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A COMPARISON

by Christophe Cahn
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In 2007 all ECB publications feature a motif taken from the €20 banknote.

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2 Corresponding author: Banque de France, DAMEP, 31 rue Croix des Petits Champs, 75049 Paris Cedex, France; e-mail: christophe.cahn@banque-france.fr
3 European Central Bank, Kaiserstrasse 29, 60311 Frankfurt am Main, Germany, and Banque de France; e-mail: arthur.saint-guilhem@ecb.int

Address
Kaiserstrasse 29
60311 Frankfurt am Main, Germany

Postal address
Postfach 16 03 19
60066 Frankfurt am Main, Germany

Telephone
+49 69 1344 0

Website
http://www.ecb.europa.eu

Fax
+49 69 1344 6000

Telex
411 144 ecb d

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CONTENTS

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, the United Kingdom, and the United States— for the period 1991-2004. The main estimates rely on a structural approach where output of the whole economy is described by a Cobb-Douglas function. This framework enables us to take temporal considerations into account, depending on the assumed volatility of potential output. Moreover, this study presents two original features, in other words, 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 assume a stable ratio in volume terms. Lastly, we use univariate methods as a benchmark. Even though 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 remained below their potential growth rate during the recent period by identifying the sources of long-run potential growth.

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

Non technical summary.

In this paper, we present estimates of medium- and long-term potential growth for several economies, namely: Canada, the euro area, France, Germany, Italy, Japan, the Netherlands, the United Kingdom, and the United States, over the period 1991-2004. Our main findings rely on a structural approach based on an explicit production function using Solow's neoclassical model as a benchmark. We consider the productive capacity of the economy as a whole, which enables us to collect the data more rapidly and to compute harmonized capital stock data based on the permanent inventory technique with National Accounts real investment data as an input. More importantly, this study sets out two original features. First, after constructing consistent and homogenous capital stock series, we assess the importance of IT equipment as a determinant of potential growth in the long run. More precisely, we explicitly distinguish - among the determinants of potential growth - between technological change and the effects of the vast and continuing substitution of IT equipment for other forms of capital and labour that took place during the 1990's. To do so, we assume capital-deepening effects based on a stable capital/output ratio in value terms, whereas standard estimations usually assume a stable ratio in volume terms. This enables us to consider relative investment prices - whose decline during the 1990's was often considered as a relevant indicator for the substitution of IT equipment to other forms of capital - as a determinant of potential growth in the long run. Second, our methodology enables us to distinguish between model-based medium and long term estimates, which is of importance for a policy-oriented point of view. Indeed the gap between medium and long term estimates provides some interesting highlights on the relative performances of the various economies considered, regarding the potential effects of higher efficiency in the use of production factors in the medium term.

The main results of our research are as follows: there is a clear distinction between European countries and Japan on the one hand and the United States on the other hand with regard to the sources of economic growth over the last fifteen years.

First, our findings suggest that differences in the growth of labour input, rather than capital input, have played a crucial role in terms of explaining the shortfall in growth in Europe (except for the Netherlands) and Japan as compared with the United States and Canada. As for the Netherlands, its labour contribution to growth appears to be higher than other European economies, owing to a significant increase in the participation rate between 1991 and 2000. For Canada and the United States, more favourable demographic developments account primarily for the higher labour contribution. Second, divergence in potential output growth between the United States and European countries could be partly explained by total factor productivity (TFP) developments, as its contribution in the US largely exceeds those in Europe —except for the United Kingdom— in the long term. This seems to coincide with more important R&D efforts in the US. Finally, by putting our results in prospect it appears that not only the European economies but also the United States have lost some opportunities of growth over the period 1991-2004, with actual growth being below medium term and long term potential.

1 Introduction

For a central banker, potential growth estimates are a major concern for several reasons. First, they provide a quantitative assessment of inflationary pressures on product and labour markets at the agregate level. Measurements of the output gap, defined as the difference between actual and potential output, may be used for such an assessment. Second, for monitoring purposes, quarterly measurements of output gap can be drawn upon as a composite and simple indicator of the economy's position in the business cycle. Finally, potential growth estimates may also be used for macroeconomic forecasts. For all these reasons, several research projects have been carried out in central banks on potential growth estimates.[1] Recent developments in Europe have also stimulated fresh interest in potential output growth measures, particularly those based on structural approaches. In fact, the need for structural reforms in Europe is all the more obvious as international comparisons suggest that potential growth in Europe remained below other areas or countries over the past two decades, especially as compared to the United States, . From this point of view, the breakdown of potential growth between labour and capital contributions is a simple but accurate way to ascertain which reforms should be preferably implemented.

In this paper, we present estimates of potential growth for several economies, namely: Canada, the euro area, France, Germany, Italy, Japan, the Netherlands, the United Kingdom, and the United States. Our main findings rely on a structural approach. Following Baghli, Cahn, and Villetelle (2006), we use Solow's neoclassical model and the so-called production function framework. In the Solow's model, economic growth is a function of standard factors of production (labour 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 the 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 work of Bai and Perron

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

(1998, 2003).[2] Regarding the collection of the data, contrary to Baghli et al. (2006) where only the business sector is modelled, we consider the productive capacity of the economy as a whole. This enabled us to collect the data more rapidly and to compute harmonized capital stock data based on the permanent inventory technique using National Accounts data as an input.

This study presents two original features. First, after constructing consistent and homogenous capital stock series, we assess the importance of IT equipment as a determinant of potential growth in the long run. More precisely, we explicitly distinguish - among the determinants of potential growth - between technological change and the effects of the vast and continuing substitution of IT equipment for other forms of capital and labour that took place during the 1990's. To do so, we assume capital-deepening effects based on a stable capital/output ratio in value terms, whereas standard estimations usually assume a stable ratio in volume terms. This leads us to consider relative investment prices - which declined significantly during the 1990's, possibly as a result of IT substitution effects - as a determinant of potential growth in the long run. Second, we distinguish between two time horizons, namely medium and long term estimates, both associated with different steady-state conditions. This distinction might be interesting from a policy-oriented point of view. Indeed the gap between medium and long term estimates provides some interesting highlights on the relative performances of the various economies considered, regarding the potential effects of higher efficiency in the use of production factors in the medium term. In addition, we also distinguish between two sources of TFP growth, namely an exogenous technical progress -modelled as the deterministic trend- and a capital embodied technical progress, partly captured by the effect of capital ageing on TFP. Regarding the distinction between medium term and long term estimates, the literature on potential growth includes various approaches that cover various time horizons, from the short to the long run, depending on the assumed volatility of potential output. Generally speaking, the further the horizon is, the less affected by short-term fluctuations and shocks the production is, while

