

# Perspectives on Productivity and Potential Output Growth

## A Summary of the Joint Banque de France/Bank of Canada Workshop, 24–25 April 2006

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*Held in Enghien, France, on 24–25 April 2006, this joint workshop<sup>1</sup> brought together researchers to quantify and better understand differences in productivity and potential output growth among industrialized countries. The workshop was attended by some 30 economists, mainly from central banks. In this short summary of the proceedings, the authors highlight the findings around the three main themes.*

**C**entral banks are keenly interested in productivity and potential output for a number of reasons.<sup>2</sup> Productivity directly affects firms' marginal cost of production, which is a key driver of prices. Productivity is also a key determinant of potential output, and short-run deviations of actual output from potential output, known as the output gap, are a useful indicator of future inflationary pressures. Productivity differentials across countries also have important implications for the behaviour of the

real exchange rate. Specifically, economic theory suggests that if productivity gains against foreign countries are concentrated in the tradable sector then, everything else being equal, the home country's real exchange rate will tend to appreciate. Lastly, and most importantly, a nation's productivity is the prime determinant of its real incomes and standard of living.

The purpose of the workshop was to bring together researchers to quantify and better understand differences in productivity and potential output growth among industrialized countries. The research presented focused on three main themes: (i) estimating potential output; (ii) productivity and growth; and (iii) institutions, policies, and growth. Eleven papers were presented; designated discussants commented on each paper; and questions were taken from the floor. Susanto Basu of Boston College served as *rapporleur* and gave his perspective on recent academic research that examines productivity growth.

This article is a short summary of the proceedings. Each section begins with an introduction to the issues and a brief summary of the research presented. Some additional details are then offered for each paper.

### Theme 1: Estimating Potential Growth

The first group of papers focused on estimating potential output growth (or, alternatively, the output gap) for several industrialized countries. Three of the papers employed statistical techniques to estimate potential

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1. The full text of the conference papers, and some of the discussants' presentations, are available on the Bank's website at [www.bankofcanada.ca/en/conference\\_papers/france2006/papers.html](http://www.bankofcanada.ca/en/conference_papers/france2006/papers.html).

2. Productivity is a measure of how efficiently an economy transforms its factors of production (e.g., labour and capital) into goods and services. Potential output is the level of production compatible with an absence of price pressures in the goods and labour markets, which is a condition for stable inflation.

output using a production-function approach, while the remaining two papers examined potential output using dynamic stochastic general-equilibrium (DSGE) models.

Despite significant measurement problems, some elements of the analysis seem to be fairly robust. In particular, the estimates of potential output growth presented at the workshop suggest sizable differences between the main industrialized countries. Over the past decade, for example, it is estimated that the United States and Canada have experienced potential output growth in the neighbourhood of three per cent per year.<sup>3</sup> At the other end of the spectrum, Italy and Japan experienced estimated potential output growth averaging only about one per cent per year. The research also suggests that the substantial differential in potential growth between countries reflects differences in labour productivity and in the growth of the labour force.<sup>4</sup> For over a decade, the United States, for example, has been experiencing labour productivity growth that is high relative to recent historical levels and much more vigorous than in most other industrialized countries. In addition, labour force growth in Europe and in Japan has fallen behind the pace in North America.

The work done with the DSGE models also proved to be quite instructive. One of the lessons learned from the workshop was that imposing additional restrictions on data that are generated by a well-specified economic model can lead to an improvement in estimates of the output gap.

The first paper in the session, by **Tommaso Proietti** (University of Rome) and **Alberto Musso** (European Central Bank, ECB), combined a traditional production-function approach to estimating potential output with a Phillips curve relationship to estimate and analyze the euro area's potential output and its components. A key finding was that there has been a significant slowdown in the growth in trend labour productivity in the euro area, from 3.7 per cent in the 1970s to 2.5 per cent in the 1980s and to 1.9 per cent in the 1990s. Since 2000, the slowdown has been even more pronounced, with growth in trend labour productivity estimated to have averaged only 0.7 per cent. In addition, potential output growth has also suffered, owing

to the weaker growth in the working-age population.<sup>5</sup> These factors have been partially offset by a rise in the trend labour force participation rate, resulting mostly from the increased participation of women. On net, the authors estimate potential output growth at about 1.8 per cent since 2000. Discussant **Marc-André Gosselin** (Bank of Canada) pointed out that the findings of the paper were broadly consistent with research on the euro area conducted at the Bank of Canada. He added that the estimated trend seems to track the actual data too closely, and that, as a result, the authors perhaps overstate the slowdown in trend labour productivity and the pickup in trend hours worked since 2000.

