasts. For both uses, it is important that the cost of updating the data and estimates should be as low as possible. For all these reasons, several researches have been carried out in central banks on potential growth.[1] Recent developments in Europe have also raised a new field of interest for potential output growth measures, particularly those based on structural approaches. Indeed the need for structural reforms in Europe is all the more obvious that international comparisons of potential growth estimates suggest that actual economic performances in Europe stood below their potential during the last fifteen years. From this point of view, the breakdown of potential growth between labour and capital contributions is a simple but accurate way to identify which reforms are to implement.

In this paper we present estimates of potential growth for several economies, namely: Canada, the euro area, France, Germany, Italy, Japan, the Netherlands, United Kingdom, and the United States. This study presents two originalities, say, the construction of consistent and homogenous capital stock series, and long run estimates including capital deepening effects based on a stable capital/output ratio in value terms, whereas standard estimations assumed a stable ratio in volume. We use a host of harmonized methods to compute our potential growth estimates for the panel of countries. As a benchmark, we use two statistical univariate methods, namely a smoothing technique (Hodrick and Prescott, 1997) and a trend estimation including possible trend breaks. Actually, our main findings rely on a structural approach based on an explicit production function. Following Baghli, Cahn, and Villetelle (2006), we use the Solow's neoclassical model and the so-called production function approach. Nevertheless, we consider the productive capacity of the economy as a whole whereas in Baghli et al. (2006) only the business sector is modelled by a production function. This enabled us to collect the data more rapidly. This also enabled us to compute harmonized capital stock data for the whole panel of economies based on the permanent inventory technique with National Accounts real investment data as an input.

In such a model, economic growth is a function of standard factors of production (labour

[1] See, for instance, Banque de France (2002) and de Bandt, Hermann, and Parigi (2006).

and capital stock) and an unobserved technological change. More precisely, this approach consists in choosing a technical relationship supposed to represent the productive capacity of the economy, calibrating key parameters on basis of the relevant data, determining the level of potential output by means of this calibrated function and modelling the resulting Solow residual in order to explain its developments using econometric techniques. Among them, we systematically tested the existence of trend breaks in the technological change structural model, using an econometric package implemented by Le Bihan (2004) based on the works of Bai and Perron (1998, 2003). It is worthwile noting that our approach considers a number of variables as exogeneous, say labour, capital, prices, etc. To treat that, a possible method would consist in implementing a general equilibrium framework, for instance a dynamic stochastic general equilibrium (DSGE) model. Though it would be better on a theorical point of view, such an approach would be very cumbersome as regards the construction of the model and the estimates, so that we decided to rely on a more simple approach that makes it possible to easily use our estimates for monitoring and forecasting purposes. Moreover, we distinguish between two sources of medium and long term TFP growth, namely an exogenous technical progress —modelled as the deterministic trend,— and a capital embodied improvement —partly captured by the effect of capital ageing on TFP.

Furthermore, we distinguish two horizons —medium and long term,— each of one being associated with steady-state conditions. Basically, in the literature on potential growth, different approaches exist covering different temporal horizons —from short to long run,— depending on the assumed volatility of potential output. Indeed, the further the horizon is, the less the inputs of production are affected by short term fluctuations and shocks, whereas structural changes become more proeminent.[2] In structural approach, horizon determines the nature of the constraints faced by the economy. In the short run, one may consider inputs of production as given, the utilisation of productive capacity being for instance the only factor that explains output fluctuations around its potential. In the medium term, accumulable factors could adjust according to limited rigidities. If one considers labour input —the labour force for instance,— one could take into account a time varying participation rate. In the very long run, inputs are considered as totally flexible. The labour force will adjust to, for instance, demographic hypotheses, and potential growth becomes indeterminate.

In this paper, we first consider medium term developments where the contributors to potential growth are the standard inputs of the production function (capital stock and labour) and the factors used to explain total factor productivity. Second, we analyze the

[2]See Cette and Delessy (1997) for a comprehensive review about these matters.

long-run steady path where the economy grows in relation to the evolution of the labour force and the technological change and the ratio between gross domestic product prices and investment prices. These relative prices are incorporated in order to take into account, over the sample, the nominal rather than real stability of the capital intensity. For the whole panel of countries except the United States, we also compute an alternative measure of real investment data, using the US investment price as a deflator. Doing this, we compute two different measures of the technological change, one with National Accounts investment prices, and the other with US investment prices. Following Cette, Mairesse, and Kocoglu (2005), we aim at correcting the National Accounts investment prices of the quality bias on IT products, using the US chained-prices index as a benchmark. Besides, the distinction between medium and long term makes it possible to compute indicators of inflationary pressures in both the medium and long term. It will also make it possible, as far as the structural reforms diagnosis is concerned, to compare long and medium potential growth and to assess whether the actual economic performance was far below the long term potential or not.

The main results of our research is that there is a clear distinction between European countries and Japan and the United States concerning the sources of growth explaining the actual economic achievements during the last fifteen years. First, our results suggest that differences in the growth of labour input, rather than capital input, have plaid a crucial role to explain the lagging growth in Europe (except the Netherlands) and Japan as compared to the United States. The Netherlands is a European exception, since it shows a very high labour contribution due to a strong increase in participation rate between 1991 and 2000, corresponding to the wage moderation policy which took place during this period. For Canada and the United States, more favourable demographic developments explain the main part of the higher labour contribution. As far as the US economy is concerned, our results suggest that there has been an acceleration of the total factor productivity growth in the mid 1990's. This specific feature explains the other side of the US higher economic achievements over the period. Jorgenson (2005) insists on the crucial role of IT investment in the resurgence of economic growth in the United States during the 1990's. Our paper suggests that this phenomenon is mainly reflected by the acceleration of the TFP growth, maybe related to a broader diffusion of knowledge in the whole economy.

All in all, these findings could shed light on the potential directions in Europe for structural reforms, on the labour market for instance, as well as for specific economic policies, particularly as regards immigration, natality or innovation. These conclusions pleed for keeping the pace and pursueing efforts in Europe to follow the Lisbon "strategy for growth and jobs."[3]

The remainder of this paper is organized as follows. In the next section we describe the technical specifications underlying our study. Data are briefly described in section 3. Section 4 presents results and estimates of potential growth, which are discussed and compared in Section 5. Section 6 concludes.

2 Theoretical framework

In this section we present the main features of our production function approach. We first set up the underlying specification and functional form of the technology and inputs of production. Then we derive the expression for medium and long term potential growth, according to the restrictions implied by the considered temporal horizon.

2.1 General overview

We consider that the economy wide production technology can be represented by a Cobb-Douglas-like production function with constant return to scale on labour and capital. Analytically, assume that the production function can be expressed as $Y_t = \sigma e^{\gamma t} \tilde{K}_t^{1-\alpha} (N_t H_t)^{\alpha}$, $0 < \alpha < 1$, where Y_t is the actual economy's output taken as the gross domestic product (GDP), $\tilde{K}_t$ is the stock of available productive capital, N_t is total employment, and H_t is the hours worked by person. Parameters α, γ, and σ represent respectively the wage share, the growth rate of a pure exogenous deterministic technical change, and a scale factor.

The stock of available productive capital derives primarily from the accumulation of investment flows. Moreover, we assume that, thanks to capital embodied technological progress, one unit of investment shows at each period a productivity gain amouting to $1 + \epsilon$, with $\epsilon > 0$. Lastly, the capacity utilisation rate CUR_t determines the availability of productive capital stock for the economy. As a result, available productive capital is tied up with measured capital stock K_t and age τ_t according to:[4]

$$\tilde{K}_t = CUR_t e^{\epsilon(t-\tau_t)} K_t. \tag{1}$$

Let note $g_t = \sigma + \gamma t + (1 - \alpha)(cur_t + \epsilon(t - \tau_t))$ the log of Total Factor Productivity (TFP).[5] The two-step approach we adopt consists in, first, setting the labour share at its average level over the sample to define the TFP as the Solow residual of the neoclassical model:[6]

$$g_t = y_t - (1 - \alpha)k_t - \alpha(n_t + h_t). \tag{2}$$

[3] See European Commission (2006) for instance.
[4] See Appendix A for further details.
[5] In the following, small case letters denote logarithms.
[6] See Section 3 for the calibrated values.

Second, the impacts of the determinants of TFP, around a time trend, are estimated using the following specification:

$$g_t = \gamma_0 + \gamma_1 g_{t-1} + \gamma_2 \triangle cur_t + \gamma_3 \triangle \tau_t + \gamma_4 t + \gamma_5 t_1 + \gamma_6 t_2 + \varepsilon_t, \tag{3}$$

where $\triangle cur_t$ is the gap between the capacity utilisation rate in logs and its long terme average, $\triangle \tau_t$ is the gap between the age of the capital stock of equipment goods in level and its long term average, ε_t is an error term.[7]

The deterministic trend t is considered assuming that the technical change is exogenous so that TFP grows at a constant rate. Both of the terms t_1 and t_2 ($t_i = \mathbb{I}(t > T_i)(t - T_i)$) are introduced in order to capture possible country-specific breaks in the rate of change at dates T_1 and/or T_2.[8] γ_2 measures the cyclical component of the TFP. We expect that TFP grows as the domestic production capacities are used more intensively than usual, so the parameter γ_2 should be positive. Moreover, an ageing stock of capital as compared to its average age, could impact negatively on the TFP such that the parameter γ_3 should be negative. Finally, an autoregressive term is introduced to capture inertia in TFP changes.

2.2 Medium Term Developments

Uncovering the TFP trend in the medium run requires two assumptions. First, we assume that the growth rate of the TFP, ρ, is constant. This rate is estimated by the average growth rate over the period. Second, the capacity utilisation rate is assumed to be at its average level so that $\triangle cur_t = 0$. From the first assumption, we can write medium run TFP (in logs) as $\tilde{g}_t = \tilde{g}_{t-1} + \rho$. So, after some calculations presented in Appendix A, we obtain the following equation which defines the medium term TFP:

$$\begin{aligned} \tilde{g}_t \quad = \quad & \tfrac{\gamma_0 - \rho + \gamma_4 + \gamma_5 (1 - T_1)\mathbb{I}(t > T_1 - 1) + \gamma_6 (1 - T_2)\mathbb{I}(t > T_2 - 1)}{1 - \gamma_1} \\ & + \tfrac{\gamma_3}{1 - \gamma_1} \triangle \tau_{t+1} + \left(\tfrac{\gamma_4 + \gamma_5 \mathbb{I}(t > T_1 - 1) + \gamma_6 \mathbb{I}(t > T_2 - 1)}{1 - \gamma_1} \right) t. \end{aligned} \tag{4}$$

In the medium run, the TFP evolves around a trend which can be divided into a measure of capital embodied technical progress which includes ageing effects, given by the RHS's second line of equation (4), and the exogenous deterministic component, represented by the last term of this equation. We assume that inflexions due to capital stock ageing or replacement sluggishly disappear at a slower pace than those caused by CUR variations. These inflexions impact on TFP and last over the medium term. However, the effect of capital ageing is assumed to vanish in the long run.[9]

[7]This specification differs from Baghli, Cahn, and Villetelle (2006) as regards age of capital stock, namely in level rather than in log, as we take into account the capital embodied technical change —see the definition of available productive capital stock in equation (1) and Appendix A.

[8]The indicator function $\mathbb{I}(\cdot)$ is defined as $\mathbb{I}(A) = 1$ if A is true and $\mathbb{I}(A) = 0$ otherwise.

[9]Drawing a parallel with the underlying structural parameters and functional specification, the following considerations apply. The coefficient related to embodied capital improvement would be $\epsilon \equiv$

After computing the medium term TFP, we have to estimate potential labour input. As we consider labour input in hours worked, we first smooth hours worked, h_t. The potential employment, N_t^*, in the economy is defined by:

$$N_t^* = \Omega_t^* r_t^* (1 - u_t^*), \tag{5}$$

where Ω_t^*, r_t^* and u_t^* represent respectively the filtered working age population, the filtered medium term participation rate and the non-accelerating inflation rate of unemployment (NAIRU).[10] As regards levels, in the medium term, potential GDP is given by:

$$Y_t^* = K_t^{1-\alpha} (N_t^* h_t^*)^{\alpha} e^{\tilde{g}_t}. \tag{6}$$

2.3 Long Run Developments

In the long run, we impose several additional assumptions. First, the age of the capital stock tends towards its average level, leading us to disregard the contribution of age to potential growth.[11] Then, we set the participation rate r_t^*, NAIRU u_t^* and the worked hours h_t^* to their average level. Finally, we assume that the output/capital ratio is stable in nominal terms over all the sample.[12] This last assumption drives us to consider the following equation:

$$\frac{P_t^Y Y_t^*}{P_t^I K_t} = \zeta, \tag{7}$$

where P_t^Y and P_t^I are respectively the GDP and investment deflators and ζ is a constant.

Furthermore, as the participation rate, the time-varying NAIRU and the worked hours are supposed to be constant in the long run, the annual growth rate of potential employment is given by variations in working age population. As a consequence, the potential GDP growth in the long run is given by:[13]

$$\triangle y_t^* = \triangle \omega_t^* + \frac{1}{\alpha} \left(\frac{\gamma_4 + \gamma_5 \mathbb{I}(t > T_1 - 1) + \gamma_6 \mathbb{I}(t > T_2 - 1)}{1 - \gamma_1} \right) + \frac{(1-\alpha)}{\alpha} \triangle \ln \left(\frac{P_t^Y}{P_t^I} \right), \tag{8}$$

$1/(1-\alpha).(-\gamma_3)/(1-\gamma_1)$, with $\gamma_3 < 0$. In the same way, the growth rate of the pure exogenous technical change is given by $\gamma \equiv (\gamma_4 + \gamma_5 \mathbb{I}(t > T_1 - 1) + \gamma_6 \mathbb{I}(t > T_2 - 1))/(1-\gamma_1) + \gamma_3/(1-\gamma_1)$. Nevertheless, since we take the age of material and equipment capital stock as proxy for τ_t , and since we use this variable to capture medium term cycle effect, identification problems concerning the breakdown of technical progress arise. Moreover, if no significant contribution of capital stock ageing is found through the estimation, as it is actually the case for UK and US economies, the same caveat applies. As a result, the distinction between the contribution of embodied capital improvement and the pure technical change is not clearly identified, as the deterministic trend in the TFP equation captures both terms.