[2] We consider this package as convenient in order to identify possible breaks in the trend component. Going further, one would investigate all the variables supposed to be directly affected by TFP breaks in order to test the robustness of the occurring dates. Nevertheless, we did not consider these econometric extensions as they were beyond the scope of this paper and we postponed them for further research.

structural changes become more prominent.[3] In the structural approach, the horizon determines the nature of the constraints faced by the economy. In the short run, one may consider production inputs as rigid and the degree of utilisation of the productive capacity could be, for instance, the only factor driving output fluctuations in deviation from its potential. In the medium term, accumulated factors of production –such as capital and labour– might adjust according to limited rigidities. For instance, as regards the contribution of labour, 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, for instance, to demographic assumptions, 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), as well as the determinants of total factor productivity. Second, we analyze the long-run steady path where the economy grows in line with changes in the labour force, technological changes and changes in the relative price of investment. As already mentioned, this relative price factor is incorporated in order to take into account, over the sample, the nominal rather than real stability of capital intensity. For the whole panel of countries except the United States, we also compute an alternative measure of real investment data, using US investment prices. While carrying this out, we compute two different measures of 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 data from the quality bias related to IT products, using the US chained-price index as a benchmark. Furthermore, the distinction between the medium and the long term makes it possible to compute indicators of inflationary pressures in both the medium and long term. As already mentioned, it also enables us, as far as the structural reforms diagnosis is concerned, to compare long- and medium-term potential growth and to assess whether actual economic performance was far below the long-term potential or not.

The main results of our research are as follows: there is a clear distinction between European countries and Japan on the one hand and the United States on the other

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

hand with regard to the sources of economic growth over the last fifteen years. First, our findings suggest that differences in the growth of labour input, rather than capital input, have played a crucial role in terms of explaining the shortfall in growth in Europe (except for the Netherlands) and Japan as compared with the United States and Canada. As for the Netherlands, the labour contribution appears to be higher than other European economies, owing to a significant increase in the participation rate between 1991 and 2000. As for Canada and the United States, more favourable demographic developments account primarily for the higher labour contribution. Second, divergence in potential output growth between the United States and European countries are also partly explained by total factor productivity (TFP) developments, as its contribution in the US largely exceeds those in Europe -except for the United Kingdom. This seems to coincide with more important R&D efforts in the US. As far as the US economy is concerned, our results suggest that total factor productivity growth accelerated in the mid-1990s. 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 1990s. Our paper suggests that this development is mainly reflected by the acceleration in TFP growth, maybe related to wider dissemination of knowledge throughout the economy. Finally, by putting our results into prospect it appears that not only the European economies but also the United States have lost some opportunities of growth over the period 1990-2004, with actual growth being below medium term and long term potential.

The main results of our research are as follows: there is a clear distinction between European countries and Japan and the United States with regard to the sources of growth that explain actual economic achievements during the last fifteen years. First, our findings suggest that differences in the growth of labour input, rather than capital input, have played a crucial role in terms of explaining the shortfall in growth in Europe (except the Netherlands) and Japan as compared with the United States. The Netherlands is a European exception, since it shows a very high labour contribution due to a significant increase in the participation rate between 1991 and 2000, corresponding to the wage restraint policy implemented during this period. For Canada and the United States, more favourable demographic developments account primarily for the higher labour contribution. As far as the US economy is concerned, our results suggest total factor productivity growth accelerated in the mid-1990s. 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 1990s. Our paper suggests that this development is mainly reflected by the acceleration in TFP growth, maybe related to wider dissemination of knowledge throughout the economy.

All in all, these findings could confirm possible directions for structural reforms in Europe, on the labour market for instance, as well as the need for specific economic policies, especially with respect to immigration, natality or innovation. These conclusions plead in favour of keeping up the pace and pursuing efforts in Europe to follow the Lisbon "strategy for growth and jobs."[4]

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 outlines our conclusions.

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 time horizon.

2.1 General overview

We consider that economy-wide production technology can be represented by a Cobb-Douglas-like production function with a constant return to scale on labour and capital. Analytically, we 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 stands for per capita hours worked. Parameters α, γ,

[4] See European Commission (2006) for instance.

and σ represent, respectively, the share of wages, the growth rate of a pure exogenous deterministic technical change, and a scale factor.

The stock of available productive capital is derived 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 amounting 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:[5]

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

Let us denote g_t the log of Total Factor Productivity (TFP).[6] The two-step approach we adopt consists in, first, setting the share of labour at its average level over the sample to define the TFP as the Solow residual of the neoclassical model:[7]

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

From the above mentioned definitions, we derive the following theoretical definition of the TFP:

$$g_t = \sigma + \gamma t + (1 - \alpha)(cur_t + \epsilon(t - \tau_t)). \tag{3}$$

Finally, we derive from this theoretical framework the TFP empirical reduced form that we will estimate. The impacts of the determinants of TFP, around a time trend, are estimated by using the following specification:[8]

$$g_t = \gamma_0 + \gamma_1 g_{t-1} + \gamma_2(cur_t - \overline{cur}) + \gamma_3(\tau_t - \overline{\tau}) + \gamma_4 t + \gamma_5 t_1 + \gamma_6 t_2 + \varepsilon_t, \tag{4}$$

where $cur_t - \overline{cur}$ is the gap between the capacity utilisation rate in logs and its long-term average, $\tau_t - \overline{\tau}$ is the gap between the age of the stock of capital equipment goods in absolute terms and its long-term average, ε_t is an error term.[9] Compared to the theoretical form, we introduce an autoregressive term to better capture inertia

[5]See Appendix A for further details.

[6]In the following, small case letters denote logarithms.

[7]See Section 3 for the calibrated values.

[8]For forecasting purposes, one would prefer to use a stochastic instead of a determinstic trend process in the TFP equation; in the former case, measurement errors could be less systematic than in the latter case. Nevertheless, as we keep a retrospective viewpoint in this paper, and we have some *a priori* about trend breaks, we do not consider stochastic trend in the TFP.

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

in the changes in TFP. The deterministic trend t is considered by assuming that the technical change is exogenous so that TFP grows at a piecewise constant rate in the long run. 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.[10] γ_2 measures the cyclical component of TFP. We expect TFP to grow as 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 TFP in such a way that the parameter γ_3 should be negative.