#### **Christophe Cahn and Arthur Saint-Guilhem**

(Banque de France) estimated potential growth for several economies: Canada, the euro area, France, Germany, Italy, Japan, the Netherlands, the United Kingdom, and the United States. A unique feature of this paper is that total factor productivity (TFP) is analyzed using econometric techniques and a specification that relates it to three factors: the capacity utilization rate, capital-embodied technological improvement<sup>6</sup> (which is partly captured by the effect of capital aging), and a trend in technology.<sup>7</sup> The model also allows for the existence of trend breaks in technological change. The results suggest that differences in the growth of labour input, rather than capital input, have played a crucial role in explaining the lagging growth in Europe and Japan compared with that of the United States and Canada. Second, some economies, namely Canada and the United States, experienced a sharp acceleration in potential output growth in the mid-1990s. For the United States, this was mainly a result of the acceleration in the growth of TFP (+0.5 percentage points), whereas for Canada, it was attributable to the contribution of labour. **Don Coletti** (Bank of Canada), in his discussion, pointed out that the univariate time-series techniques used by the authors to try to uncover trend breaks in TFP growth have very low power, particularly near the end of sample, where they are most relevant for policy-makers.

3. These figures are taken from the *OECD Economic Outlook*, various issues.

4. Labour productivity is defined as output per hour worked.

5. Average hours worked per person have declined gradually over the past three decades. In very recent years, however, the trend level of hours worked per person has remained, on average, broadly unchanged or has even gradually increased.

6. Capital-embodied technological improvement refers to the adoption of advances in technology through acquisition of capital stock whose design and construction reflects those advances.

7. In general, growth in TFP represents output growth not accounted for by growth in capital and labour.

**Werner Roeger** (European Union Commission) assessed recent potential output growth and productivity trends in the European Union and the United States, using a production-function approach. Consistent with the results presented in the previous papers, the author finds that potential growth is on a downward trend in the European Union. In particular, for the euro area, potential growth declined from 2.5 per cent in the mid-1980s to 1.9 per cent over the 2001–2005 period. This compares to a fairly stable potential growth trend for the United States of about 3.0 per cent over the same periods. The author also finds that potential output in the European Union is characterized by two divergent trends; namely, declining growth of TFP that is not fully compensated by a rising contribution of labour. His preferred explanation for the declining trend in productivity growth centres on the European Union's weak performance in terms of the production of information and communications technology (ICT). **Jean-Paul Fitoussi** (Observatoire Français des Conjonctures Économiques), in his discussion, pointed out that these estimates of potential output level and growth depend only on supply-side variables, which are considered exogenous. He argued that the determinants of potential output are partly determined by demand-side variables over the medium and long term.

**Michel Juillard** (CEPREMAP<sup>8</sup>), **Ondra Kamenik** (Czech National Bank), **Michael Kumhof** (International Monetary Fund), and **Douglas Laxton** (International Monetary Fund) (JKKL) develop and estimate a DSGE model of the U.S. economy that allows for both transitory and highly persistent shocks to the growth rate of TFP. Allowing for the highly persistent shocks helps the model to generate a positive correlation between hours worked and output at business cycle frequencies. JKKL use their model to compute an extended real-time measure of potential output using a Hodrick-Prescott (HP) filter. As the authors note, it is well known that univariate filters such as the HP filter give very imprecise estimates of the output gap at the end of the sample.<sup>9</sup> JKKL exploit the good forecasting performance of their model to construct a two-sided measure of the output gap. The extended measure is constructed by treating the model's forecasts as additional data that extend the sample period and

then using the sample period to estimate potential output. To evaluate this extended measure of potential, JKKL look at the magnitude of the revisions that would be required as new data become available and find that the extended measure requires less revision, on average, than the standard measure. On this basis, they conclude that their extended HP filter measure is more reliable. The discussant, **Patrick Fève** (Banque de France and Université de Toulouse), pointed out that it is not surprising that the DSGE model performs well compared with other economic and statistical models, since it includes numerous exogenous stochastic processes and several non-parsimonious structural parameters.