[10] In order to derive smoothed components, the HP filter has been always used, with standard value for the smoothing parameter ($\lambda = 1600$, since we are dealing with quarterly data, except for the hours worked for which $\lambda = 20000$.) We choose a non-standard value for the smoothing parameter related to hours worked in order to eliminate any cyclical evolution of filtered data. As regards the NAIRU, we use as a proxy the series taken from the OECD (2005) database. These series are based on Kalman filter estimates of reduced-form Phillips curve equations, according to Richardson et al. (2000).

[11] We can show that on a balanced growth path, the age of the capital stock corresponds to the inverse of the depreciation rate plus the growth rate of the economy.

[12] See Jorgenson and Stiroh (1999), Cette, Mairesse, and Kocoglu (2005) for more details.

[13] Appendix A provides the details.

where $\omega_t^* = \ln \Omega_t^*$.

The growth rate of the economy is driven by the growth rate of the population $\triangle\omega_t^*$, the value of the trend of TFP and the drift in relative prices. It is worthwhile to mention that the TFP trend contributes differently to the potential growth depending on the time horizon: as we assumed that the economy evolves on its steady growth path in the long run, the contribution of TFP corresponds analytically to the trend divided by the share of labour, which is lower than one. As a result, the contribution of TFP appears higher in the long run than in the medium term.[14]

3 Data

This section provides a brief overview of the data used for this study; a detailed description is given in appendix B. Labour market series are mostly taken from OECD (2005), except for hours worked by employee which are taken from the University of Groningen (2005) database. Finally, shares of labour input are taken from the study of Lequiller and Sylvain (2006) as an approximation of the constant parameter α. Table 1 presents the calibrated values chosen in this paper.

Table 1: Calibrated value for the parameter α

Country	α
Canada	0.637
Euro area	0.645
France	0.654
Germany	0.649
Germany-WR	0.649
Italy	0.629
Japan	0.689
Netherlands	0.647
United Kingdom	0.655
United States	0.627

Source : Lequiller and Sylvain (2006), Whole economy excluding administrations, education, and health and social services; Self-employed compensations : average compensation of the related branch; FISIM taken as intermediate consumption.

Such an approximation is consistent with the assumption of a Cobb-Douglas like production function and constant returns to scale. To estimate potential growth, our starting point is mainly the datasets from the national accounts, as regards gross domestic product (GDP) and investment by product –"Machinery, Equipment, and Software" (MES) and "Structures including Housing" (SH)– for the whole economy. In order to get longer series

[14]We could have avoided the introduction of α in the expression of the long run GDP growth by considering the TFP as a Harrod-neutral technological change.

on investment, we first backcasted all the national accounts series back to 1960 using the OECD (2005) database. Second, we used the long historical series on investment at annual frequency constructed by Maddison (2003) for France, Germany, Japan, the Netherlands, United Kingdom, and the United States.[15] We paid particular attention to euro area and Germany data. As for the euro area, we chose to use the official data from Eurostat for the 1995–2004 period. We backcasted the series with OECD (2005) data back to 1963. As for investment series, we used an aggregate made up with France, Germany, Italy, and the Netherlands, in order to give the breakdown by products of investment. Concerning Germany, we compute two different capital stock series based on two different assumptions regarding investment; as the former we consider that Eastern and Western German investment grow at the same rate before 1991 —for the economy we call "Germany" in the remaining of this paper,— the latter assumption shows a discontinuity in 1991 since we make the assumption that Eastern German investment is unusable —forming the so-called "Germany-WR" for West Retropolated. These two limit cases might surround the true path of investment for Germany as a whole.

Furthermore, as mentionned in the introduction, we also compute an alternative measure of real investment data, using the US investment price as a deflator.[16] Doing this, we compute two different capital stock series, and therefore two different measures of the technological change, one with National Accounts investment prices, and the other with US investment prices, so-called "US prices correction" estimates in the remaining of the paper.

For the whole panel of economies, we compute consistent data for real capital stocks and age of capital according to a methodology developed by Villetelle (2004), based on the permanent inventory method (PIM). Our methodology, which is quite easy to implement, requires as only input data on gross fixed capital formation by product. Contrary to the PIM that requires long time series, our method is meant to compute capital stock series from relatively short investment series. This was adapted to our study since we didn't have at our disposal long investment series for the euro area, Canada and Italy.[17] We used the same depreciation rates as for France for the whole panel, namely, 2.4 % and 0.4 % per quarter for respectively MES and SH capital stock.

We particularly investigated our assessment of capital stock for the US economy. Indeed, we noticed that our data could be considered as underestimating capital stock growth on the 1995-2000 period for the US economy compared to other studies.[18] We discuss this matter in

[15]See Appendix B for further details.

[16]This assumption amounts to consider the following investment deflator for the country C: $\tilde{P}^I_C = P^I_{US} \frac{P^Y_C}{P^Y_{US}}$, where P^Y is the GDP deflator.

[17]See appendix A for further details on technical considerations.

[18]see Oliner and Sichel (2002) and Jorgenson and Vu (2005).

Appendix B and give a possible explanation for these differences in capital stock deepening magnitude on the 1995-2000 period. Different definitions of productive capital stock may explain this phenomenon. Indeed we consider the whole economy, including public sector and housing, as being the productive sector, contrary to usual statements that focus on business sector excluding housing. For comparison, we corrected our data of this sector effect and found out that our capital stock growth appears to be higher than the BEA's one, due to a composition effect on depreciation rates.

TFP is calculated according to equation (2) with the two types of capital stock —with or without US prices correction. It is worthwile to mention that the US prices correction tends to slightly revise downwards the level of TFP for each economy, given that this correction implies a higher level of productive capital stock. This effect amounts between −1.3 % —as for Italy— to −5.7 % —as for Japan—, except for Germany and Germany-WR for which the US prices correction implies a positive impact on the level of TFP of about +11 %. As for Germany, the US prices correction appears to be meaningless, all the more that our data show a stable output/capital ratio in real term rather than nominal.[19]

4 Results

4.1 Estimates for the TFP

We test the existence of trend breaks in the TFP model according to equation (3), following Le Bihan (2004) and Bai and Perron (1998, 2003). We used a non parametric correction of the residual auto correlation based on the works of Newey and West (1987). One of our main concerns as regards the test method was to choose between two approaches. One possible approach would be to test the existence of breaks in a simple determinist trend equation. But given that the residuals of such a regression are considered as stationary, there is no particular trade off with our approach consisting in testing the existence of a trend break in the strucural model. Yet it might be a problem to estimate a trend break in a model including an autoregressive component. Theoretically speaking, it is difficult to significantly distinguish the trend break from the potentially large effects of a persistent autoregressive process.[20] However, given the lack of definitive and consensual view on this matter, we decided to perfom the tests in the structural model. Table 2 shows our results as regards the break tests. We simultaneously tested for the stability of the model by iterating on the starting date of estimate, the ending date being 2004q4. Consequently, we finally chose different start dates of estimation for each country, and selected the sample showing the

[19] Baghli et al. (2006) found similar results.
[20] This issue is expertly discussed by Stock (2006).

best properties of stability.

Table 2: Period of estimation and significant TFP break

Country	Start date	Break date	Test-stat. SupF
Canada	1982q4	1989q4(+)	25.24***
Euro area[a]	1975q4	1995q1(-)	22.20***
France[b]	1965q1	1983q4(-)	14.76***
Germany	1960q2	1976q4(-)	13.93***
Germany-WR	1960q2	1977q1(-)	12.93***
Italy	1961q3	1973q3(-),1997q2(-)	60.00***
Japan	1970q2	1978q3(-)	7.88*
Netherlands	1969q1	1975q4(-)	25.35***
United Kingdom[c]	1960q2	1968q1(-)	11.54**
United States[c]	1961q1	1972q2(-),1995q4(+)	22.02***

Note: In parentheses are presented the sign of trend break. In the case of the test one break versus none, the critical values for SupF are 7.63, 9.31, and 12.69 for respectively 10%(*), 5%(**), and 1%(***) significant value. In the case of two breaks versus none, these critical values are 6.93, 7.92, and 10.14 for respectively 10%(*), 5%(**), and 1%(***) significant value.

[a] Age elasticity has been calibrated to -0.005106329 according to the mean value for France, Germany, Italy, and the Netherlands.

[b] Data corrected of 1968 impact on TFP.

[c] For the U.K. and the U.S., age of capital stock has been disregarded as a non significant variable.

Generally speaking, the tests were all highly significant, but in a lesser extent for Japan and United Kingdom. For Italy and the US, the tests showed high significance with two trend breaks instead of one. For the whole panel, we found out a negative trend break of the TFP taking place roughly in the middle of the sample. For Germany, Italy, Japan, the Netherlands, and the United States, this negative break takes place in the mid 1970's, and may be caused by the oil shock. As for Italy, a second negative break takes place in 1997q2, which may be viewed as the lasting effects of the 1993 recession and the 1992 monetary crisis. As for United Kingdom, the negative break takes place quite early in 1968q1, though it is less significant than other economies. As for France, the negative break takes place quite late compared to common knowledge on the subject, say a negative break in the mid 1970's.[21] For the euro area, the negative break takes place in the mid 90's. Obviously, this result is not coherent with what we get for the four economies composing the main part of the euro area. But we prefered to start pretty late (in 1975q4) our estimates for the euro area, bbecause of better properties in terms of stabilities, even if the break appears quite late. Two economies appear to show significant positive trend breaks, namely, Canada in 1989q4 and the United States in 1995q4. As for the former, the break date corresponds

[21] Indeed 1983q4 appears to be a kind of center of mass between the early 70's and the early 90's. These dates correspond to the two negative productivity breaks as revealed by Belorgey et al. (2004). We prefered to select the model with one negative break rather than two, since the results show the better properties in terms of consistency and stability.

roughly to the end of the deep recession in the late 1980s and early 1990s, and the beginning of the recovery. This is normal since we start the estimate in 1982q4, because of better statistical properties.[22] As for the US economy, the positive trend break in 1995q4 (+0.6 %) is coherent with the common view on this period.[23]

Estimation by ordinary least squares (OLS) of the TFP parameters of regression (3) are presented in Table 3 for the panel of economies.

Table 3: Estimation results

Country	γ_0 *const.*	γ_1 g_{t-1}	γ_2 $\triangle cur_t$	γ_3 $\triangle\tau_t$	γ_4 t	γ_5 t_1	γ_6 t_2
Canada	−2.82	0.62	0.15	−7.1E-3	−0.9E-3	1.4E-3	–
	(−6.73)	(10.97)	(5.94)	(−3.51)	(−5.21)	(6.88)	
Euro area[a]	−2.56	0.67	0.07	−5.1E-3	1.1E-3	−0.5E-3	–
	(−4.57)	(9.48)	(2.99)	–	(4.48)	(−4.47)	
France	−2.28	0.72	0.08	−7.8E-3	1.9E-3	−1.0E-3	–
	(−5.08)	(13.26)	(4.08)	(−4.36)	(4.84)	(−4.69)	
Germany	−3.11	0.63	0.11	−2.4E-3	2.9E-3	−1.7E-3	–
	(−6.39)	(10.97)	(4.57)	(−2.41)	(6.21)	(−6.13)	
Germany-WR	−3.17	0.62	0.12	−1.9E-3	2.9E-3	−1.8E-3	–
	(−6.53)	(10.73)	(4.90)	(−2.19)	(6.36)	(−6.30)	
Italy	−3.89	0.53	0.15	−5.5E-3	4.1E-3	−2.3E-3	−2.1E-3
	(−7.67)	(8.51)	(5.70)	(−2.79)	(7.43)	(−7.03)	(−7.22)
Japan	−1.36	0.71	0.06	−6.0E-3	1.6E-3	−0.4E-3	–
	(−4.85)	(12.07)	(3.90)	(−3.91)	(4.40)	(−2.74)	
Netherlands	−3.81	0.53	0.22	−4.7E-3	5.0E-3	−3.8E-3	–
	(−6.94)	(7.78)	(5.07)	(−3.47)	(6.29)	(−5.95)	
United Kingdom	−2.42	0.72	0.04	–	1.6E-3	−0.6E-3	–
	(−5.35)	(13.50)	(2.20)		(5.28)	(−4.08)	
United States	−2.80	0.64	0.08	–	1.6E-3	−0.7E-3	0.6E-3
	(−5.63)	(10.10)	(4.11)		(5.10)	(−4.31)	(4.58)

Note: For estimation start date, see Table 4. Estimations end in 2004q4. In parentheses are given the t-stat values.
[a] Age elasticity has been calibrated to −0.005106329 according to the mean value for France, Germany, Italy, and the Netherlands.

All coefficients are significant.[24] The signs of estimated parameters are consistent with our expectations: coefficients are positive for the trend and the capacity utilisation rate, negative for the age-gap. Concerning the estimation of parameter related to age of capital, France is the only country for which we are aware of a comparable assessment in the related litterature. In Baghli et al. (2006) and Cette and Szpiro (1989), a one year younger MES stock leads to an increase of the TFP by respectively +6.4 % and +3.6 %, against +3.1 % in our study when considering age in years instead of quarters as presented in Table 3.

The same tests and estimations have been performed with the US prices correction for

[22] We tried as far as possible not to select break dates that were to close to the bounds of the sample of estimate to avoid business cycle effects.
[23] See for instance Oliner and Sichel (2002); Belorgey et al. (2004).
[24] One should keep in mind that for UK and US, the regression does not include age of MES capital stock.

Table 4: Period of estimation and significant TFP break (US relative prices correction)

Country	Start date	Break date	Test-stat. SupF
Canada	1982q4	1989q3(+)	20.80***
Euro area[a]	1975q4	1999q4(-)	20.06***
France[b]	1970q1	1983q2(-)	13.81***
Germany	1960q2	1976q2(-)	26.29***
Germany-WR	1960q2	1977q1(-)	43.13***
Italy	1961q3	1973q3(-),1997q3(-)	70.37***
Japan	1970q2	1980q4(-)	19.28***
Netherlands	1969q1	1975q4(-)	29.64***
United Kingdom[c]	1961q3	1968q1(-)	8.75*

Note: In parentheses are presented the sign of trend break. In the case of the test one break versus none, the critical values for SupF are 7.63, 9.31, and 12.69 for respectively 10%(*), 5%(**), and 1%(***) significant value. In the case of two breaks versus none, these critical values are 6.93, 7.92, and 10.14 for respectively 10%(*), 5%(**), and 1%(***) significant value.