2.2 Medium Term Developments

Ascertaining the medium-term trend in TFP requires two assumptions. First, we assume that the growth rate in 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 $cur_t = \overline{cur}$. From the first assumption, we can write medium-term TFP (in logs) as $\tilde{g}_t = \tilde{g}_{t-1} + \rho$. Accordingly, after a few calculations presented in Appendix A, we obtain the following equation which defines medium-term TFP:

$$\begin{aligned} \tilde{g}_t \;=\; & \frac{\gamma_0 - \rho + \gamma_4 + \gamma_5(1-T_1)\mathbb{I}(t>T_1-1) + \gamma_6(1-T_2)\mathbb{I}(t>T_2-1)}{1-\gamma_1} \\ & + \frac{\gamma_3}{1-\gamma_1}(\tau_{t+1} - \overline{\tau}) + \left(\frac{\gamma_4 + \gamma_5\mathbb{I}(t>T_1-1) + \gamma_6\mathbb{I}(t>T_2-1)}{1-\gamma_1}\right) t. \end{aligned} \quad (5)$$

In the medium run, TFP fluctuates around a trend that can be divided into a measure of capital embodied technical progress which includes ageing effects, given by the RHS's second line of equation (5), 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 changes in the CUR. 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.[11]

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

[11] Drawing a parallel with the underlying structural parameters and functional specification, the following considerations apply. The coefficient related to embodied capital improvement would be $\epsilon \equiv 1/(1-\alpha).(-\gamma_3)/(1-\gamma_1)$, 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

After computing 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:

$$N_t^* = \Omega_t^* r_t^* (1 - u_t^*), \tag{6}$$

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).[12] As regards absolute terms, in the medium term, potential GDP is given by:

$$Y_t^* = K_t^{1-\alpha} (N_t^* h_t^*)^\alpha e^{\tilde{g}_t}. \tag{7}$$

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.[13] Then, we set the participation rate r_t^*, NAIRU u_t^*, and the worked hours h_t^* at their average level. Finally, we assume that the output/capital ratio is stable in nominal terms throughout the sample rather than in volume. Supported by recent empirical studies (Jorgenson and Stiroh, 1999; Cette et al., 2005), this assumption addresses the question of a relevant price/volume split for investment series, that consequently affect series of capital stock services, which could take into account the impact on growth accounting of the lasting, huge decrease in some investment prices, as those related to IT products for instance. If from a theoretical point of view, prices are expected to grow at the same rate and output/capital ratio is expected to remain broadly constant, this is not corroborated by the data. Main possible explanations of this phenomena deal with the nature of series taken from national accounts -at constant prices, chained index, and so forth- and the pertinence of quality-adjustment in the data. Taking into account

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.

[12] 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).

[13] 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.

the discrepancy related to relative prices observed in the last decades leads us to consider the following equation:

$$\frac{P_t^Y Y_t^*}{P_t^I K_t} = \zeta, \tag{8}$$

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 changes in the working age population. As a consequence, potential GDP growth in the long run is given by:[14]

$$\triangle y_t^* = \triangle \omega_t^* + \frac{1}{\alpha}\left(\frac{\gamma_4 + \gamma_5 \mathbb{I}(t > T_1 - 1) + \gamma_6 \mathbb{I}(t > T_2 - 1)}{1 - \gamma_1}\right) + \frac{(1-\alpha)}{\alpha} \triangle \ln\left(\frac{P_t^Y}{P_t^I}\right), \tag{9}$$

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.[15]

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.

Such an approximation is consistent with the assumption of a Cobb-Douglas like production function and constant returns to scale. To estimate potential growth,

[14] Appendix A provides the details.

[15] 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.

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.

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 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 an annual frequency constructed by Maddison (2003) for France, Germany, Japan, the Netherlands, United Kingdom, and the United States.[16] We paid particular attention to the 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 the investment series, we used an aggregate made up by France, Germany, Italy, and the Netherlands, in order to give a breakdown by capital goods. With respect to Germany, we computed two different capital stock series based on two different assumptions regarding investment. In 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,— while the other 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 extreme cases might define the boundaries of the true path of investment for Germany as a whole.

[16]See Appendix B for further details.

Furthermore, as mentioned in the introduction, we also computed an alternative measure of real investment data, using US investment prices as a deflator.[17] In order to do so, we computed two different capital stock series, and therefore two different measures of TFP, 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 computed 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 data on gross fixed capital formation by product as the only input. 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 did not have at our disposal long investment series for the euro area, Canada and Italy.[18] We used the same depreciation rates as for France for the whole panel, namely, 2.4 % and 0.4 % per quarter for MES and SH capital stock, respectively.

We particularly investigated our assessment of capital stock for the US economy. Indeed, we noticed that our data could be deemed to underestimate capital stock growth in the 1995-2000 period for the US economy compared to other studies.[19] We discuss this matter in Appendix B and give a possible explanation for these differences in the magnitude of capital stock deepening in 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 conventional approaches that focus on business sector excluding housing. For the sake of comparison, we corrected our data of this sector effect and found that our capital stock growth appears to be higher than the BEA's figure, 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. A point worth mentioning is that the US prices correction tends to slightly revise downwards the level of TFP for each

[17] 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.

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

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

economy, given that this correction implies a higher level of productive capital stock. This effect amounts to 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 %. Regarding Germany, the US prices correction appears to be meaningless, all the more so as our data show a stable output/capital ratio in real terms rather than nominal ones.[20]

4 Results

4.1 Estimates for the TFP

We test the existence of trend breaks in the TFP model according to equation (4), following Le Bihan (2004) and Bai and Perron (1998, 2003). We used a non-parametric correction of the residual autocorrelation based on the studies 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 deterministic trend equation. But since the residuals of such a regression are considered to be stationary, there is no particular trade-off with our approach consisting in testing the existence of a trend break in the structural 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 distinguish significantly the trend break from the potentially large effects of a persistent autoregressive process.[21] However, given the lack of any definitive and consensual view on this matter, we decided to perform tests in the structural model. Table 2 shows our results for break tests. We simultaneously tested the stability of the model by iterating on the initial estimation date, with the end date set in 2004q4. Consequently, we finally chose different starting estimation dates for each country, and selected the sample showing the best stability properties.