**Magnus Jonsson, Stefan Laséen, and Karl Walentin** (Sveriges Riksbank) studied the usefulness of four possible indicators of inflation: (i) the trend-adjusted output gap (i.e., the traditional output gap); (ii) the flexible-price output gap; (iii) the flexible-price real interest rate gap; and (iv) real marginal cost of production within the context of the Swedish Riksbank's new DSGE model (Adolfson et al. 2005).<sup>10</sup> The authors find the only "reliable indicator" of inflation over history to be the flexible-price real interest rate gap. Although it is well known that the real interest rate gap is a good indicator of inflation in simple New Keynesian models (see, e.g., Neiss and Nelson 2003), the paper contributes to the literature by extending this result to a much larger model with a variety of shocks and frictions. The discussant, **Rhys Mendes** (Bank of Canada), pointed out that, in models of this class, aggregate demand depends not just on the current real interest rate, but also on all future rates. Hence, the fact that the current real interest rate gap has good indicator properties suggests that monetary policy, over history, was not fully exploiting the role of expectations. But policy-makers increasingly view the policy problem as one of managing expectations so as to influence the entire yield curve. Thus, new developments in the communication and practice of monetary policy may, over time, weaken the indicator properties of the real interest gap.

8. CEPREMAP is the Centre Pour la Recherche Economique et ses Applications in Paris, France.

9. The HP filter takes an average of past and future data. At the end of the sample, it only uses past information.

10. The flexible-price output gap is defined as the difference between actual output and the level of output that would prevail if all prices and wages were perfectly flexible. Similarly, the flexible-price real interest rate gap is defined as the difference between the real interest rate and the level of interest rates that would prevail if all prices and wages were perfectly flexible.

## Theme 2: Productivity and Growth

The second group of papers used growth accounting to review historical developments in growth in the gross domestic product (GDP) in the United States and the United Kingdom. Growth accounting breaks down economic growth into components associated with changes in factor inputs and TFP.

**Dale Jorgenson** (Harvard University), **Mun Ho** (Resources for the Future Inc.), and **Kevin Stiroh** (Federal Reserve Bank of New York) analyzed the sources of U.S. productivity growth through 2004 and compared the first surge in productivity growth after 1995 with the second surge after 2000. The paper finds important differences between the two episodes. The acceleration in productivity growth in the first surge was driven by the production and use of information technology (IT) equipment and software. The contribution of both IT total factor productivity and IT capital deepening accounted for most of the acceleration in productivity growth. In contrast, these forces played a much smaller role in explaining the second productivity surge, which was more heavily influenced by both non-IT capital deepening and non-IT-related growth in TFP. The authors project growth for the next decade in U.S. private sector productivity of 2.6 per cent per year, close to the 1995–2000 average, but a substantial decline from the torrid pace of 2000–2004. The authors emphasize the substantial range of uncertainty by presenting an optimistic projection of productivity of 3.2 per cent per year and a pessimistic projection of only 1.4 per cent. The discussant, **Nicholas Oulton** (London School of Economics), pointed out that imposing a constant capital-output ratio in the medium-to-long run helps to reduce the uncertainty around the base-case projection.

**Nicholas Oulton** and **Sylaja Srinivasan** (Bank of England) used a new industry-level data set to quantify the roles of structural change and information and communication technology (ICT) in explaining productivity growth in the United Kingdom over the 1970–2000 period. The authors find that, despite being only a small fraction of the total capital stock, ICT-related capital deepening accounted for 47 per cent of productivity growth in the market sector over the 1995–2000 period, up from 15 per cent over the 1990–95 period and from 22.5 percent over the 1970–2000 period. Supplementary econometric evidence also supports an important role for ICT-related capital deepening. On the other hand, the authors find that TFP growth slowed between 1995 and 2000. The authors also show econometric evidence that a boom in “complementary

investment,” i.e., expenditure on reorganization that accompanies ICT investment but is not officially measured as investment, could have led to a decline in the conventional measure of TFP growth. Discussant **Kevin Stiroh** remarked that acceleration in TFP and ICT capital deepening are concentrated in fewer industries in the United Kingdom than in the United States, and that this difference across the two countries is not well understood.

## Theme 3: Institutions, Policies, and Growth

While IT is credited with the acceleration in productivity that took place in the United States between 1995 and 2002, many other industrialized countries have not experienced a pickup in productivity growth. By its nature, the adoption of new technology should be causing productivity growth to rise in all the industrialized countries because IT is not specific to a particular location and can easily be applied to other economies. Some researchers have argued that continental Europe’s relatively weak productivity performance could be a result of its tax and regulatory framework, which is thought to stifle competitive forces and hamper IT diffusion. Although an abundant literature exists on the negative effects on economic growth and economic welfare implied by structural market rigidities, empirical evidence that quantifies these effects remains relatively imprecise. Moreover, these effects appear to depend on the way reforms are introduced (sequentially vs. concurrently) and the market they affect (labour vs. product).