[a] Age elasticity has been calibrated to -0.004080014 according to the mean value for France, Germany, Italy, and the Netherlands.

[b] Data corrected of 1968 impact on TFP.

[c] For the U.K., age of capital stock has been disregarded as a non significant variable.

TFP and age of MES equipment. Table 4 presents the results for the break tests, which are quite similar to the non corrected estimates. Indeed we tried to keep the same specifications as regards the number of breaks and the start date, except for France (1970q1 instead of 1965q1) and United Kingdom (1961q3 instead of 1961q2). Therefore the break dates are roughly the same, except for euro area (1999q4 instead of 1995q1) and Japan (1980q4 instead of 1978q3).

Table 5 presents the results for the estimates with US price correction. It is worthwile to notice that the values of the elasticities are roughly the same except for the age variable. The latter appears to be lower in absolute value than for the non corrected model. The reason for this is relatively not clear-cut. Nevertheless, one may assert that taking into account the US investment deflator may improve the measure of capital stock, so that the discrepancy between actual capital stock measure and "true" productive capital stock may narrow.

4.2 Medium term potential growth

Table 6 shows the different contributions to potential growth in the medium term over the 1991-2004 period.[25] In the medium term, potential growth splits up between four components: the growth of capital stock, the growth of labour input (hours worked), the TFP growth and the changes in the age of MES equipments. Over the period 1991-2004,

[25] We present in Appendix C paths of the medium term potential growth. See Figures 3 and 5. Results of medium term potential growth estimates including US relative prices correction are presented in Table 16 in the same section.

Table 5: Estimation results (US relative prices correction)

Country	γ_0 *const.*	γ_1 g_{t-1}	γ_2 $\triangle cur_t$	γ_3 $\triangle\tau_t$	γ_4 t	γ_5 t_1	γ_6 t_2
Canada	−3.03	0.59	0.13	−4.2E-3	−0.5E-3	1.2E-3	–
	(−6.18)	(9.08)	(5.84)	(−3.15)	(−5.24)	(6.80)	
Euro area[a]	−2.02	0.74	0.04	−4.1E-3	0.8E-3	−0.7E-3	–
	(−4.80)	(13.99)	(2.27)	–	(4.68)	(−4.70)	
France	−2.60	0.68	0.08	−6.7E-3	2.2E-3	−1.4E-3	–
	(−5.77)	(12.21)	(4.53)	(−4.06)	(5.30)	(−4.91)	
Germany	−3.83	0.54	0.12	−1.1E-3	3.4E-3	−2.5E-3	–
	(−7.69)	(8.90)	(4.90)	(−0.98)	(7.55)	(−7.49)	
Germany-WR	−4.88	0.41	0.15	−4.8E-3	4.5E-3	−3.6E-3	–
	(−9.20)	(6.32)	(6.23)	(−4.13)	(9.07)	(−9.02)	
Italy	−4.29	0.47	0.17	−4.4E-3	4.3E-3	−2.6E-3	−2.4E-3
	(−8.36)	(7.57)	(6.50)	(−4.40)	(8.14)	(−7.93)	(−7.92)
Japan	−1.47	0.70	0.06	−9.2E-3	2.4E-3	−1.3E-3	–
	(−4.83)	(11.26)	(4.13)	(−4.13)	(4.56)	(−4.15)	
Netherlands	−4.34	0.47	0.25	−4.0E-3	6.0E-3	−4.8E-3	–
	(−7.76)	(6.78)	(5.98)	(−3.89)	(7.27)	(−6.89)	
United Kingdom	−2.11	0.75	0.03	–	1.5E-3	−0.7E-3	–
	(−4.81)	(14.69)	(1.74)		(4.61)	(−3.57)	

Note: For estimation start date, see Table 4. Estimations end in 2004q4. In parentheses are given the t-stat values.
[a] Age elasticity has been calibrated to −0.004080014 according to the mean value for France, Germany, Italy, and the Netherlands.

the average annual growth rate of potential output is comprised between 1.3 (Italy) and 3.2 (United States). The main contributors to potential growth are capital stock and TFP. The contribution of capital stock is comprised between 0.8 (Italy) and 1.1 (Canada). The contribution of TFP is comprised between 0.5 (Canada) and 1.5 (Japan). It is worthwile to notice that, when excluding Canada and Italy, the panel shows a rather stable contribution of TFP growth, between 0.9 and 1.5. On the contrary, there are important differences inside the panel regarding the contribution of labour. For some economies, labour has contributed significantly to medium term growth (Canada, Netherlands, United States), whereas for the rest of the panel labour input has contributed very little or even negatively to potential growth (Germany, Japan). Not surprisingly the economies with the highest medium term potential growth are also those with the most significant labour contribution. Lastly, the contribution of age appears to be very little or even negative (France and Japan).

Table 6 shows also the changes in medium term potential growth over the 1991-2004 period. Some economies, namely Canada and United States, have experienced a sharp accelaration in medium term growth in the mid 1990's. The annual growth rate of potential output in the United States and respectively Canada was 2.7, respectively 2.1, during the 1991-1995 period, against 3.6, respectively 3.2, during the 1995-2000 period, that is to say a one point acceleration. For the United States, it was mainly due to the acceleration of the

TFP growth (+0.5 pp), whereas for Canada, it was due to the labour contribution.

Table 6: Sources of medium term potential growth

	Period 1991–1995				
		Contributions			
Economy	Growth	Capital	Labour	TFP	Age
Canada	2.1	1.1	0.4	0.5	0.1
Euro area	2.3	0.9	0.0	1.3	0.1
France	1.8	1.0	0.0	1.3	-0.5
Germany	2.3	0.9	0.1	1.3	0.0
Germany-WR	2.5	1.1	0.1	1.2	0.0
Italy	1.4	0.8	-0.7	1.5	-0.2
Japan	2.3	1.3	-0.1	1.5	-0.3
Netherlands	2.7	0.8	1.0	1.0	-0.1
United Kingdom	1.9	0.9	-0.4	1.4	-
United States	2.7	0.9	0.9	1.0	-
	Period 1995–2000				
		Contributions			
Economy	Growth	Capital	Labour	TFP	Age
Canada	3.2	1.1	1.1	0.5	0.6
Euro area	2.0	0.8	0.3	0.8	0.1
France	2.2	0.8	0.4	1.3	-0.3
Germany	1.8	0.8	-0.3	1.3	0.0
Germany-WR	1.9	1.0	-0.3	1.2	0.0
Italy	1.4	0.7	0.1	0.6	0.0
Japan	1.3	0.9	-0.4	1.5	-0.7
Netherlands	3.0	0.9	1.1	1.0	0.0
United Kingdom	2.8	0.9	0.4	1.4	-
United States	3.6	1.1	1.0	1.5	-
	Period 2000–2004				
		Contributions			
Economy	Growth	Capital	Labour	TFP	Age
Canada	3.0	1.2	0.9	0.5	0.4
Euro area	2.2	0.9	0.4	0.7	0.2
France	2.0	0.9	-0.2	1.3	0.1
Germany	2.0	0.7	-0.1	1.3	0.0
Germany-WR	1.9	0.8	-0.1	1.2	0.0
Italy	1.1	0.8	0.5	-0.3	0.1
Japan	0.6	0.7	-0.6	1.5	-0.9
Netherlands	2.6	0.8	0.8	1.0	0.0
United Kingdom	2.7	1.0	0.3	1.4	-
United States	3.2	1.2	0.4	1.6	-
	Period 1991–2004				
		Contributions			
Economy	Growth	Capital	Labour	TFP	Age
Canada	2.8	1.1	0.8	0.5	0.3
Euro area	2.2	0.9	0.2	0.9	0.1
France	2.0	0.9	0.1	1.3	-0.3
Germany	2.1	0.8	-0.1	1.3	0.0
Germany-WR	2.1	1.0	-0.1	1.2	0.0
Italy	1.3	0.8	0.0	0.6	0.0
Japan	1.5	1.0	-0.4	1.5	-0.6
Netherlands	2.8	0.8	1.0	1.0	0.0
United Kingdom	2.5	0.9	0.1	1.4	-
United States	3.2	1.0	0.8	1.4	-

4.3 Long run potential growth

Table 7 shows the different contributions to potential growth in the long run over the 1991-2004 period with the US prices correction.[26] In the long run, potential growth splits up between three components: the growth of working age population, the TFP growth and the changes in the relative prices. With the US prices correction, the comparisons are easier

[26]We present in Appendix C paths of the long term potential growth. See Figures 4 and 6. Results of long term potential growth estimates without US relative prices correction are presented in Table 15 in the same section.

because the panel shows very similar contributions of relative prices, comprised between 0.4 and 0.6. Over the period 1991-2004, the average annual growth rate of long run potential output is comprised between 1.3 (Italy) and 3.9 (United States). As for European countries and Japan, the contribution of population to long run potential growth is smaller as compared to the TFP contribution, whereas North American economies show larger population contributions, thanks to more favourable demographic developments over the period.[27]

Table 7: Sources of long term potential growth (US prices correction)

	Period 1991–1995			
		Contributions		
Economy	Growth	Rel. prices	Population	TFP
Canada	2.8	0.6	1.1	1.1
Euro area	2.8	0.5	0.4	1.9
France	2.3	0.5	0.3	1.5
Germany	2.1	0.5	0.3	1.2
Germany-WR	1.8	0.5	0.3	0.9
Italy	2.8	0.6	0.2	2.1
Japan	2.9	0.4	0.3	2.1
Netherlands	2.4	0.5	0.5	1.4
United Kingdom	2.8	0.5	0.1	2.2
United States	3.2	0.6	1.0	1.5
	Period 1995–2000			
		Contributions		
Economy	Growth	Rel. prices	Population	TFP
Canada	2.8	0.6	1.1	1.1
Euro area	2.2	0.5	0.2	1.4
France	2.3	0.5	0.3	1.5
Germany	1.8	0.5	0.0	1.2
Germany-WR	1.5	0.5	0.0	0.9
Italy	1.3	0.6	0.0	0.7
Japan	2.5	0.4	-0.1	2.1
Netherlands	2.3	0.5	0.4	1.4
United Kingdom	3.1	0.5	0.4	2.2
United States	4.1	0.6	1.2	2.3
	Period 2000–2004			
		Contributions		
Economy	Growth	Rel. prices	Population	TFP
Canada	2.8	0.5	1.2	1.1
Euro area	1.6	0.5	0.3	0.8
France	2.4	0.5	0.5	1.5
Germany	1.5	0.5	-0.2	1.2
Germany-WR	1.2	0.5	-0.2	0.9
Italy	-0.4	0.5	-0.1	-0.8
Japan	2.3	0.4	-0.3	2.1
Netherlands	2.3	0.5	0.5	1.4
United Kingdom	3.3	0.4	0.7	2.2
United States	4.5	0.5	1.4	2.6
	Period 1991–2004			
		Contributions		
Economy	Growth	Rel. prices	Population	TFP
Canada	2.8	0.5	1.2	1.1
Euro area	2.2	0.5	0.3	1.4
France	2.4	0.5	0.3	1.5
Germany	1.8	0.5	0.0	1.2
Germany-WR	1.5	0.5	0.0	0.9
Italy	1.3	0.5	0.0	0.7
Japan	2.6	0.4	0.0	2.1
Netherlands	2.4	0.5	0.5	1.4
United Kingdom	3.0	0.5	0.4	2.2
United States	3.9	0.6	1.2	2.2

Table 7 shows also the changes in long run potential growth by sub period over 1991-2004. Again, the US economy has experienced a sharp accelaration in potential growth in

[27]On this particular matter, it would be of great interest to distinguish between migration and natality effects in the growth of the population, but this topic remains out of the scope of this study.

the mid 1990's. The annual growth rate of potential output in the United States was 3.2 over 1991-1995 against 4.1 during the 1995-2000 period and 4.5 over the 200-2004. It was mainly due to the acceleration of the TFP growth and to a lesser extent the acceleration of population growth (0.2 pp per subperiod. On the contrary, potential growth of European economies has remained stable (France and Netherlands) or even decreased (Germany and Italy). It is worthwile to notice that Italy shows a negative potential growth during the 2000-2004 period. This is mainly due to both a decreasing TFP trend and to a less extent a negative contribution of the population growth. This is not the case for the medium term growth for which the negative contribution of the TFP is more than offset by the positive contributions of capital and labour.[28]

5 Discussion

The previous section suggests that in the medium and long term, one of the most stricking indicators which allow to distinguish between the studied economies relies on TFP growth rate. Moreover, differences in the labour contribution play a key role in explaining the lower potential growth in European economies and Japan as compared to the US. Besides, temporal considerations reveal differences in potential growth assessment that one may wish to compare with usual univariate estimates of potential growth. For these reasons, we draw in this section a particular attention to the potential reasons explaining TFP gaps, to the breakdown of labour contribution, as well as comparisons of various assessments of potential growth.

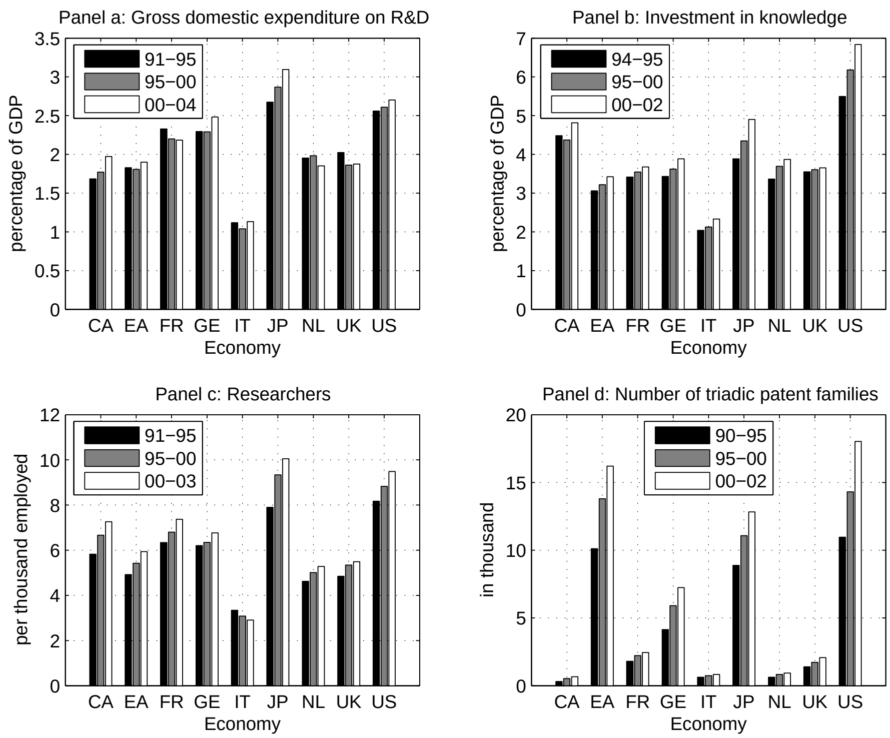
5.1 What could explain TFP gaps among these economies?