Generally speaking, the tests were all highly significant, but to 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 in the TFP occurring, roughly speaking, in the middle of the sample. For Germany, Italy, Japan, the Netherlands, and the United States, this negative

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

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.

break happened in the mid-1970s, and may be caused by the oil shock. As for Italy, a second negative break occurred in 1997q2, which may be viewed as the lasting effect of the 1993 recession and the 1992 monetary crisis. As for United Kingdom, the negative break took place quite early in 1968q1, though it is less significant than in other economies. In France, the negative break occurred quite late compared with common knowledge on the subject, in other words a negative break in the mid 1970s.[22] For the euro area, the negative break happened in the mid-1990s. Obviously, this result is not coherent with what we find for the four economies composing the main part of the euro area. But we preferred to start our estimates for the euro area quite late (in 1975q4), because of better properties in terms of stability, even though 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 roughly to the end of the severe 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

[22] Indeed 1983q4 appears to be a kind of center of mass between the early 70s and the early 90s. 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.

properties.[23] As for the US economy, the positive trend break in 1995q4 (+0.6 %) is consistent with the common view on this period.[24]

Estimation by ordinary least squares (OLS) of the TFP parameters of regression (4) 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 $cur_t - \overline{cur}$	γ_3 $\tau_t - \overline{\tau}$	γ_4 t	γ_5 t_1	γ_6 t_2
Canada	−2.82 (−6.73)	0.62 (10.97)	0.15 (5.94)	−7.1E-3 (−3.51)	−0.9E-3 (−5.21)	1.4E-3 (6.88)	–
Euro area[a]	−2.56 (−4.57)	0.67 (9.48)	0.07 (2.99)	−5.1E-3 –	1.1E-3 (4.48)	−0.5E-3 (−4.47)	–
France	−2.28 (−5.08)	0.72 (13.26)	0.08 (4.08)	−7.8E-3 (−4.36)	1.9E-3 (4.84)	−1.0E-3 (−4.69)	–
Germany	−3.11 (−6.39)	0.63 (10.97)	0.11 (4.57)	−2.4E-3 (−2.41)	2.9E-3 (6.21)	−1.7E-3 (−6.13)	–
Germany-WR	−3.17 (−6.53)	0.62 (10.73)	0.12 (4.90)	−1.9E-3 (−2.19)	2.9E-3 (6.36)	−1.8E-3 (−6.30)	–
Italy	−3.89 (−7.67)	0.53 (8.51)	0.15 (5.70)	−5.5E-3 (−2.79)	4.1E-3 (7.43)	−2.3E-3 (−7.03)	−2.1E-3 (−7.22)
Japan	−1.36 (−4.85)	0.71 (12.07)	0.06 (3.90)	−6.0E-3 (−3.91)	1.6E-3 (4.40)	−0.4E-3 (−2.74)	–
Netherlands	−3.81 (−6.94)	0.53 (7.78)	0.22 (5.07)	−4.7E-3 (−3.47)	5.0E-3 (6.29)	−3.8E-3 (−5.95)	–
United Kingdom	−2.42 (−5.35)	0.72 (13.50)	0.04 (2.20)	–	1.6E-3 (5.28)	−0.6E-3 (−4.08)	–
United States	−2.80 (−5.63)	0.64 (10.10)	0.08 (4.11)	–	1.6E-3 (5.10)	−0.7E-3 (−4.31)	0.6E-3 (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.[25] 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. With regard to the estimation of parameter related to the age of capital, France is the only country for which we are aware of a comparable assessment in the related literature. 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.

[23] We tried as far as possible not to select break dates that were to close to the bounds of the estimation sample to avoid business cycle effects.
[24] See for instance Oliner and Sichel (2002); Belorgey et al. (2004).
[25] One should keep in mind that for the 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.

The same tests and estimations have been performed with the US prices correction for 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 starting date, except for France (1970q1 instead of 1965q1) and the United Kingdom (1961q3 instead of 1961q2). Therefore the break dates are roughly similar, except for the euro area (1999q4 instead of 1995q1) and Japan (1980q4 instead of 1978q3).

Table 5 presents the results for the estimates with US price correction. A noteworthy point is that the values of elasticities are roughly similar except for the age variable. The latter appears to be lower in absolute value than for the non-corrected model. The reason for this discrepancy is relatively uncertain. Nevertheless, one may assert that taking into account the US investment deflator may improve the measure of capital stock, so that the discrepancy between the measure of actual capital stock 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.[26] In the medium term, potential growth breaks down

[26] 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 $cur_t - \overline{cur}$	γ_3 $\tau_t - \overline{\tau}$	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.

between four components: growth in capital stock, growth in labour input (hours worked), TFP growth and changes in the age of MES equipment. Over the period 1991-2004,the average annual growth rate of potential output ranges 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 lies between 0.8 (Italy) and 1.1 (Canada). The contribution of TFP ranges between 0.5 (Canada) and 1.5 (Japan). A point worth mentioning is that, when Canada and Italy are stripped out, the panel shows a rather stable contribution of TFP growth, between 0.9 and 1.5. On the contrary, there are substantial differences within the panel with respect to the contribution of labour. For some economies, labour has contributed significantly to medium-term growth, i.e. Canada, the Netherlands and the United States, whereas for the rest of the panel labour input has hardly contributed, or even negatively, to potential growth, *e.g.* Germany and Japan. Unsurprisingly, 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 small or even negative, as for France and Japan. . For the euro area as a whole, our results show a relatively robust potential growth (2.2% over 1991-2004), especially supported by solid contributions of TFP and capital, whereas the contribution of labour remained marginal, as for France and Germany. The results for the euro area as a whole appear to be consistent with the aggregation of France, Italy, Germany and the Netherlands (which represent about 73% of the euro area), although a simple weighted average of these four countries would lead to a slightly slower potential growth that measured for the euro area (2.0% against 2.2%). This can be attributed to the fact that among euro area countries not included in the panel are those - such as Ireland, Spain, Greece, Austria - which have experienced the fastest growth rates over 1991-2004, whereas euro area countries included in the panel, which are also the largest, have experienced relatively slower growth. All in all, the results would suggest that euro area countries not included in the panel contributed to increase euro area potential growth, especially through labour and capital accumulation, by roughly 0.2 pp on average over 1991-2004 (based on a simple weighted average calculation of the residual potential growth). However, by contrast with capital and labour accumulation, one could put forward the key role of Germany and France concerning TFP growth in the euro area: the contribution of TFP amounted to 1.3 pp over 1991-2004, 0.4 pp higher than for the euro area as a whole.