In previous work, Gust and Marquez (2002) have investigated the reasons why IT may be more readily adapted in some economies than in others. The basic intuition behind their results is that inflexibility in labour and product markets prevents firms from making the adjustments required to benefit from the new IT. **Christopher Kent**, **John Simon**, and **Kathryn Smith** (Reserve Bank of Australia) extend that work using 30 years of cross-country data by asking whether market flexibility influences TFP growth independently of whether a country has invested heavily in ICT. The authors find tentative empirical support for the hypothesis that lower levels of regulation in product and labour markets are associated with higher TFP growth in subsequent years. The authors also find evidence that labour and product market deregulations have more effect in combination than separately. The discussant, **Remy Lecat** (Banque de France), highlighted some of the difficulties associated with using

the common indicators of the labour and product market regulations in this sort of analysis.

**Andrea Bassanini** (Organisation for Economic Co-operation and Development, OECD) and **Romain Duval** (OECD) presented an extensive study of the impact of structural policies and institutions on aggregate unemployment and employment rates across countries belonging to the OECD. Their analysis was based on cross-country/time-series econometric estimates of reduced-form models of unemployment and labour force participation rates. Some main findings are that the effects of macroeconomic shocks on unemployment appear to be amplified by high unemployment benefits and damped by highly centralized or coordinated wage-bargaining systems. More tentatively, high rates of home ownership—which are often associated with low degrees of labour mobility across regions—increase the impact of shocks on unemployment, while public spending on active labour market policies (e.g., labour market training) reduces it. Policies and institutions affect employment through their impact on aggregate unemployment and also through their effects on labour market participation, particularly for those groups “at the margin” of the labour market. The paper also shows that a package of reforms sharing specific objectives will have a bigger effect than will a group of separate reforms. The discussant, **Gilbert Cette** (Banque de France), pointed out that, even if the results appear to bear out certain conclusions, they should be treated with caution because of simultaneity biases that could amplify some estimated results.

**Danny Leung, Césaire Meh, and Yasuo Terajima** (Bank of Canada) attempt to explain part of the difference in aggregate TFP between Canada and the United States by focusing on the relationship between the rate at which a firm adopts new technology and aggregate productivity in the presence of financial constraints. In their paper, they develop a dynamic general-equilibrium (DGE) model in which firms adopt technology endogenously and display dynamics (i.e., entry, growth, and exit) that are affected by financial market imperfections and taxation. The authors consider the implications of the differences between Canada and the United States in several determinants of technology adoption and firm size, such as financial market imperfections, the cost of adopting a technology, and the tax structures on aggregate TFP. They argue that a sizable part of the TFP gap between the two countries is a result of the difference in the economic environment that distorts a firm’s technology-adoption behaviour.

The discussant, **Jacques Mairesse**, National Institute of Statistics and Economic Studies (INSEE); Center for Research in Economics and Statistics (CREST); and National Bureau of Economic Research (NBER), pointed out that the relation between firm size and productivity level and growth is a difficult question that should be more explicitly treated in the paper.

**Aaron Drew** (Reserve Bank of New Zealand), **Max Dupuy** (New Zealand Treasury), **Richard Downing** (New Zealand Treasury), and **Özer Karagedikli** (Reserve Bank of New Zealand) reviewed the recent literature on New Zealand’s labour productivity performance and offered empirical evidence that suggests there is scope for higher labour productivity growth in the future. The authors show that, although labour productivity growth in New Zealand improved to 1.1 per cent per year over the 1993–2005 period, it remained below the OECD average. They examine several possible reasons for the weakness in measured labour productivity growth, including measurement issues, the quality of policies and institutions, geography and scale, impediments to capital accumulation, and labour-absorption dynamics. The authors demonstrate that the entrance of less-qualified workers into the labour force held back productivity growth in the order of 0.5 percentage points per year, which is equivalent to the difference between New Zealand’s recent growth rates in labour productivity and those of upper-income OECD countries. The paper also presents estimates of trend labour productivity from a multivariate Kalman filter. The uncertainty bands around the estimates of trend productivity encompass the growth rates of labour productivity of upper-income OECD countries. Given their empirical evidence and the findings in the existing literature, the authors feel there is room for labour productivity to improve as labour market deepening runs its course. Discussant **Gérard Belet** (Ministry of Finance, Government of France) pointed out that New Zealand’s low rate of productivity growth seems to have the same cause as that of continental European countries: the increasing share of less-qualified people in employment, which is a result of immigration to New Zealand and of labour market policies designed to reduce unemployment among less-skilled people in Europe.