As shown by the results, a large part of the potential output growth is mainly explained by TFP developments which could imply various gaps among economies studied here. As for the TFP contribution to long potential growth, taking into account US relative prices correction, Japan, UK, and US appear to be ones of the front runners with 2.1/2.2 percentage points contributions over the 1991-2004 period. At the opposite, Italy seems to be as a laggard among the panel, with a TFP contribution of 0.7 percentage point for the same period.

An interesting way to understand these differences is to focus on one of the modern engines of growth, say innovation activities. Indeed, given the efforts of economic theorists to model endogenous, particularly R&D-driven, growth process from the mid-80's, activities of research, development, and innovation play a key role as economic growth determinants.

[28]This reflects partly a specific phenomenon, namely the increase in the participation rate at the end of the 1990's in Italy (see Table 8). This increase could be due to the incorporation of moonlight workers in National Accounts' measures of the labour force.

To this respect, one could have a glance at some available innovation indicators to reveal differences among economies. Figure 5.1 depicts for the panel such indicators.



Source: OECD (2006). Panel a: Gross domestic expenditure on R&D as a percentage of GDP; Panel b: Investment in knowledge as a percentage of GDP, sub-periods over 94-02 only; Panel c: Researchers per thousand employed, full-time equivalent, sub-periods over 91-03 only; Panel d: Number of triadic patent families according to the residence of the inventors, sub-periods over 90-02 only. The euro are data are proxied by EU15, except in Panel b for which investment in knowledge is proxied by the GDP-weighted average among France, Germany, Italy, and the Netherlands. Missing values are proxied by mean of previous and following periods, except for UK in Panel c, for which figures have been kept constant since 1999. We highly recommand the reader to refer to OECD (2006) website for definitions.

Figure 1: Innovation indicators

It is worth noting that over a similar period, Japan and US showed higher efforts in innovation activities than the other panel's economies. Again, Italy appears to lag behind others, as its efforts are far below the rest of the panel. A brief cross-country correlation as regards the effect of gross domestic expenses of R&D on long run TFP contribution is shown in Figure 2.

One can see the positive correlation between R&D efforts and TFP contibution. On the last quarter of Figure 2, which covers the whole period of investigation, we identify four blocks: the first consists in the Japanese and US economies, for which TFP contributions

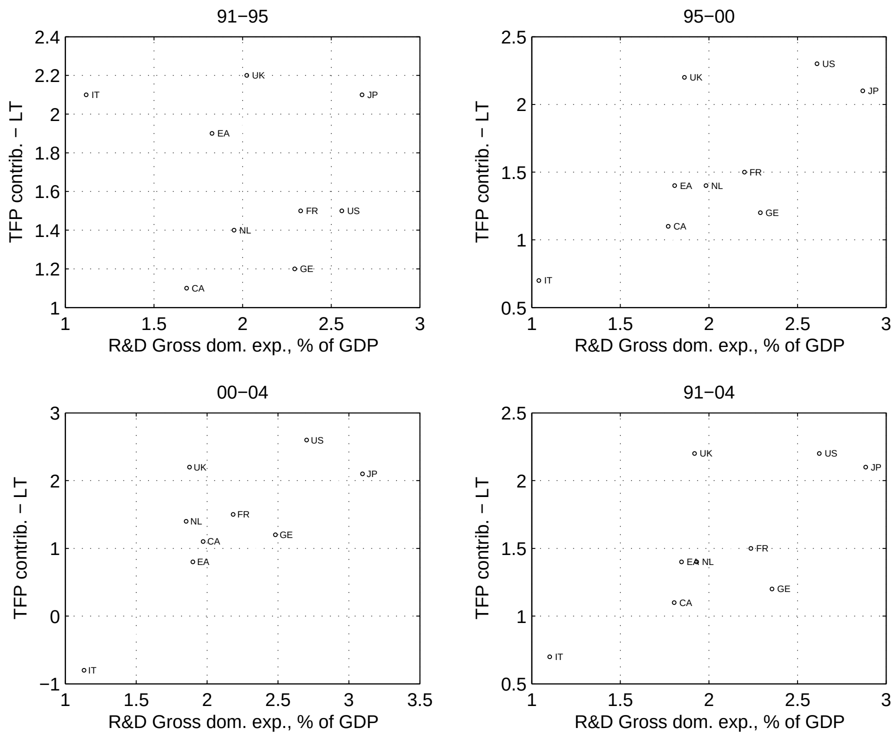


Figure 2: Gross domestic expenses on R&D and long term TFP contribution

are among the highest and R&D efforts draw near 3% of GDP. The second relies on Italy, which presents lower R&D efforts for lower TFP contribution. A third group consists of Canada, France, Germany, and the Netherlands, with R&D efforts amounting to about 2% of GDP. As an particular exception, UK, which constitutes the fourth block, experienced high TFP contribution for a relatively low level of expenses on R&D.

To conclude with this issue, these rapid considerations lead to comfort the predominant and consensual view on the positive impact of an increase in R&D expenditure on economic growth.[29] It appears that an increase in R&D efforts by roughly 1% of GDP in the euro area could allow to fill the gap with the first block, and would potentially increase the TFP contribution by about 0.5 point.[30]

[29]As far as France is concerned, this view was largely discussed and debated among French parliament, and especially in the Sénat. See for instance Brécart at al. (2003) and Bourdin (2004).

[30]Another field of interest would concern the impact of product market regulation. On the one hand, one may consider that regulatory reforms that liberalize entry on good market are very likely to spur investment (Alesina et al., 2003, see). On the other hand, recent works including Acemoglu et al. (2006) rely on the nexus between distance to frontier and economic growth based on the degree of rigidity in the product market. According to this literature, the greater the economy's distance to technological frontier is, the potentially lower the marginal gain of deregulation is. As we do not provide with comparative measures of TFP in levels in this paper, we could not deal with this promising issue.

5.2 What could explain differences in labour contributions?

Differences in labour contributions are important to explain the differences in potential growth among the panel. For instance, the country with the highest average potential growth, namely the United States, shows a very positive labour contribution, whereas European countries, except the Netherlands, show very low labour contributions over the 1991-2004 period. One may look for explanation for these differences. Table 8 shows the breakdown of labour contribution in the medium run. The growth of labour input in the medium term splits up into four components: the growth of the working age population – the so-called population contribution–, the changes in the participation rate – participation – , the changes in the employment rate – employment – and lastly the changes in hours worked per worker in the whole economy – hours.

First, it is worthwile to notice that the contribution of hours is not the main source of differences in potential growth. Indeed in the majority of OECD countries, hours worked have fallen over the period from 1990 to 2004 as shown in Table 9.

That's why the contribution of hours has remained negative for the whole panel during this period. Japan and France show a relatively higher negative contribution of hours (-0.6 and -0.4).[31] In Japan, as pointed out by the ILO, Article 32 of the Labor Standards Law, which was revised in 1987, provided for a 40-hour week. The general introduction of the 40-hour week has taken place gradually in the 1990s. Another reason why the contribution of hours is negative for all the economies considered here is the increase of part-time employment among the OECD countries during the 1991-2004 period (see Table 9). This is particularly true for Germany, Italy, the Netherlands and Japan.

Second, differences in demographic developments play a crucial role in explaining differences in potential growth. The United States and Canada, which have a relatively high medium term labour contribution compared to other countries, show a high growth of the working age population, due to favourable demographic conditions (see Table 9.)

Third, differences in the contribution of participation rate explain why the Netherlands stands as a European exception as regards potential growth. This economy shows higher potential growth as compared to other european countries, due to increases in the participation rate during the period from 1991 to 2004 and thus higher participation contributions. (0.7 for 1991-1995 and 0.8 for 1995-2000). This reflects important economic reforms that took place in this country during the 1980's, among which the general agreement for a wage moderation policy in Netherlands that started in 1982 (Wasenaar agreements) and whose

[31] As previously analized, long run potential growth in Japan is only driven by a relatively high TFP as compared to other countries. But medium term potential growth is one point lower than in the long run because of negative contributions of age and labour.

Table 8: Breakdown of labour contributions to medium term potential growth (in percentage point)

	Period 1991–1995				
Economy	Total	Population	Participation	Employment	Hours
Canada	0.4	0.7	-0.2	0.0	-0.1
Euro area	0.0	0.2	0.1	-0.1	-0.2
France	0.0	0.2	0.2	-0.2	-0.1
Germany	0.1	0.2	0.1	0.0	-0.2
Germany-WR	0.1	0.2	0.1	0.0	-0.2
Italy	-0.7	0.1	-0.4	-0.2	-0.2
Japan	-0.1	0.2	0.5	0.0	-0.8
Netherlands	1.0	0.3	0.7	0.3	-0.3
United Kingdom	-0.4	0.1	-0.2	0.1	-0.3
United States	0.9	0.6	0.1	0.1	0.1

	Period 1995–2000				
Economy	Total	Population	Participation	Employment	Hours
Canada	1.1	0.7	0.1	0.2	0.0
Euro area	0.3	0.2	0.4	0.0	-0.3
France	0.4	0.2	0.4	0.1	-0.3
Germany	-0.3	0.0	0.3	-0.2	-0.5
Germany-WR	-0.3	0.0	0.3	-0.2	-0.5
Italy	0.1	0.0	0.3	-0.1	-0.1
Japan	-0.4	0.0	0.3	-0.1	-0.5
Netherlands	1.1	0.3	0.8	0.2	-0.2
United Kingdom	0.4	0.2	0.0	0.2	0.0
United States	1.0	0.8	0.1	0.1	0.2

	Period 2000–2004				
Economy	Total	Population	Participation	Employment	Hours
Canada	0.9	0.8	0.4	-0.1	-0.2
Euro area	0.4	0.2	0.5	0.1	-0.4
France	-0.2	0.3	0.3	0.1	-0.8
Germany	-0.1	-0.2	0.5	-0.1	-0.4
Germany-WR	-0.1	-0.2	0.5	-0.1	-0.4
Italy	0.5	0.0	0.6	0.1	-0.2
Japan	-0.6	-0.2	0.0	-0.1	-0.3
Netherlands	0.8	0.3	0.4	0.2	-0.1
United Kingdom	0.3	0.4	0.0	0.1	-0.3
United States	0.4	0.9	-0.1	0.0	-0.3

	Period 1991–2004				
Economy	Total	Population	Participation	Employment	Hours
Canada	0.8	0.7	0.1	0.0	-0.1
Euro area	0.2	0.2	0.3	0.0	-0.3
France	0.1	0.2	0.3	0.0	-0.4
Germany	-0.1	0.0	0.3	-0.1	-0.3
Germany-WR	-0.1	-0.0	0.3	-0.1	-0.3
Italy	0.0	0.0	0.1	0.0	-0.2
Japan	-0.4	0.0	0.3	-0.1	-0.6
Netherlands	1.0	0.3	0.7	0.2	-0.2
United Kingdom	0.1	0.2	-0.1	0.1	-0.2
United States	0.8	0.8	0.0	0.1	0.0

Table 9: OECD indicators on labour market and population

Economy	demography[a]	women' employment rate[b]			hours worked[c]	part-time[d]
	90-04	1990	2004	90-04	90-04	90-04
Canada	1.06	62.7	68.4	5.7	-6	1.5
France	0.43	50.3	56.7	6.4	-156	1.2
Germany	0.39	52.2	59.9	7.8	-98	6.7
Italy	0.14	36.2	45.2	9.0	-71	6.0
Japan	0.24	55.8	57.4	1.6	-242	6.3
Netherlands	0.61	47.5	64.9	17.5	-99	6.9
United Kingdom	0.31	62.8	66.6	3.7	-98	4.0
United States	1.17	64.0	65.4	1.3	-37	-0.9
EU15	0.40	48.7	56.7	8.1	-	4.1
Panel's average	0.53	53.3	60.1	6.8	-101	4.0

Note: [a] annual average growth rate of population over 1990-2004, [b] levels in 1990 and 2004 and change in percentage point, [c] change in yearly worked hours per head over 1990-2004, [d] as a percentage of total employment, change in percentage point over 1990-2004 ("+" = increase)

effects on the participation rate appear to be exceptionallly positive. A striking feature of these effects concerns the female employment rate. Table 9 shows that all the economies have experienced a rise in the employment rate of women over the 1991-2004 period but the Netherlands shows the most important increase among the panel. To some extent, one may conclude that, had other european countries implemented such labour market policies, they would have experienced more rapid potential and actual growth paths over the period from 1991 to 2004, as much as 0.5 point higher or even more, due to higher participation and employment contributions.

5.3 How much growth have they lost?

Table 10 compares the production function estimates with two statistical univariate methods, namely a smoothing technique (Hodrick and Prescott, 1997) and a trend estimation including possible trend breaks.[32] The magnitude of the intervals is comprised between 0.2 point for Italy to 1.3 point for Japan. Indeed the production function approach results are close to the univariate methods. Table 10 also provides us with comparisons of actual growth, medium term potential growth and long term potential growth. For a given economy, differences between medium term and long term potential growth may arise due to rigidities in the medium term regarding capital stock growth, age of capital and labour input. In the long run, capital growth is taken equal to GDP growth, age is constant, and labour input grows at the same rate than the working age population. Therefore, should medium term potential growth be lower than long term potential growth, this would be due either to the ageing of the capital stock, either to labour market rigidities, either to lagging capital stock growth.

Generally speaking, medium term potential growth appears to be lower than long term potential growth, and actual growth appears to be lower than medium term growth. This result implies that all the economies have lost opportunities of growth during the period from

[32]Date of break are presented in AppendixC, Table 17.