Table 6 also shows the changes in medium-term potential growth over the 1991-2004 period. Some economies, namely Canada and United States, witnessed a sharp acceleration in medium-term potential growth in the mid 1990s, by roughly one percentage point. The annual growth rate of the potential output in the United States and Canada stood at respectively 2.7% and 2.1% over 1991-1995, against respectively 3.6%, and 3.2% over 1995-2000 period. For the United States, the faster growth rate was mainly due to the acceleration in TFP growth (+0.5 pp), while, in the case of Canada, it was due to the labour contribution. On the contrary, medium-term potential growth in European economies remained stable (France and Netherlands) or even decreased (Germany and Italy). As for Italy, this was mainly due to a significant deceleration of TFP growth over the period. However the decrease in the contribution of TFP was partly offset by the increase in the contribution of labour (from -0.7 between 1991 and 1995 to 0.5 pp between 2000 and 2004).[27]

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.[28] In the long run, potential growth breaks down between three components: growth in the working age population,

[27] This reflects partly a specific phenomenon, namely the increase in the participation rate in the late 1990s in Italy (see Table 8). This increase could be due to the inclusion of workers in the informal economy into National Accounts' measures of the labour force.

[28] We present in Appendix C paths of 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.

TFP growth and changes in relative prices, which represents substitution effects derived from the more intensive use of IT equipment. With the US price correction, comparisons are easier because the panel shows very similar contributions of relative prices, ranging between 0.4 and 0.6 percentage point. Over the period 1991-2004 the average annual growth rate of the potential output ranges 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 with the contribution of TFP, while North American economies show larger population contributions, thanks to the more favourable demographic developments over the period.[29]

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

	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

5 Discussion

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

[29]On this particular matter, it would be of great interest to distinguish between migration and birth rate effetcs in population growth, but this topic falls out of the scope of this study.

5.1 What could explain TFP gaps among these economies?

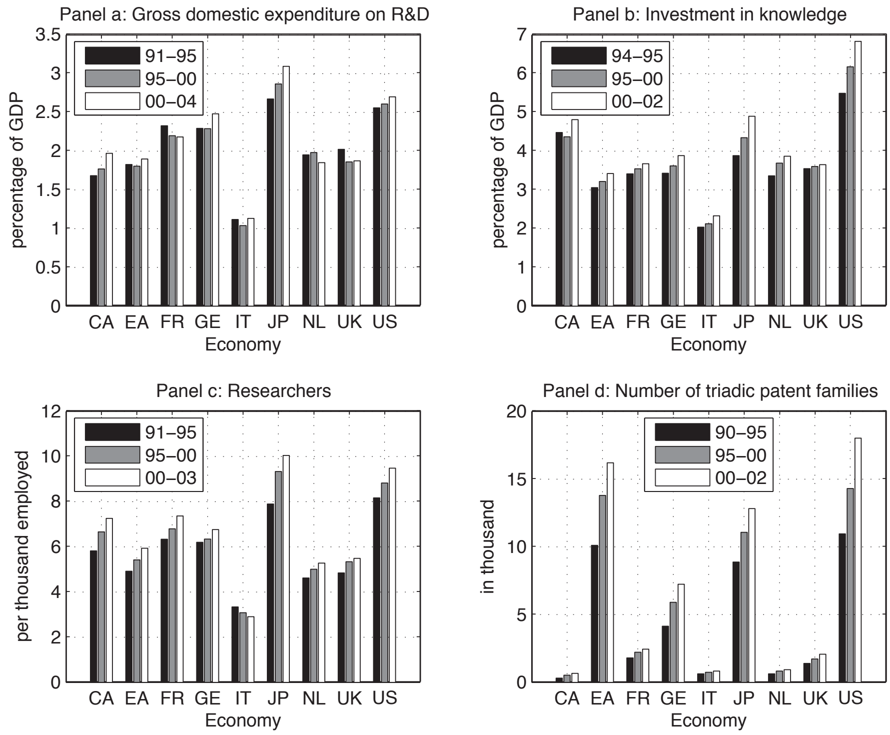
As shown by our results, a large part of the potential output growth is mainly explained by TFP developments which could imply various gaps among the economies studied in this paper. With respect to the contribution of TFP to long-term potential growth, taking into account the US relative price correction, Japan, the UK, and the US appear to be some of the front runners with contributions of 2.1-2.2 percentage points over the 1991-2004 period. At the other end of the scale, Italy seems to be as a laggard in 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, i.e. innovation activities. Indeed, given the efforts by economic theorists to model endogenous, in particular R&D-driven, growth processes since the mid-1980s, activities of research, development, and innovation play a key role as economic growth determinants. In this respect, we can glance at some available innovation indicators to ascertain differences among economies. Figure 5.1 depicts such indicators for the panel.

A point worth mentioning is that over a similar period, Japan and the US showed greater efforts in innovation activities than the other economies of the panel. Once more, Italy appears to lag behind other countries, as its efforts are far smaller than is the case for the rest of the panel. A brief cross-country correlation with respect to the effect of gross domestic expenses on R&D on the long-run TFP contribution is shown in Figure 2.

One can see the positive correlation between R&D efforts and TFP contribution. In 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 are among the highest and R&D efforts are close to 3% of GDP. The second relies on Italy, which presents a lower R&D effort and a 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 a particular exception, the UK that makes up the fourth block, experienced a high TFP contribution for a relatively low level of expenses on R&D.

To conclude on this issue, these rapid considerations add credence to the predom-



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

inant and consensual view on the positive impact of an increase in R&D expenditure on economic growth.[30] It can be seen that an increase in the R&D drive of roughly 1% of GDP in the euro area could allow the area to catch up with the first block, and would potentially increase the TFP contribution by about 0.5 percentage point. From a more general perspective, one could think that all measures aiming at to enhance innovationnal activites —reducing credit constraints related to structural investment, increasing competition in product markets depending on the distance to frontier,...— could impact positively the TFP contribution to potential growth.[31]

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

[31] Another field of interest would concern the impact of product market regulation. On the one hand,