## Rapporteur

**Susanto Basu** (Boston College and NBER) gave his perspective on recent academic research that examines productivity growth and offered some interesting sug-

gestions for future research. His presentation covered three key areas: i) interpreting the past: What happened in the U.S.? ii) predicting the future: What tools should we use? and iii) past and future: What (hasn't) happened in Europe?

In his presentation, Basu challenged the conventional view of information and communication technology (ICT) as the story to explain the acceleration in U.S. productivity growth since 1995. He argues that much of the acceleration is an increase in TFP outside of the production of ICT (Basu, Fernald, and Shapiro 2001). Although ICT should—and does—show up in labour productivity growth in ICT-using industries, there is no reason why that should be the case for TFP in ICT-using industries. Basu concludes that, if the rise in TFP in ICT-using industries was caused by ICT, then it occurred through a channel that is not well understood.<sup>11</sup> He then suggested that studying the economic history associated with the advent of other great inventions like the telegraph or railroads may be able to help us improve our understanding of the processes at work.

Basu reviewed the relative advantages and disadvantages of the main tools available to economists for predicting the future: i) growth accounting combined with extrapolative techniques; ii) single- or multi-variable statistical models and predictions based on estimated stochastic processes; and iii) full economic models applied to the data. The key advantage associated with accounting-plus-extrapolation is that the exercise is very transparent. On the downside, we cannot assess the underlying uncertainty around these

forecasts as well as can be done with the statistical approach. Both the growth accounting and statistical approaches, however, try to forecast the future from the recent behaviour of a few aggregate series. Since the historical productivity data for the U.S. contain only two trend breaks, this raises the issue of how the effects of something novel can be forecast. Alternatively, he argues that it might be advantageous to apply more well-developed economic models. Using an economic theory like the personal-income hypothesis, for example, can help us to infer what economic agents are thinking about the expected persistence of a change in TFP. Cochrane (1994) tells us that a large jump in consumption implies a large expected future increase in income, which in turn suggests to us that economic agents expect the increase in TFP that we observe to be quite persistent. Basu then described other examples of how economic theory could be used to inform our analysis, based on more recent and sophisticated papers by Ireland and Schuh (2006); Edge, Laubach, and Williams (2003); and Guerrieri, Henderson, and Kim (2005).

Finally, Basu discussed the European question and challenged the conventional pessimistic story that regulations and distortions in European economies have prevented the euro area from taking full advantage of new technological opportunities. He questioned how this story could be true in light of the rapid catch up of both Europe and Japan after World War II and the natural advantages to being “followers.”

*This summary will also be published in the February 2007 issue of Le Bulletin de la Banque de France. Slight differences in the text represent the style of the two journals.*

11. The intuition here is that changes in factor prices don't shift production functions.

## Literature Cited

- Adolfson, M., S. Laséen, J. Lindé, and M. Villani. 2005. “Bayesian Estimation of an Open Economy DSGE Model with Incomplete Pass-Through.” *Sveriges Riksbank Working Paper No. 179.*
- Basu, S., J. Fernald, and M. Shapiro. 2001. “Productivity Growth in the 1990s: Technology, Utilization, or Adjustment?” *Carnegie-Rochester Conference Series on Public Policy* 55: 117–65.
- Cochrane, J. 1994. “Permanent and Transitory Components of GNP and Stock Prices.” *Quarterly Journal of Economics* 104 (1): 241–65.
- Edge, R., T. Laubach, and J. Williams. 2003. “Monetary Policy and the Effects of a Shift in the Growth Rate of Technology.” Manuscript. Federal Reserve Bank of San Francisco.

## Literature Cited (cont'd)

- Guerrieri, L., D. Henderson, and J. Kim. 2005. "Investment-Specific and Multifactor Productivity in Multi-Sector Open Economies: Data and Analysis." International Finance Discussion Papers No. 828. Board of Governors of the Federal Reserve System (U.S.).
- Gust, C. and J. Marquez. 2002. "International Comparisons of Productivity Growth: The Role of Information Technology and Regulatory Practices." International Finance Discussion Papers No. 727. Board of Governors of the Federal Reserve System (U.S.).
- Ireland, P. and S. Schuh. 2006. "Productivity and U.S. Macroeconomic Performance: Interpreting the Past and Predicting the Future with a Two-Sector Real Business Cycle Model." Boston College Working Papers in Economics No. 642. Boston College Department of Economics.
- Neiss, K. and E. Nelson. 2003. "The Real-Interest-Rate Gap as An Inflation Indicator." *Macroeconomic Dynamics* 7 (2): 239–62.