Table 10: Comparison of GDP potential growth measures (average annual growth rate in %)

Period 1991–1995

	GDP	Prod. function		Prod. func. (US cor.)		Statistical	
Economy	Actual	Medium	Long	Medium	Long	HP	Trend
Canada	1.6	2.1	2.3	2.0	2.8	1.8	2.8
Euro area	1.6	2.3	3.1	2.4	2.8	1.9	2.3
France	1.2	1.8	2.7	1.7	2.3	1.5	2.1
Germany	2.4	2.3	2.2	2.4	2.1	2.3	2.2
Germany-WR	2.4	2.5	1.9	2.6	1.8	2.3	2.2
Italy	1.2	1.4	3.2	1.4	2.8	1.4	1.5
Japan	1.6	2.4	2.7	2.3	2.9	2.0	2.1
Netherlands	2.2	2.7	2.3	2.8	2.4	2.5	2.7
United Kingdom	1.5	1.9	3.2	1.9	2.8	1.8	2.6
United States	2.4	2.7	3.2	2.7	3.2	2.7	3.1

Period 1995–2000

	GDP	Prod. function		Prod. func. (US cor.)		Statistical	
Economy	Actual	Medium	Long	Medium	Long	HP	Trend
Canada	3.9	3.2	2.2	3.3	2.8	3.7	2.8
Euro area	2.6	2.0	2.0	2.2	2.2	2.3	2.3
France	2.6	2.2	2.5	2.2	2.3	2.3	2.1
Germany	2.0	1.8	2.6	1.7	1.8	1.7	2.2
Germany-WR	2.0	1.9	2.3	1.6	1.5	1.7	2.2
Italy	2.1	1.4	1.4	1.5	1.3	1.8	1.5
Japan	1.0	1.2	2.4	1.3	2.5	0.8	0.9
Netherlands	3.6	3.0	2.3	3.0	2.3	3.2	2.7
United Kingdom	3.2	2.8	3.2	2.7	3.1	3.1	2.6
United States	3.9	3.6	4.1	3.6	4.1	3.6	3.2

Period 2000–2004

	GDP	Prod. function		Prod. func. (US cor.)		Statistical	
Economy	Actual	Medium	Long	Medium	Long	HP	Trend
Canada	3.2	3.0	2.5	3.0	2.8	3.3	2.8
Euro area	2.0	2.2	1.6	2.2	1.6	2.0	2.3
France	2.2	2.0	2.5	2.2	2.4	2.2	2.1
Germany	1.3	2.0	2.6	1.6	1.5	1.2	2.2
Germany-WR	1.3	1.9	2.4	1.5	1.2	1.2	2.2
Italy	1.4	1.1	-0.3	1.0	-0.4	1.3	1.5
Japan	1.4	0.6	2.3	0.6	2.3	1.1	0.9
Netherlands	1.5	2.6	2.5	2.5	2.3	1.7	2.7
United Kingdom	2.8	2.7	3.4	2.6	3.3	2.7	2.6
United States	2.6	3.2	4.5	3.2	4.5	2.9	3.3

Period 1991–2004

	GDP	Prod. function		Prod. func. (US cor.)		Statistical	
Economy	Actual	Medium	Long	Medium	Long	HP	Trend
Canada	2.7	2.8	2.3	2.8	2.8	2.9	2.8
Euro area	2.0	2.2	2.2	2.3	2.2	2.1	2.3
France	1.9	2.0	2.6	2.0	2.4	2.0	2.1
Germany	1.7	2.1	2.5	1.9	1.8	1.8	2.2
Germany-WR	1.7	2.1	2.2	1.9	1.5	1.8	2.2
Italy	1.4	1.3	1.4	1.3	1.3	1.5	1.5
Japan	1.3	1.4	2.5	1.5	2.6	1.3	1.3
Netherlands	2.4	2.8	2.4	2.8	2.4	2.5	2.7
United Kingdom	2.4	2.5	3.3	2.4	3.0	2.5	2.6
United States	2.9	3.2	3.9	3.2	3.9	3.1	3.2

1991 to 2004. This was the case for all the countries, though with different magnitudes. It is worthwile noting that, even if the US economy stood below its potential growth over the 1991-2004 period, their actual growth was higher than other economies. The US economy, despite an actual growth amounting to 2.9 in annual terms, has lost 0.3 growth point per year as compared to medium term potential growth, and 1 point per year as compared to long term potential growth. Among the other economies that show the highest average loss as compared to long term potential growth over the period, let us mention Japan, UK, and

France with a loss of respectively 1.3, 0.6, and 0.5 percentage point.

6 Conclusion

The analysis of output growth in a panel of major economies undertaken in this paper confirms the lagging of European economies, as well as Japan, as compared to North American, especially the US, over the last 15 years. Among the euro area, France and Germany experienced an quite identical average potential output growth over the considered period, whereas Italy is going through a period of exceptionnaly low potential growth. On the contrary, the Netherlands, thanks to favourable conditions on the labour market, has performed better than other in terms of potential growth. An interpretation of these divergent growths which prevail in the major euro area economies, may be, besides the differences in economic performances, the differing macroeconomic policies, especially as regards the labour market. This would pleed for more structural reforms in the euro area.

Another interesting way of research would be to focus on the comparison of the TFP levels that such a methodology could allow. Indeed, after homogenizing the data —*i.e.* taking into account differences in exchange rate or purchase power parity for example— one should better distinguish the sources of differences in TFP developments and their impacts on the economy.[33] A possible future research would consist in trying to identify the technological frontier by comparing levels of TFP at each date for the whole panel, and then to estimate relations between TFP and the technological frontier. Doing this could bring new enlightments on the sources of technological progress based either on pure country-specific innovation or on imitation and catch-up effects. Should this research be fruitful, this would be extremely informative for the medium and long term diagnosis about the process of economic convergence among the countries studied here.

[33] Although first results have been performed in this sense, we set this issue out of the scope of this paper, letting for further research.

A Technical appendix

A.1 Real capital stock and age series

Starting from the law of capital accumulation with a constant depreciation rate, we have:

$$\begin{aligned} K_t &= (1-\delta)K_{t-1} + I_t \\ &= (1-\delta)^{t-1}(I_t + k) + \sum_{j=0}^{t-2}(1-\delta)^j I_{t-j} \\ &= k(1-\delta)^{t-1} + \sum_{j=0}^{t-1}(1-\delta)^j I_{t-j}, \end{aligned}$$

where k is the initial capital stock value.

To identify k, we suppose that the economy stands on a balanced growth path, where capital stock and investment grow at the same constant rate g. On such a path, the capital stock/investment ratio is the following :

$$\frac{K_t}{I_t} = \frac{1+g}{g+\delta}.$$

We calculate k such as the ratio K_t/I_t equals $(1+\bar{g})/(\bar{g}+\delta)$, where $\bar{g}$ is the mean growth rate of investment on the same period, namely:

$$\frac{1}{T}\sum_{t=1}^{T}\frac{K_t}{I_t} = \frac{1+\bar{g}}{\bar{g}+\delta}.$$

From this assumption, we have:

$$k = \frac{T\frac{1+\bar{g}}{\bar{g}+\delta} - \sum_{t=1}^{T}\frac{\sum_{j=0}^{t-1}(1-\delta)^j I_{t-j}}{I_t}}{\sum_{t=1}^{T}\frac{(1-\delta)^{t-1}}{I_t}}.$$

The age of capital stock is given by:

$$\sum_{j=0}^{t-1}(1-\delta)^j \frac{I_{t-j}}{K_t} j$$

A.2 Why age in level rather than in log?

Assume that productive capital $\tilde{K}_t$ consists in the accumulated flows of investment for which we take into account a improvement of productivity, increasing each capital services by a factor $1+\epsilon$, with $\epsilon > 0$ and sufficiantly lower than 1. Introducing capacity utilisation rate which modulate the level of productive stock, we can write:

$$
\begin{aligned}
\tilde{K}_t &= CUR_t \left[\underbrace{k(1-\delta)^{t-1}}_{\text{negligible}} + \sum_{j=0}^{t-1} (1-\delta)^j I_{t-j} (1+\epsilon)^{t-j} \right] \\
&= CUR_t \left[\sum_{j=0}^{t-1} (1-\delta)^j I_{t-j} (1+\epsilon)^{t-j} \right] \frac{K_t(1+\epsilon)^{t-\tau_t}}{K_t(1+\epsilon)^{t-\tau_t}} \\
&= CUR_t K_t (1+\epsilon)^{t-\tau_t} \left[\sum_{j=0}^{t-1} (1-\delta)^j \frac{I_{t-j}}{K_t} (1+\epsilon)^{-j+\tau_t} \right] \\
&= CUR_t K_t e^{(t-\tau_t)\ln(1+\epsilon)} \left[\sum_{j=0}^{t-1} (1-\delta)^j \frac{I_{t-j}}{K_t} \underbrace{(1+\epsilon(-j+\tau_t))}_{1^{\text{st}}\text{order approx.}} \right] \\
&= CUR_t K_t e^{(t-\tau_t)\epsilon} \left[(1+\epsilon\tau_t) \underbrace{\sum_{j=0}^{t-1} (1-\delta)^j \frac{I_{t-j}}{K_t}}_{\simeq 1} - \epsilon \underbrace{\sum_{j=0}^{t-1} (1-\delta)^j \frac{I_{t-j}}{K_t} j}_{\simeq \tau_t} \right] \\
&= CUR_t K_t e^{(t-\tau_t)\epsilon},
\end{aligned}
$$

which gives equation (1).

A.3 Medium and long run TFP

In this section, we present the calculations in details which lead to equation (4). Let's assume that the logarith of medium term TFP evolves as $\tilde{g}_t = \tilde{g}_{t-1} + \rho$, where ρ is the constant growth rate of TFP. A combination with eqution (3) gives:[34]

$$
\begin{aligned}
\tilde{g}_t = \tilde{g}_{t-1} + \rho &= \gamma_0 + \gamma_1 g_{t-1} + \gamma_3 \triangle\tau_t + \gamma_4 t + \gamma_5 t_1 + \gamma_6 t_2 \\
&= \gamma_0 + \gamma_1 g_{t-1} + \gamma_3 \triangle\tau_t + \gamma_4 t + \gamma_5 \mathbb{I}(t > T_1)(t - T_1) + \gamma_6 \mathbb{I}(t > T_2)(t - T_2) \\
\Longrightarrow (1-\gamma_1)\tilde{g}_{t-1} &= (\gamma_0 - \rho + \gamma_4 + \gamma_5(1-T_1)\mathbb{I}(t > T_1) + \gamma_6(1-T_2)\mathbb{I}(t > T_2)) \\
&\quad + \gamma_3 \triangle\tau_t + (\gamma_4 + \gamma_5 \mathbb{I}(t > T_1) + \gamma_6 \mathbb{I}(t > T_2))(t-1),
\end{aligned}
$$

which gives the following period:

$$
\begin{aligned}
(1-\gamma_1)\tilde{g}_t &= (\gamma_0 - \rho + \gamma_4 + \gamma_5(1-T_1)\mathbb{I}(t+1 > T_1) + \gamma_6(1-T_2)\mathbb{I}(t+1 > T_2)) \\
&\quad + \gamma_3 \triangle\tau_{t+1} + (\gamma_4 + \gamma_5 \mathbb{I}(t+1 > T_1) + \gamma_6 \mathbb{I}(t+1 > T_2))\; t.
\end{aligned}
$$

This last equation defines the medium term TFP:

$$
\begin{aligned}
\tilde{g}_t = &\frac{\gamma_0 - \rho + \gamma_4 + \gamma_5(1-T_1)\mathbb{I}(t > T_1 - 1) + \gamma_6(1-T_2)\mathbb{I}(t > T_2 - 1)}{1-\gamma_1} \\
&+ \frac{\gamma_3}{1-\gamma_1} \triangle\tau_{t+1} + \left(\frac{\gamma_4 + \gamma_5 \mathbb{I}(t > T_1 - 1) + \gamma_6 \mathbb{I}(t > T_2 - 1)}{1-\gamma_1} \right) t.
\end{aligned}
$$

[34] One should keep in mind that we consider in the medium term $\triangle cur_t = 0$.

In the long run, we have $\triangle\tau_t = 0$ and participation rate r_t^*, NAIRU u_t^* and the worked hours h_t^* are set to their average level. Combining the definition of medium term TFP in (4) and equation (6) in logs, we find:

$$\triangle y_t^* = (1-\alpha)\triangle k_t + \alpha\triangle n_t^* + \left(\frac{\gamma_4 + \gamma_5\mathbb{I}(t > T_1 - 1) + \gamma_6\mathbb{I}(t > T_2 - 1)}{1-\gamma_1}\right).$$

Moreover, according to the constant capital/output ratio in values assumption (see equation (7)), we have:

$$\triangle k_t = \triangle y_t^* + \triangle \ln\left(\frac{P_t^Y}{P_t^I}\right).$$

Hence, the long term potential GDP growth is given by the combination of the two last equations:

$$\triangle y_t^* = \frac{(1-\alpha)}{\alpha}\triangle \ln\left(\frac{P_t^Y}{P_t^I}\right) + \triangle n_t^* + \frac{1}{\alpha}\left(\frac{\gamma_4 + \gamma_5\mathbb{I}(t > T_1 - 1) + \gamma_6\mathbb{I}(t > T_2 - 1)}{1-\gamma_1}\right).$$