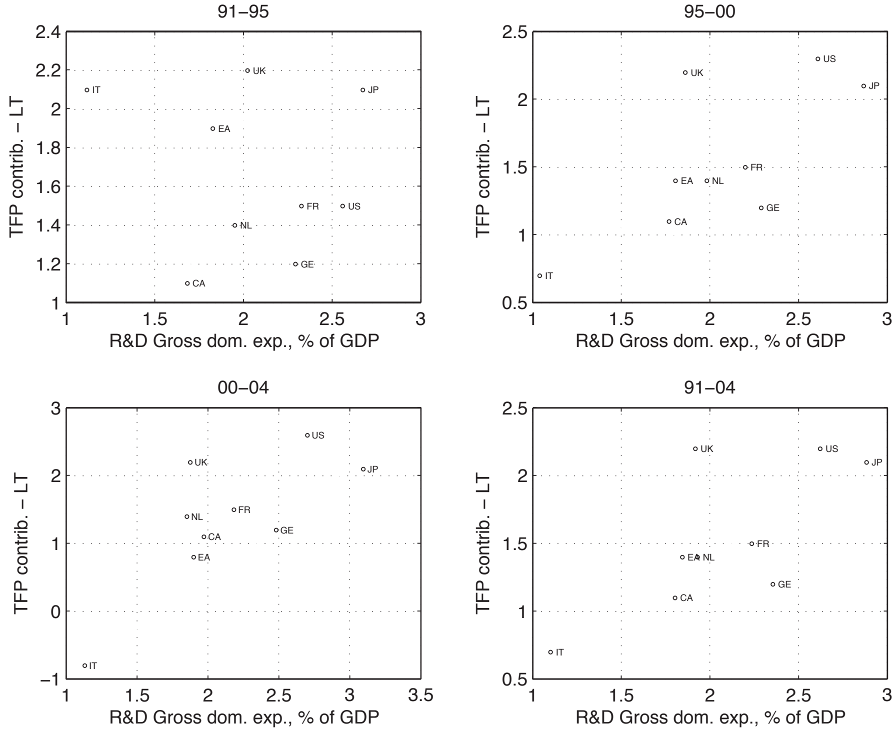


Figure 2: Gross domestic expenses on R&D and long term TFP contribution

5.2 What could explain differences in labour contributions?

Differences in labour contributions are important in terms of explaining differences in potential growth within 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 for the Netherlands, record very low labour contributions over the 1991-2004 period. One may look for an 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: growth in the working age population, the so-called "population contribution"; changes in the participation rate, or participation; changes in the employment rate, or employment; and, lastly, changes in hours worked per worker

regulatory reforms that liberalize entry into the good market could be deemed very likely to spur investment (see Alesina et al., 2003). On the other hand, recent studies 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 and stock markets. According to this literature, the greater the economy's distance to technological frontier is, the marginal gain of deregulation is potentially lower. As we do not draw on comparative measures of TFP in absolute terms in this paper, we could not deal with this promising issue.

in the whole economy, or hours.

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

First, a noteworthy point is that the contribution of hours is not the main source of differences in potential growth. Indeed in most OECD countries, hours worked declined over the period from 1990 to 2004 as shown in Table 9.

Table 9: OECD indicators on labour market and population

	demography[a]	women' employment rate[b]			hours worked[c]	part-time[d]
Economy	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)

This is 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).[32] 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 working week. The general introduction of the 40-hour week occurred gradually in the 1990s. Another reason why the contribution of hours is negative for all the economies considered here is the increase in part-time employment in 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 with other countries, record high growth in 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 out as a European exception with respect to potential growth. This economy shows the highest potential growth when compared with other European countries, due to increases in the participation rate in the period from 1991 to 2004 and thus higher participation contributions. (0.7% for 1991-1995 and 0.8% for 1995-

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

2000). This reflects the important economic reforms carried out in this country during the 1980s, *inter alia* the general agreement for a wage restraint policy in the Netherlands that started in 1982 (Wasenaar agreements) and whose effects on the participation rate appear to be exceptionally positive. A striking feature of these effects is seen in the female employment rate. Table 9 shows that all the economies considered witnessed a rise in the employment rate of women in 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.[33] The magnitude of the intervals ranges between 0.2 percentage point for Italy to 1.3 percentage points for Japan. In fat, 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 because of rigidities in the medium term regarding capital stock growth, the age of capital and labour inputs. In the long run, capital growth is taken as equal to GDP growth, age is constant, and labour inputs grow at the same rate as 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, or to labour market rigidities, or 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 considered lost growth opportunities between 1991 and 2004. This finding holds for all the countries, though with different magnitudes. An interesting point is that, even though the US econ-

[33]Dates of breaks are presented in AppendixC, Table 17.

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

Period 1991–1995

Economy	GDP Actual	Prod. function Medium	Prod. function Long	Prod. func. (US cor.) Medium	Prod. func. (US cor.) Long	Statistical HP	Statistical 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

Economy	GDP Actual	Prod. function Medium	Prod. function Long	Prod. func. (US cor.) Medium	Prod. func. (US cor.) Long	Statistical HP	Statistical 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

Economy	GDP Actual	Prod. function Medium	Prod. function Long	Prod. func. (US cor.) Medium	Prod. func. (US cor.) Long	Statistical HP	Statistical 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

Economy	GDP Actual	Prod. function Medium	Prod. function Long	Prod. func. (US cor.) Medium	Prod. func. (US cor.) Long	Statistical HP	Statistical 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

omy remained under its potential growth rate in the 1991-2004 period, its actual growth was higher than posted by other economies. The US economy, despite actual growth amounting to 2.9% in annual terms, lost 0.3 percentage point in growth per year when compared with its medium-term potential growth, and 1 percentage point per year when compared with its long-term potential growth. Among the other economies that show the highest average loss when compared with long-term potential growth over the period, let us mention Japan, the UK, and France with a shortfall of 1.3, 0.6, and 0.5 percentage points, respectively.

6 Conclusion

The analysis of output growth in a panel of major economies undertaken in this paper confirms that European economies, as well as Japan, have lagged behind North American, especially the US, over the last 15 years. Within the euro area, France and Germany experienced quite identical average potential output growth over the period considered, while Italy went through a period of exceptionally low potential growth. On the contrary, the Netherlands, thanks to favourable conditions on the labour market, has outperformed other economies in the euro area in terms of potential growth. An interpretation of these divergent growth rates found in the major euro area economies may be found, in addition to differences in economic performances, in differing macroeconomic policies, above all with regard to the labour market. The foregoing points to the need for more structural reforms in the euro area. Indeed, several empirical studies suggest a positive impact of product and labour markets reforms on employment and TFP growth.[34] Using a variety of models, Arpaia et al. (2007) find that reforms in areas such as unemployment benefits, taxes, and the ease of entry for new firms have reduced the structural unemployment rate by 1.4 p.p. and boosted GDP in the EU15 by 2% since 1995. Similarly, by conducting panel data analysis on a wide range of OECD countries, Aghion et al. (2007) find that TFP growth is positively impacted by structural reforms on product and labour markets, and these effects appear to be especially significant for countries close to the technological frontier. Moreover their main findings suggests that product market reforms are complementary to labour market reforms. In case there is too little competition on product market, firms lack incentives to innovate, no matter how important is the degree of liberalization on the labour market.