B Data Appendix

B.1 Main sources

Table 11: Database sources

data	periods	sources	description	comments
		Canada		
GDP	2005q1–2007q4	Econonomic Outlook (OECD)	Gross Domestic Product (Market prices), Volume	Use for extrapolation & for HP filtering only
	1961q1–2005q1	Quarterly National Accounts (Datastream)	CN GDP AT MARKET PRICES (CHAINED, SA, AR) CONA'	
	1961q1–2005q1		CN GDP AT MARKET PRICES (SA,AR) CURA'	
Investment	1961q1–2005q1	Quarterly National Accounts (Datastream)	CN BUSINESS GFCF (CHAINED,SA, AR) CONA	
Total	1961q1–2005q1	"	CN GOVERNMENT GFCF (CHAINED,SA, AR) CONA	
	1961q1–2005q1		CN BUSINESS GFCF (SA,AR) CURA	
	1961q1–2005q1		CN GOVERNMENT GFCF (SA,AR) CURA	
Investment - MES	1961q1–2005q1	Quarterly National Accounts (Datastream)	CN BUSINESS GFCF: MACHINERY & EQUIPMENT (CHAINED, SA, AR) CONA	
	1981q1–2005q1	"	CN GOVERNMENT GFCF: MACHINERY & EQUIPMENT (CHAINED, SA, AR) CONA	backcasted with total government investment before 1981q1
	1961q1–2005q1		CN BUSINESS GFCF: MACHINERY & EQUIPMENT (SA,AR) CURA	
	1981q1–2005q1		CN GOVERNMENT GFCF: MACHINERY & EQUIPMENT (SA, AR) CURA	backcasted with total government investment before 1981q1
Investment - SH	1981q1–2005q1	Quarterly National Accounts (Datastream)	CN GFCF - RESIDENTIAL STRUCTURES (CHAINED, SA, AR) CONA	backcasted with total investment before 1981q1
	1981q1–2005q1	"	CN GOVERNMENT GFCF: NONRESL. STRUCTURES (CHAINED, SA, AR) CONA	backcasted with total government investment before 1981q1

Continued on next page

data	periods	sources	description	comments
	1961q1–2005q1		CN BUSINESS GFCF: NONRESIDENTIAL STRUCTURES(CHAINED,SA, AR) CONA	
	1981q1–2005q1	Quarterly National Accounts (Datastream)	CN GFCF - RESIDENTIAL STRUCTURES (SA, AR) CURA	backcasted with total investment before 1981q1
	1981q1–2005q1	"	CN GOVERNMENT GFCF: NONRESIDENTIAL STRUCTURES (SA, AR) CURA	backcasted with total government investment before 1981q1
	1961q1–2005q1		CN BUSINESS GFCF: NONRESIDENTIAL STRUCTURES (SA,AR) CURA	
CUR	1987q1–2005q1	Quarterly National Accounts (Datastream)	CN CAPACITY UTILIZATION RATE:ALL INDUSTRIES NADJ	
	1962q1–2001q4	Macro database (BIS)	CAPACITY UTILIZATION RATES IN MANUFACTURING, TOTAL - INDEX SA-DISC	

Euro area

data	periods	sources	description	comments
GDP	2005q1–2007q4	Econonomic Outlook (OECD)	Gross Domestic Product (Market prices), Volume	Use for extrapolation & for HP filtering only
	1995q1–2005q1	National Accounts (Eurostat)	Euro 12 - Gross domestic product at market price - Constant prices - ECU/euro - Seasonally and partly working day adjusted, mixed method of adjustment	
	1995q1–2005q1	National Accounts (Eurostat)	Euro 12 - Gross domestic product at market price - Deflator - ECU/euro - Seasonally adjusted, not working day adjusted	Due to wrong implicit deflator in Eurostat data (values includes change effects of ECU with out of euro area countries), GDP in values is recalculated with the corrected deflator & volumes.
	1963q1–1995q1	Econonomic Outlook (OECD)	Gross Domestic Product (Market prices), Volume (West Germany before 1991)	
	1963q1–1995q1	Econonomic Outlook (OECD)	Gross Domestic Product (Market prices), Value (West Germany before 1991)	
Investment - MES	1991q1–2005q1	National Accounts (Eurostat)	Euro area (changing composition) - Gross fixed capital formation metal products, machinery and transport equipments - Constant prices - ECU/euro - Seasonally and partly working day adjusted, mixed method of adjustment	
	1991q1–2005q1	National Accounts (Eurostat)	Euro area (changing composition) - Gross fixed capital formation other products - Constant prices - ECU/euro - Seasonally and partly working day adjusted, mixed method of adjustment	

Continued on next page

Table 11 – continued from previous page

data	periods	sources	description	comments
	1991q1–2005q1	National Accounts (Eurostat)	Euro area (changing composition) - Gross fixed capital formation metal products, machinery and transport equipments - Current prices - ECU/euro - Seasonally and partly working day adjusted, mixed method of adjustment	
	1991q1–2005q1	National Accounts (Eurostat)	Euro area (changing composition) - Gross fixed capital formation other products - Current prices - ECU/euro - Seasonally and partly working day adjusted, mixed method of adjustment	
	1963q1–1991q1	Authors' calculation	Backcasted with weighted average from France, Germany, Italy, and the Netherlands	
Investment - SH	1991q1–2005q1	National Accounts (Eurostat)	Euro area (changing composition) - Gross fixed capital formation housing - Constant prices - ECU/euro - Seasonally and partly working day adjusted, mixed method of adjustment	
	1991q1–2005q1	National Accounts (Eurostat)	Euro area (changing composition) - Gross fixed capital formation other construction - Constant prices - ECU/euro - Seasonally and partly working day adjusted, mixed method of adjustment	
	1991q1–2005q1	National Accounts (Eurostat)	Euro area (changing composition) - Gross fixed capital formation housing - Current prices - ECU/euro - Seasonally and partly working day adjusted, mixed method of adjustment	
	1991q1–2005q1	National Accounts (Eurostat)	Euro area (changing composition) - Gross fixed capital formation other construction - Current prices - ECU/euro - Seasonally and partly working day adjusted, mixed method of adjustment	
	1963q1–1991q1	Authors' calculation	Backcasted with weighted average from France, Germany, Italy, and the Netherlands	
CUR	1980q1–2005q1	Macro database (BIS)	CAPACITY UTILISATION IN MANUFACTURING (MU12), SA	
	1963q1–1980q1	Authors' calculation	Backcasted with weighted average from France, Germany, Italy, and the Netherlands	

France

[to be completed]

Germany

[to be completed]

Continued on next page

Table 11 – continued from previous page

data	periods	sources	description	comments
			Italy	
GDP	2005q1–2007q4	Econonomic Outlook (OECD)	Gross Domestic Product (Market prices), Volume	Use for extrapolation & for HP filtering only
	1970q1–2005q1	National Accounts (Datastream)	IT GDP CONA	backcasted with OECD serie before 1970q1
	1960q1–2005q1	Econonomic Outlook (OECD)	Italy : Gross domestic product volume market prices / Unit: EUR 1995	
	1970q1–2005q1	National Accounts (Datastream)	IT GDP CURA	backcasted with OECD serie before 1970q1
	1960q1–2005q1	Econonomic Outlook (OECD)	Italy : Gross domestic product value market prices / Unit: EUR	
Investment	1960q1–2005q1	Econonomic Outlook (OECD)	Italy : Gross total fixed capital formation volume / Unit: EUROS	
Investment - MES	1970q1–2005q1	National Accounts (Datastream)	IT GFCF - MACHINERY & EQUIPMENT CONA	
	1970q1–2005q1	National Accounts (Datastream)	IT GFCF: MEANS OF TRANSPORT(NEW SCHEME) CONA	
	1960q1–2005q1	Authors' calculation	MES (volume) : Sum of IT GFCF - MACHINERY & EQUIPMENT CONA and IT GFCF: MEANS OF TRANSPORT(NEW SCHEME) CONA	backcasted with OECD series before 1970q1
	1960q1–2005q1	Authors' calculation	MES (current) : (Sum of IT GFCF - MACHINERY & EQUIPMENT CONA and IT GFCF: MEANS OF TRANSPORT(NEW SCHEME) CONA) multiplied with OECD Italy : Private non-residential fixed capital formation deflator	backcasted with OECD series before 1970q1
Investment - SH	1960q1–2005q1	Econonomic Outlook (OECD)	Italy : Private residential fixed capital formation volume / Unit: EUR 1995	
	1970q1–2005q1	National Accounts (Datastream)	IT GFCF: CONSTRUCTION (NEW SCHEME) CONA	backcasted with OECD serie before 1970q1
	1960q1–2005q1	Authors' calculation	Current SH = backcasted IT GFCF: CONSTRUCTION (NEW SCHEME) CONA multiplied with calculated deflator	
CUR	1970q1–2005q1	National Accounts (Datastream)	IT INDUSTRY SURVEY: CAPACITY UTILISATION - ITALY SADJ	backcasted with BIS serie before 1970q1
	1953q1–2002q4	Macro database (BIS)	CAPACITY UTILIZATION IN INDUSTRY - WHARTON SCHOOL METHOD SA-DISC	
			Japan	
GDP	2005q1–2007q4	Econonomic Outlook (OECD)	Gross Domestic Product (Market prices), Volume	Use for extrapolation & for HP filtering only
	1994q1–2005q1	National Accounts (Datastream)	JP GDP (AR) CONA	backcasted with OECD serie before 1994q1
	1960q1–2005q1	Econonomic Outlook (OECD)	Japan : Gross domestic product value market prices / Unit: JPY	
	1980q1–2005q1	National Accounts (Datastream)	JP GDP (AR) CURA	backcasted with OECD serie before 1994q1
	1960q1–2005q1	Econonomic Outlook (OECD)	Japan : Gross domestic product volume market prices / Unit: JPY 2000	

Continued on next page

Table 11 – continued from previous page

data	periods	sources	description	comments
Investment	1994q1–2005q1	Macro database (BIS)	INVESTMENT, GROSS DOMEST.FIXED CAP.FORM.,TOTAL(SNA 93)-CH.2000JPY SAAR	
Investment - MES	1960q1–2005q1	Econonomic Outlook (OECD)	Japan : Private non-residential fixed capital formation volume / Unit: JPY 2000	
	1960q1–2005q1	Authors' calculation	Sum of old national series (volume)	backcasted with OECD serie
	1960q1–2005q1	Authors' calculation	Sum of old national series (current)	backcasted with OECD serie
Investment - SH	1960q1–2005q1	Econonomic Outlook (OECD)	Japan : Private residential fixed capital formation volume / Unit: JPY 2000	
	1960q1–2005q1	Authors' calculation	Sum of old national series (volume)	backcasted with OECD serie
	1960q1–2005q1	Authors' calculation	Sum of old national series (current)	backcasted with OECD serie
CUR	1968q1–2005q1	National Accounts (Datastream)	JP OPERATING RATIO - MANUFACTURING SADJ	

Netherlands

[to be completed]

United Kingdom

data	periods	sources	description	comments
GDP	2005q1–2007q4	Econonomic Outlook (OECD)	Gross Domestic Product (Market prices), Volume	Use for extrapolation & for HP filtering only
	1955q1–2005q1	National Accounts (Datastream)	UK GDP AT MARKET PRICES (CVM) CONA	
	1955q1–2005q1	National Accounts (Datastream)	UK GDP AT MARKET PRICES CURA	
Investment - MES	1955q1–2005q1	Macro database (BIS)	INVESTMENT, GROSS FIXED CAPITAL FORM.,TOTAL (ESA 95) - CURR.PR.SA	
	1965q1–2005q1	Authors' calculation	Difference between INVESTMENT, GROSS FIXED CAPITAL FORM.,TOTAL (ESA 95) - CURR.PR.SA and current SH	
	1965q1–2005q1	National Accounts (Datastream)	UK GROSS FXD.CAP.FORMATION:VEHICLES, SHIPS & AIRCRAFT: CVM CONA	
	1965q1–2005q1	National Accounts (Datastream)	UK GROSS FIXED CAPITAL FORMATION: PLANT & MACHINERY: CVM CONA	
	1965q1–2005q1	Authors' calculation	Sum of UK GROSS FXD.CAP.FORMATION :VEHICLES, SHIPS & AIRCRAFT: CVM CONA and UK GROSS FIXED CAPITAL FORMATION: PLANT & MACHINERY: CVM CONA	
Investment - SH	1962q1–2005q1	National Accounts (Datastream)	UK GROSS FIXED CAPITAL FORMATION: TOTAL ECONOMY: DWELLINGS CONA	
	1965q1–2005q1	National Accounts (Datastream)	UK GROSS FXD.CAP.FORMATION:OTHER NEW BLDG.S & WORKS: CVM CONA	

Continued on next page

data	periods	sources	description	comments
	1965q1–2005q1	Authors' calculation	Sum of UK GROSS FIXED CAPITAL FORMATION: TOTAL ECONOMY: DWELLINGS CONA and UK GROSS FXD.CAP.FORMATION:OTHER NEW BLDG.S & WORKS: CVM CONA	
	1986q1–2005q1	Macro database (BIS)	INVESTMENT, FIXED, NON-RESIDENTIAL CONSTR. (ESA 95) - CURR.PR. SA	backcasted with INVESTMENT, FIXED, RESIDENTIAL CONSTR., PRIVATE (ESA 95) - CURR.PR. SA + INVESTMENT, FIXED, RESIDENTIAL CONSTR., PUBLIC - CURR.PR. SA before 1986q1
	1965q1–2005q1	Macro database (BIS)	INVESTMENT, FIXED, RESIDENTIAL CONSTR., PRIVATE (ESA 95) - CURR.PR. SA	
	1965q1–2005q1	Macro database (BIS)	INVESTMENT, FIXED, RESIDENTIAL CONSTR., PUBLIC - CURR.PR. SA	
	1965q1–2005q1	Authors' calculation	Sum of INVESTMENT, FIXED, RESIDENTIAL CONSTR., PRIVATE (ESA 95) - CURR.PR. SA, INVESTMENT, FIXED, RESIDENTIAL CONSTR., PUBLIC - CURR.PR. SA and backcasted INVESTMENT, FIXED, NON-RESIDENTIAL CONSTR. (ESA 95) - CURR.PR. SA	
CUR	1970q1–2005q1	National Accounts (Datastream)	UK INDUSTRY SURVEY: CAPACITY UTILISATION - UK SADJ	backcasted with german CUR before 1970q1

United States

data	periods	sources	description	comments
GDP	2005q1–2007q4	Econonomic Outlook (OECD)	Gross Domestic Product (Market prices), Volume	Use for extrapolation & for HP filtering only
	1950q1–2005q1	National Accounts (BEA - Datastream)	US GROSS DOMESTIC PRODUCT (AR) CONA	
	1950q1–2005q1	National Accounts (BEA - Datastream)	US GROSS DOMESTIC PRODUCT (AR) CURA	
Investment - MES	1990q1–2005q1	National Accounts (BEA - Datastream)	US PRIVATE FIXED INVESTMENT IN EQUIPMENT & SOFTWARE CONA	backcasted with deflated US PRIVATE FIXED INVESTMENT IN EQUIPMENT & SOFTWARE CURA before 1990q1
	1990q1–2005q1	National Accounts (BEA - Datastream)	US GOVT CNSMPT EXPEND.S & INVESTMENT - EQUIPMENT & SOFTWARE CONA	backcasted with deflated US GOVT CONSMPTN.EXPNDS & INVESTMENT - EQUIPMENT & SOFTWARE CURA before 1990q1
	1950q1–2005q1	Authors' calculation	Sum of backcasted private and public invt in equipment & software	
	1950q1–2005q1	National Accounts (BEA - Datastream)	US PRIVATE FIXED INVESTMENT IN EQUIPMENT & SOFTWARE CURA	

Continued on next page

Table 11 – continued from previous page

data	periods	sources	description	comments
	1950q1–2005q1	National Accounts (BEA - Datastream)	US GOVT CONSMPTN.EXPNDS & INVESTMENT - EQUIPMENT & SOFTWARE CURA	
Investment - SH	1990q1–2005q1	National Accounts (BEA - Datastream)	US PRIVATE FIXED INVESTMENT IN STRUCTURES CONA	backcasted with deflated US PRIVATE FIXED INVESTMENT IN STRUCTURES CURA before 1990q1
	1990q1–2005q1	National Accounts (BEA - Datastream)	US GOVT CNSMPT EXPENDITURES & INVESTMENT - STRUCTURES CONA	backcasted with deflated US GOVT CONSUMPTION EXPNDS& INVESTMENT - STRUCTURES CURA before 1990q1
	1950q1–2005q1	Authors' calculation	Sum of backcasted private and public invt in structures	
	1950q1–2005q1	National Accounts (BEA - Datastream)	US PRIVATE FIXED INVESTMENT IN STRUCTURES CURA	
	1950q1–2005q1	National Accounts (BEA - Datastream)	US GOVT CONSUMPTION EXPNDS& INVESTMENT - STRUCTURES CURA	
CUR	1967q1-2005q1	Federal Reserve - Datastream	US CAPACITY UTILIZATION RATE - ALL INDUSTRY SADJ	backcasted with CAPACITY UTILIZATION IN MANUFACTURING - FED. RESERVE BOARD SA before 1967q1
	1948q1-2005q1	Macro database (BIS)	CAPACITY UTILIZATION IN MANUFACTURING - FED. RESERVE BOARD SA	

B.2 Some Remarks on the Measure of US Capital Stock

This section briefly discusses the differences in capital stock data for the US economy depending on the calculation method, the sectors and the products. First, we use BEA's investment data to compute capital stock data with the methodology described in this paper using 9.5% and 1.5% *per annum* depreciation rates for respectively MES and SH investment. We then agregate both data to compute the whole economy capital stock. We compare our estimates with the BEA's capital stock data (see Table 12).

Table 12: Average annual growth rate of fixed capital stock : a comparison with BEA's data (%)

	91-95		95-00		00-04	
	BEA	Authors	BEA	Authors	BEA	Authors
Total	2.1	2.6	2.8	3.5	2.5	3.2
MES	2.9	5.1	5.3	7.8	3.6	5.8
SH	1.8	2.2	2.3	2.5	2.3	2.4

Sources : NIPA, Table 9.1. Real Net Stock of Fixed Assets and Consumer Durable Goods for BEA and authors' calculations based on BEA's investment data. MES and SH stand for Material, Equipment, and Software and Strcuctures including Housing respectively.

Our estimates of capital stock growth rates appear to be higher than BEA's (roughly 0.5 percentage point for the whole economy resulting from 2 percentage points for MES and about 0.2 point for SH) mainly due to composition effects. Indeed, the BEA's estimates are based on a disagregated approach with specific by-product depreciation rates. For the period 1995-2000, the use of higher depreciation rates for the IT component of capital growth tends to lower the capital stock growth as far as the agregate data are concerned.

Second, we compute capital stock data for different sectors (see Table 13) and we compare them with our whole economy approach. When considering private sector excluding housing, the average capital growth is roughly 1 point higher than for the whole economy.

Table 13: Average annual growth rate of fixed capital stock by products and sectors for the US economy (%)

	91-95	95-00	00-04
Whole economy			
Total	2.6	3.5	3.2
MES	5.1	7.8	5.8
SH	2.2	2.5	2.4
Private			
Total	2.7	3.8	3.3
MES	5.4	8.8	6.1
SH	2.2	2.6	2.4
Private excl. housing			
Total	3.0	4.6	3.5
MES	5.4	8.8	6.1
SH	2.0	2.3	1.8
Private non-farm			
Total	2.7	3.8	3.3
MES	5.5	8.9	6.1
SH	2.2	2.6	2.4

Sources : Authors' calculations based on BEA's investment data.

Note : Figures presented here can slightly differ from data used in our estimates since we back-date investment data on a longer period with Maddison (2003).

Lastly, we compare the contribution of capital deepening to labor productivity growth with other estimates based on BLS's mutlifactor productivity data.

Table 14: Contributions to Growth in Labor productivity, a Comparison with BLS's data-based estimates

	89-95		95-01	
	Authors	O&S[a]	Authors	O&S
Labour productivity growth	1.31	1.54	2.17	2.43
Capital deepening	0.28	0.52	0.52	1.19

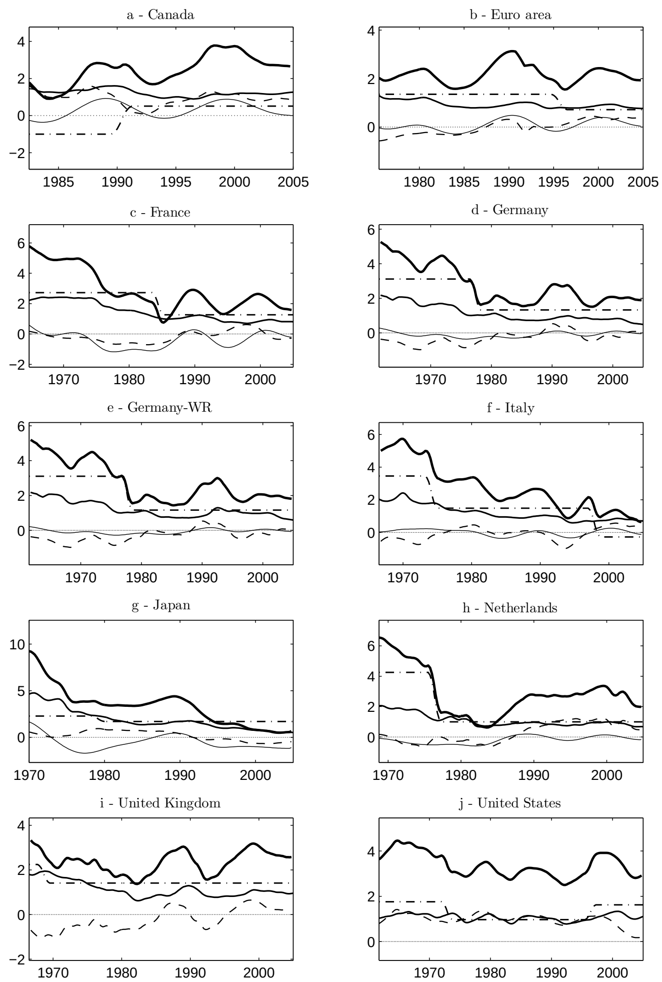
Sources : Authors' calculations based on BEA's investment data and Oliner and Sichel (2002)[a]. As for the latter, figures cover the non farm business sector only.

It is worth noting that results of Oliner and Sichel (2002) are higher than our estimates (see Table 14) because of (i) difference in sectors (non farm business with BLS data) and (ii) difference in method between BLS and BEA for the capital stock calculation. Indeed, the appropriate comparison with BEA stocks is BLS measure of productive stocks which currently show a 2.7% growth rate for the 1995-2000 period for the private business sector. BEA did make a number of changes to their 1995-2000 estimates so that the data is not totally comparable. Moreover, BLS data currently does not incorporate the new BEA investment measures through 2004. As far as we know, the BLS data should be revised soon and the analaysis of the recent US growth sources could be updated downwards concerning the contribution of capital.

To conclude, our estimates of the growth of capital stock are consistent with those published by the BEA, especially for the 1995-2000 period. On the contrary, other estimates based on BLS multifactor productivity tend to over estimate the contribution of capital stock for the whole economy.

C Additional tables and figures

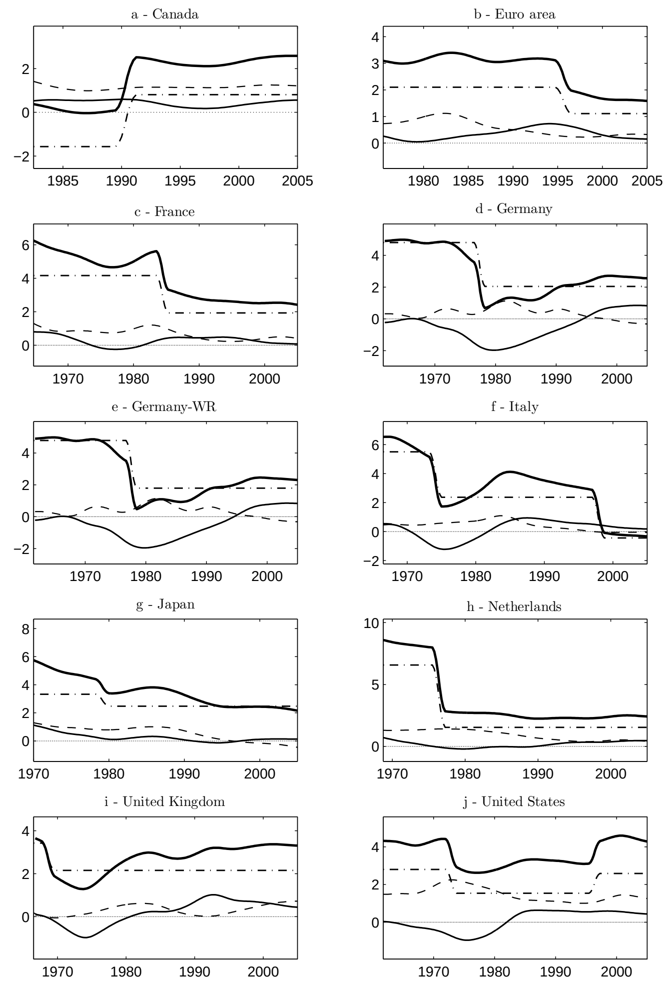
This last section contains additional figures and tables. Figure 3 below shows the path of medium term potential growth and its contributions.



Legend : (▬▬) medium term potential growth, (▬▬) capital stock, (- - -) labour, (- · - · -) TFP, and (——) age of MES capital stock.

Figure 3: Medium term potential growth and contributions

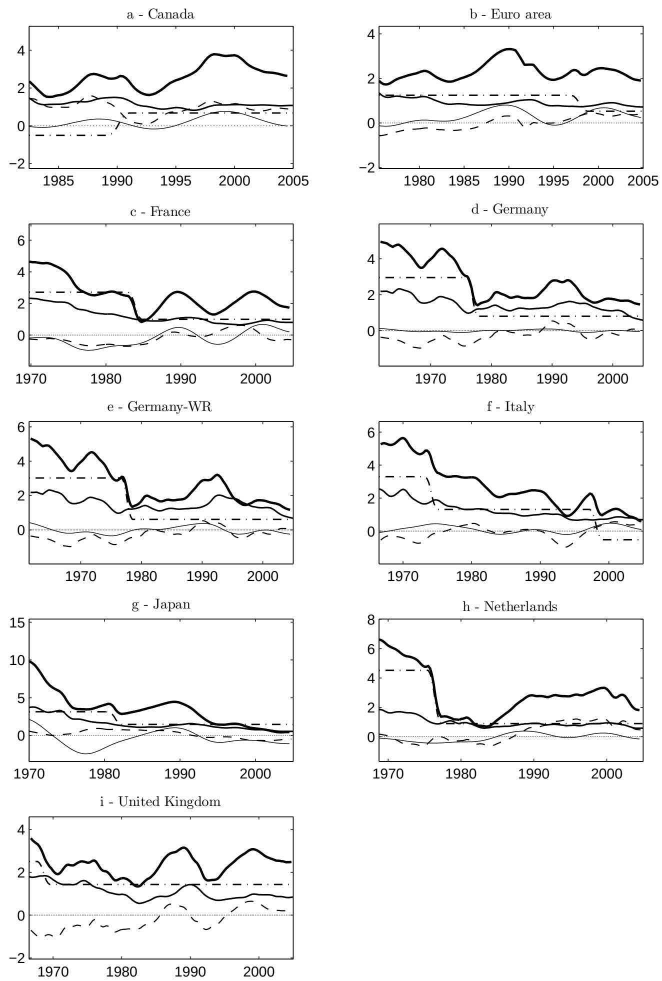
Figure 4 below shows the path of long term potential growth and its contributions.



Legend : (▬▬) long term potential growth, (——) relative prices, (- - -) labour, and (- · -) TFP.

Figure 4: Long term potential growth and contributions

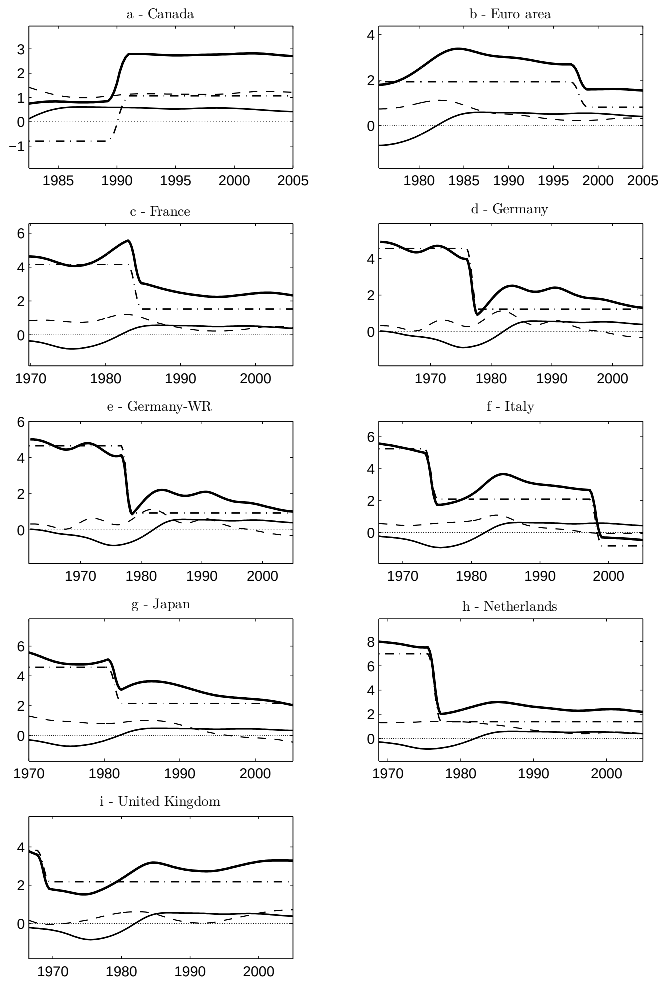
Figure 5 below shows the path of medium term potential growth and its contributions, including US relative prices correction.