Interestingly, a possible further path of research would focus on a comparison of TFP levels that our methodology could allow. Indeed, after homogenizing the data—*i.e.* taking into account differences in exchange rates or purchasing power parity for example— one should be able to compare levels of TFP and to better distinguish the sources of differences in TFP developments and their impacts on the

[34]See Arpaia et al. (2007), Pichelmann and Roeger (2002), Pichelmann (2003), Aghion et al. (2007).

economy.[35] A possible future research project would consist in seeking to identify the technological frontier by comparing levels of TFP at each date for the whole panel, and then estimating relationships between TFP and the technological frontier. Such a project could shed light on the sources of technological progress based either on purely country-specific innovation or on imitation and catching-up effects. Should this research project be fruitful, it would provide extremely interesting information for the medium- and long-term diagnosis of the process of economic convergence among the countries studied in this paper.

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[35] Although initial results have been achieved in this sense, we set this issue out of the scope of this paper, leaving it for further research.

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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 is 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 as follows :

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

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 absolute terms rather than in log?

Assume that productive capital $\tilde{K}_t$ consists in the accumulated investment flows for which we take into account an improvement in productivity, increasing each capital services by a factor $1+\epsilon$, with $\epsilon > 0$ and sufficiantly lower than 1. Introducing the capacity utilisation rate which modulates 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 in detail the calculations which lead to equation (5). Let us assume that the logarithm 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 (4) gives:[36]

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

which gives the following period:

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

[36] One should keep in mind that we consider in the medium term $cur_t = \overline{cur}$.

This last equation defines the medium term TFP:

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

In the long run, we have $\tau_t = \overline{\tau}$ and participation rate r_t^*, NAIRU u_t^* and the worked hours h_t^* are set at their average level. Combining the definition of medium-term TFP in (5) and equation (7) 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 assumption of the constant capital/output ratio in value terms (see equation (8)), 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 last two 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	

Continued on next page

Table 11 – continued from previous page

data	periods	sources	description	comments
	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
	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)	

Continued on next page

Table 11 – continued from previous page

data	periods	sources	description	comments
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	
	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	

Continued on next page

Table 11 – continued from previous page

data	periods	sources	description	comments
	1963q1–1980q1	Authors' calculation	Backcasted with weighted average from France, Germany, Italy, and the Netherlands	

France

[to be completed]

Germany

[to be completed]

Italy

data	periods	sources	description	comments
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	

Continued on next page

Table 11 – continued from previous page

data	periods	sources	description	comments
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	
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				
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	

Continued on next page

Table 11 – continued from previous page

data	periods	sources	description	comments
	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	
	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				
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

Continued on next page

Table 11 – continued from previous page

data	periods	sources	description	comments
	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	
	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, sectors and 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 MES and SH investment, respectively. We then agregate both sets of data to compute the whole economy's capital stock. We compare our estimates with the BEA's capital stock data (see Table 12).

Our estimates of capital stock growth rates appear to be higher than the BEA's

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.

(*circa* 0.5 percentage point for the economy as a whole resulting from 2 percentage points for MES and about 0.2 percentage point for SH) mainly due to composition effects. Indeed, BEA estimates are based on a disaggregated 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 aggregate data are concerned.

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

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

A noteworthy point is that results provided by Oliner and Sichel (2002) are higher than our estimates (see Table 14) because of (i) the difference in sectors (non-farm business with BLS data) and (ii) the difference in method between the BLS and BEA with regard to capital stock calculation. The appropriate comparison with BEA stocks is the 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 are not totally comparable. Moreover, BLS data currently do 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 with respect to the contribution of capital.

To conclude, our estimates of the growth of capital stock are consistent with those

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).

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

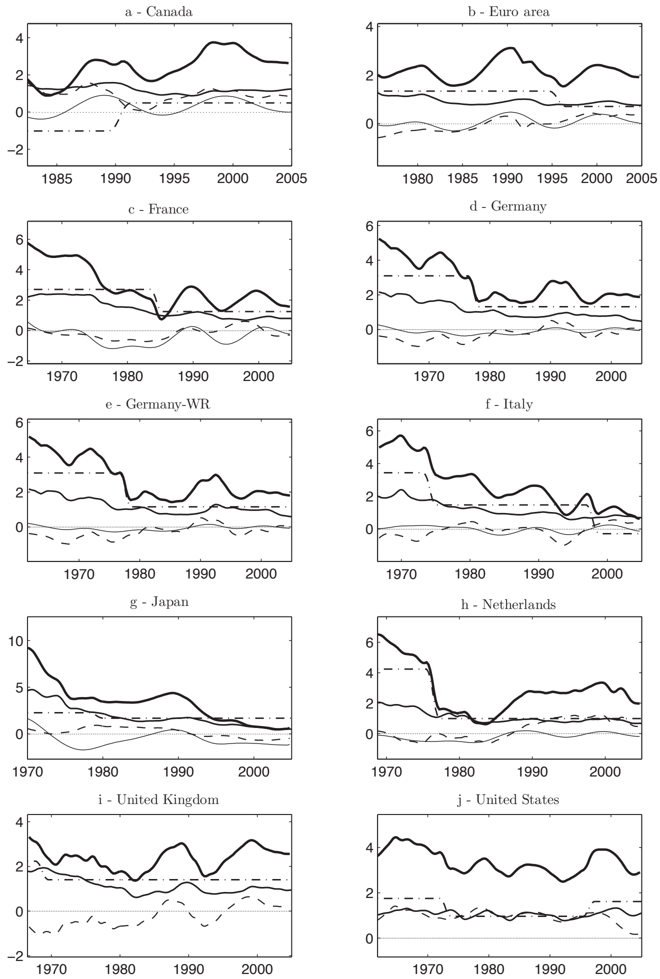
	89-95		95-01	
	Authors	O&S[a]	Authors	O&S
Labour productivity growth	1.31	1.54	2.17	2.43
Capital deepening	0.28	0.52	0.52	1.19

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.

published by the BEA, especially for the 1995-2000 period. On the contrary, other estimates based on BLS multifactor productivity tend to overestimate the contribution of capital stock for the economy as a whole.

C Additional tables and figures

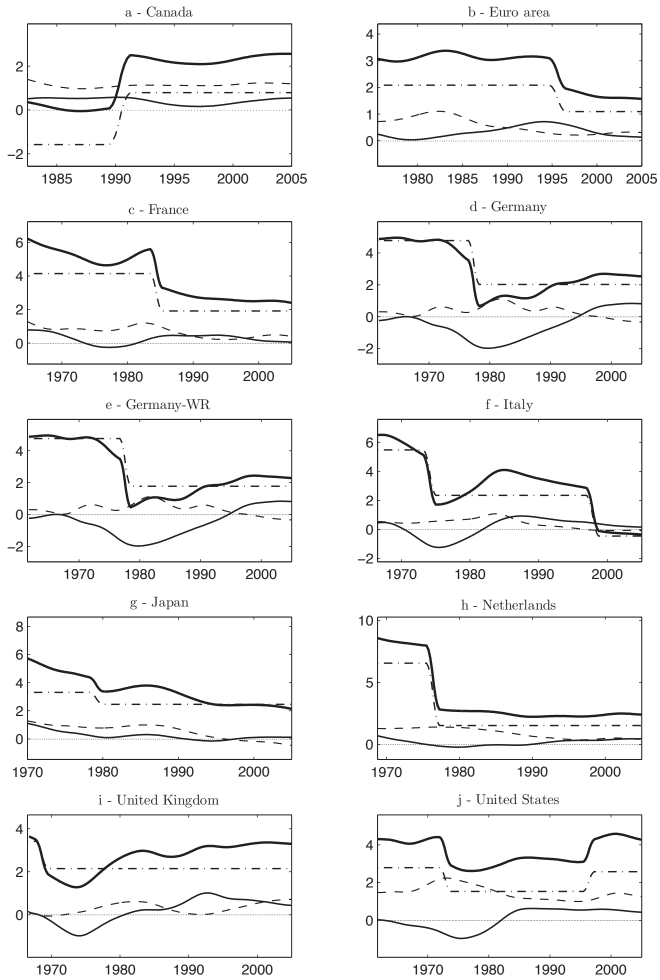
This last section contains additional figures and tables. Figure 3 below shows the path of medium term potential growth and its contributions.



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

Figure 3: Medium term potential growth and contributions

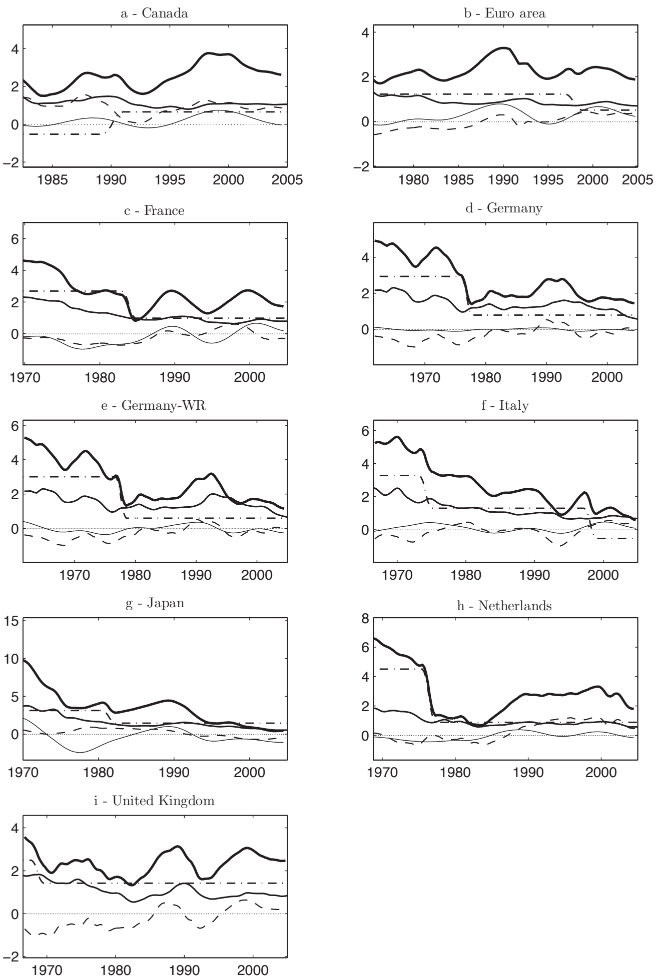
Figure 4 below shows the path of long term potential growth and its contributions.



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

Figure 4: Long term potential growth and contributions

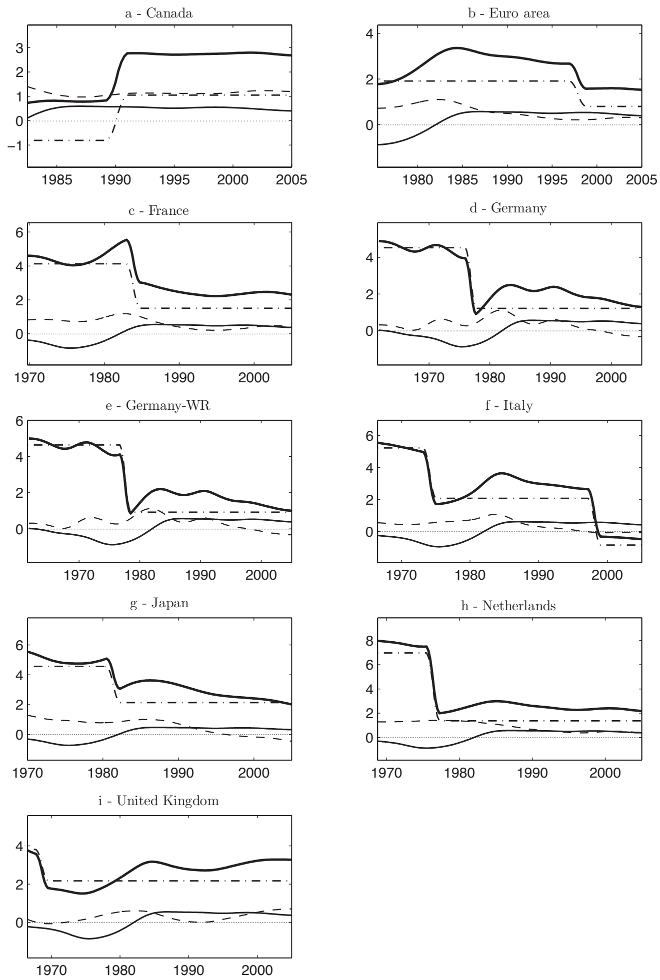
Figure 5 below shows the path of medium term potential growth and its contributions, including US relative prices correction.



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)

	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	2.0	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)

	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	2.8	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(+)

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