Legend : (▬▬) medium term potential growth, (▬▬) capital stock, (- - -) labour, (- · · · -) TFP, and (——) age of MES capital stock.

Figure 5: Medium term potential growth and contributions (US relative prices correction)

Figure 6 below shows the path of long term potential growth and its contributions, including US relative prices correction.



Legend : (——) long term potential growth, (——) relative prices, (- - -) labour, and (- · -) TFP.

Figure 6: Long term potential growth and contributions (US relative prices correction)

Part 1: Sources of medium term potential output growth

	Period 1991–1995					Period 1995–2000					Period 2000–2004				
		Contributions)					Contributions					Contributions			
Economy	Growth	Capital	Labour	TFP	Age	Growth	Capital	Labour	TFP	Age	Growth	Capital	Labour	TFP	Age
Canada	2.1	1.1	0.4	0.5	0.1	3.2	1.1	1.1	0.5	0.6	3.0	1.2	0.9	0.5	0.4
Euro area	2.3	0.9	0.0	1.3	0.1	2.0	0.8	0.3	0.8	0.1	2.2	0.9	0.4	0.7	0.2
France	1.8	1.0	0.0	1.3	-0.5	2.2	0.8	0.4	1.3	-0.3	2.0	0.9	-0.2	1.3	0.1
Germany	2.3	0.9	0.1	1.3	0.0	1.8	0.8	-0.3	1.3	0.0	2.0	0.7	-0.1	1.3	0.0
Germany-WR	2.5	1.1	0.1	1.2	0.0	1.9	1.0	-0.3	1.2	0.0	1.9	0.8	-0.1	1.2	0.0
Italy	1.4	0.8	-0.7	1.5	-0.2	1.4	0.7	0.1	0.6	0.0	1.1	0.8	0.5	-0.3	0.1
Japan	2.3	1.3	-0.1	1.5	-0.3	1.3	0.9	-0.4	1.5	-0.7	0.6	0.7	-0.6	1.5	-0.9
Netherlands	2.7	0.8	1.0	1.0	-0.1	3.0	0.9	1.1	1.0	0.0	2.6	0.8	0.8	1.0	0.0
United Kingdom	1.9	0.9	-0.4	1.4	-	2.8	0.9	0.4	1.4	-	2.7	1.0	0.3	1.4	-
United States	2.7	0.9	0.9	1.0	-	3.6	1.1	1.0	1.5	-	3.2	1.2	0.4	1.6	-

Part 2: Sources of long term potential output growth

	Period 1991–1995				Period 1995–2000				Period 2000–2004			
		Contributions)				Contributions				Contributions		
Economy	Growth	Rel. prices	Population	TFP	Growth	Rel. prices	Population	TFP	Growth	Rel. prices	Population	TFP
Canada	2.3	0.4	1.1	0.8	2.2	0.2	1.1	0.8	2.5	0.5	1.2	0.8
Euro area	3.1	0.7	0.4	2.0	2.0	0.5	0.2	1.2	1.6	0.2	0.3	1.1
France	2.7	0.5	0.3	1.9	2.5	0.3	0.3	1.9	2.5	0.1	0.5	1.9
Germany	2.2	-0.2	0.3	2.0	2.6	0.6	0.0	2.0	2.6	0.8	-0.2	2.0
Germany-WR	1.9	-0.2	0.3	1.8	2.3	0.6	0.0	1.8	2.4	0.8	-0.2	1.8
Italy	3.2	0.6	0.2	2.4	1.4	0.4	0.0	1.0	-0.3	0.2	-0.1	-0.4
Japan	2.7	-0.1	0.3	2.5	2.4	0.0	-0.1	2.5	2.3	0.1	-0.3	2.5
Netherlands	2.3	0.2	0.5	1.5	2.3	0.4	0.4	1.5	2.5	0.4	0.5	1.5
United Kingdom	3.2	0.9	0.1	2.2	3.2	0.7	0.4	2.2	3.4	0.5	0.7	2.2
United States	3.2	0.6	1.0	1.5	4.1	0.6	1.2	2.3	4.5	0.5	1.4	2.6

Table 15: Sources of potential output growth, medium vs long term

Part 1: Sources of medium term potential output growth (US relative prices correction)

Economy	Period 1991–1995					Period 1995–2000					Period 2000–2004				
		Contributions)					Contributions					Contributions			
	Growth	Capital	Labour	TFP	Age	Growth	Capital	Labour	TFP	Age	Growth	Capital	Labour	TFP	Age
Canada	2.0	1.0	0.4	0.7	-0.1	3.3	1.0	1.1	0.7	0.5	3.0	1.1	0.9	0.7	0.3
Euro area	2.4	0.9	0.0	1.2	0.2	2.2	0.8	0.3	0.9	0.3	2.2	0.8	0.4	0.5	0.5
France	1.7	0.9	0.0	1.0	-0.3	2.2	0.7	0.4	1.0	0.0	2.2	0.9	-0.2	1.0	0.5
Germany	2.4	1.6	0.1	0.8	0.0	1.7	1.3	-0.3	0.8	0.0	1.6	0.9	-0.1	0.8	0.0
Germany-WR	2.6	1.9	0.1	0.6	0.0	1.6	1.5	-0.3	0.6	-0.1	1.5	1.0	-0.1	0.6	-0.1
Italy	1.4	0.9	-0.7	1.3	-0.1	1.5	0.7	0.1	0.5	0.2	1.0	0.8	0.5	-0.5	0.3
Japan	2.3	1.3	-0.1	1.5	-0.3	1.3	0.9	-0.4	1.5	-0.7	0.6	0.7	-0.6	1.5	-0.9
Netherlands	2.8	0.8	1.0	0.9	0.0	3.0	0.9	1.1	0.9	0.1	2.5	0.8	0.8	0.9	0.0
United Kingdom	1.9	0.8	-0.4	1.4	-	2.7	0.9	0.4	1.4	-	2.6	0.9	0.3	1.4	-

Part 2: Sources of long term potential output growth (US relative prices correction)

Economy	Period 1991–1995				Period 1995–2000				Period 2000–2004			
		Contributions)				Contributions				Contributions		
	Growth	Rel. prices	Population	TFP	Growth	Rel. prices	Population	TFP	Growth	Rel. prices	Population	TFP
Canada	2.8	0.6	1.1	1.1	2.8	0.6	1.1	1.1	2.8	0.5	1.2	1.1
Euro area	2.8	0.5	0.4	1.9	2.2	0.5	0.2	1.4	1.6	0.5	0.3	0.8
France	2.3	0.5	0.3	1.5	2.3	0.5	0.3	1.5	2.4	0.5	0.5	1.5
Germany	2.1	0.5	0.3	1.2	1.8	0.5	0.0	1.2	1.5	0.5	-0.2	1.2
Germany-WR	1.8	0.5	0.3	0.9	1.5	0.5	0.0	.9	1.2	0.5	-0.2	.9
Italy	2.8	0.6	0.2	2.1	1.3	0.6	0.0	0.7	-0.4	0.5	-0.1	-0.8
Japan	2.9	0.4	0.3	2.1	2.5	0.4	-0.1	2.1	2.3	0.4	-0.3	2.1
Netherlands	2.4	0.5	0.5	1.4	2.3	0.5	0.4	1.4	2.3	0.5	0.5	1.4
United Kingdom	2.8	0.5	0.1	2.2	3.1	0.5	0.4	2.2	3.3	0.4	0.7	2.2

Table 16: Sources of potential output growth, medium vs long term (US relative prices correction)

Table 17 shows the estimated breaks on GDP potential growth trend

Table 17: Breaks on GDP potential growth trend

	Start date	Break 1	Break 2
Canada	1962q2	1975q2(-)	
Euro area	1963q2	1973q3(-)	
France	1963q2	1974q1(-)	
Germany	1960q2	1972q4(-)	
Germany-WR	1960q2	1972q4(-)	
Italy	1960q2	1973q4(-)	1989q3(-)
Japan	1970q1	1992q1(-)	
United Kingdom	1960q2	1973q3(-)	1982q2(+)
United States	1960q1	1966q3(-)	1996q1(+)

References

Acemoglu, D., Aghion, P., Zilibotti, F. (2006). "Distance to Frontier, Selection, and Economic Growth". *Journal of the European Economic Association*, 4(1), 37–74, March.

Alesina, A., Ardagna, S., Nicoletti, G., Schiantarelli, F. (2003). "Regulation and Investment". *NBER Working Paper*, N^o 9560, March.

Baghli, M., Cahn, C., Villetelle, J.-P. (2006). "Estimating Potential Output with a Production Function for France, Germany and Italy". In: de Bandt, O., Herrmann, H., Parigi, G. (Eds.), *Convergence or Divergence in Europe? Growth and Business Cycles in France, Germany and Italy.* Springer Verlag, pp. 159–181.

Bai, J., Perron, P. (1998). "Estimating and Testing Linear Models whith Multiple Structural Breaks". *Econometrica*, 66(1), 47–78.

Bai, J., Perron, P. (2003). "Computation and Analysis of Structural Changes Models". *Journal of Applied Econometrics*, 18, 1–22.

de Bandt, O., Herrmann, H., Parigi, G. (2006). *Convergence or Divergence in Europe? Growth and Business Cycles in France, Germany and Italy.* Springer Verlag, pp. 159–181.

Banque de France (2002). "Potential Output Growth, the Economys Position in the Cycle and Inflationary Pressures". *Banque de France Bulletin Digest*, N^o 106, October.

Belorgey, N., Lecat, R., Maury, T., and Pluyaud, B. (2004). "Productivité par employé: rupture de tendance et déterminants". In: Artus, P., Cette, G. (Eds.), *Productivité et croissance.* Rapport du Conseil d'Analyse Économique, pp. 245–264, June.

Bourdin, J. (2004). "Rapport d'information, fait au nom de la délégation du Sénat pour la planification, sur les incidences économiques d'une augmentation des dépenses de recherche en Europe". *Annexe au procès-verbal de la séance du 30 juin 2004*, N^o 391.

Brécart, D., Fougeyrollas, A., Lemiale, L., Le Mouël, P., Zagamé, P. (2003). "Évaluation pour la France des conséquences de l'augmentation de l'effort de R&D". *Annexe au Rapport d'information N^o 391 du Sénat fait au nom de la délégation du Sénat pour la planification, sur les incidences économiques d'une augmentation des dépenses de recherche en Europe.*

Cette, G., Delessy, H. (1997). "Écart de PIB: une grande variété de méthodes et de diagnostics". *Économie Internationale*, 69(1), 5–16.

Cette, G., Mairesse, J., Kocoglu, Y. (2005). "ICT diffusion and potential output growth". *Economics Letters*, 87(2), 231–234, May.

Cette, G., Szpiro, D. (1989). "Une interprétation du ralentissement de la productivité industrielle au moment du second choc pétrolier". *Économie et Prévision*, 87, 33–42.

European Commission (2006). "Time to Move Up A Gear". *The European Commission's 2006 Annual Progress Report on Growth and Jobs.*

Hodrick, R., Prescott, E.C. (1997). "Postwar U.S. Business Cycles: An Empirical Investigation". *Journal of Money, Credit, and Banking*, 29(1), 1–16, February.

Jorgenson, D. (2005). "Information Technology and the G7 Economies". *mimeo*, Harvard Univesity, May.

Jorgenson, D., Stiroh, K. (1999). "Productivity Growth: Current Recovery and Longer-Term trend". *The American Economic Review*, 89(2), 109–150, May.

Jorgenson, D., Vu, K. (2005). “Information Technology and the World Economy”. *Scandinavian Journal of Economics*, 107(4), 631–650.

Le Bihan, H. (2004). “Tests de rupture: une application au PIB tendanciel français”. *Économie et Prévision*, 163(2), 133–154.

Lequiller, F., Sylvain, A. (2006). “Partage de la valeur ajoutée: éléments descriptifs et comparaison internationale”. *11th Symposium of the National Accounting Association*, conferences proceedings, January.

Maddison, A. (2003). “Essays on Innovation Natural Resources and the International Economy, Standardized Estimates of Fixed Capital Stock: a Six Country Comparison”. *Innovazione E Materie Prime*, April, 1–29.

Newey, W., West, K. (1987). “A Simple, Positive Definite, Heteroscedasticity and Autocorrelation Consistent Covariance Matrix”. *Econometrica*, 55(3), 703–708.

OECD (2005). “OECD Economic Outlook”. N^o 78, December.

OECD (2006). “OECD Factbook 2006: Economic, Environmental and Social Statistics”. available at: `www.SourceOECD.org/factbook`.

Oliner, S., Sichel, D. (2002). “Information Technology and Productivity: Where Are We Now and Where Are We Going?”. *Federal Reserve Bank of Atlanta Economic Review*, 3rd Quarter, 15–44.

Richardson, P., Boone, L., Giorno, C., Meacci, M., Rae D., Turner D. (2000). “The Concept, Policy Use and Measurement of Structural Unemployment: Estimating a Time Varying NAIRU Across 21 OECD Countries”. *OECD Economics Department Working Papers*, N^o 250, June.

Stock, J.H. (2004). “Inflation Persistence in the Euro Area: Evidence from Aggregate and Sectoral Data”. *Inflation Persistence Network Conference*, conferences proceedings, December.

University of Groningen (2005). Groningen Growth and Development Centre and The Conference Board. Total Economy Database, August.

Villetelle, J.-P. (2004). “Le bloc d’offre de la maquette zone euro”. *Banque de France*, Internal Document, December.