Editor's Overview

THIS 17TH ISSUE OF THE *International Productivity Monitor* published by the Centre for the Study of Living Standards contains six articles. Topics covered are the effect of labour market regulation on productivity in OECD countries; the relationship between the growth in labour productivity and real wages in Canada; the importance of higher education and market rigidities for the diffusion of information and communications technology (ICT) in OECD countries; the importance of the ICT-producing sector for productivity growth in Finland and Sweden; the appropriate measurement of total factor productivity (TFP) in unstable economies with an application to Argentina; and recent and proposed changes to US National Accounts.

It has been argued that certain labour market reforms that increase labour utilisation may at the same time reduce productivity growth. To assess this hypothesis, **Andrea Bassanini** and **Danielle Venn** of the OECD investigate the impact of several labour market policies on productivity. At an aggregate level, pro-employment policy reforms can affect productivity indirectly by changing the skills composition of the labour force, or directly by, for example, changing incentives for workers or firms to invest in training, facilitating the movement of resources across industries or improving the quality of job matches. Based on their empirical analysis, the authors conclude that more stringent employment protection legislation and less generous unemployment benefits are likely to reduce measured aggregate labour productivity, while increases in the ratio of the minimum wage to the median wage and additional parental leave appear to increase labour productivity.

The most direct mechanism by which labour productivity affects living standards is through real wages. Yet, between 1980 and 2005, the median real earnings of Canadians were unchanged, while labour productivity rose 37 per cent. In the second article, **Andrew Sharpe, Jean-François Arsenault** and **Peter Harrison** of the Centre for the Study of Living Standards examine why growth in real wages has lagged behind growth in labour productivity in Canada. They find that the divergence between median earnings growth and labour productivity growth can be explained by four factors of roughly equal importance: inconsistent measurement, in particular, the failure to account for important increases in supplementary labour income; an increase in income inequalities; a decline in labour's terms of trade expressed as the ratio of output prices to consumer prices; and a decline in labour's share of national income. The failure of real median earnings to track labour productivity growth raises an important question: if Canadians are not seeing the benefits of labour productivity growth, why should they view labour productivity growth as an important societal goal?

Since the early 1990s, investment in ICT has been one of the key drivers of labour productivity growth in OECD countries, yet one observes significant gaps in ICT diffusion among major advanced countries. In the third article, **Gilbert Cette** and **Jimmy Lopez** of the Banque de France and the Université de la Méditerranée conduct an empirical investigation into the gap in ICT diffusion between European countries and the United States. They conclude that compared to the United States, lower ICT diffusion in the other major advanced countries can be largely explained by a smaller share of the population with higher education and a higher level of rigidity in labour and product markets. They provide a quantification of the expected effects of education and market rigidities on ICT diffusion. For instance, they find that of the 48 percentage-point gap in ICT diffusion between France and the United States, 29 points are due to lower educational levels and 17 points are related to more rigid markets. The identification of areas where greater efforts are needed, in each country, to reduce the gap has important implications for policymakers.

While ICT diffusion has been important for productivity growth in many countries, Sweden and Finland have both become known for the development and manufacture of ICT products. In the fourth article, **Daniel Lind**, Chief Economist at Unionen, a Swedish trade union, compares the contribution of the ICT sector to labour productivity growth in Sweden and Finland from 1975 to 2004. The author finds that the level of labour productivity in Finland has been converging with that of Sweden, but that a gap remains. He argues that significant growth in the Finnish ICT sector since the mid-1990s, especially in the electrical engineering industry, has contributed to the labour productivity convergence.

In the fifth article, the focus shifts from Sweden and Finland, which have seen robust growth over the past decade, to an economy that has experienced considerable economic instability: Argentina. In this article, **Ariel Coremberg** of the United Nations Economic Commission for Latin America and the Caribbean develops a methodology for isolating the contribution of technological change, which he defines as a shift in the production function or "pure" TFP, to economic growth. The key question the author seeks to answer is whether Argentina's economic growth from 1990 to 2004 was driven by changes in the quantity and quality of the factors of production or by pure TFP growth. Particular attention is paid to the cyclical fluctuations that have affected the Argentine economy over the period analyzed and their effect on the measurement of TFP. The author finds that TFP, when appropriately adjusted to take into account short-term phenomena, has grown slowly. In 2004, both TFP and labour productivity were below their 1998 levels. These findings raise doubts about the ability of the Argentine economy to generate productivity gains independently of composition and quality effects and cyclical variations in factor utilisation, gains necessary to maintain sustainable long-run growth.

Developed and developing economies alike face the challenge of quantifying economic activity in a way that is accurate, affordable, and that provides useful data to analysts. In the sixth and final article **Jean-Pierre Villetelle** of the Banque de France reviews the volume *A New Architecture for the U.S. National Accounts* edited by Dale W. Jorgenson, J. Steven Landefeld, and William D. Nordhaus. The author sequentially examines each chapter, highlighting key findings and commentary. He finds the volume a valuable resource for statisticians and economists around the world who want to learn about the future directions and solutions proposed by their US colleagues for the development of the System of National Accounts.

The Impact of Labour Market Policies on Productivity in OECD Countries

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ABSTRACT

We investigate the impact of labour market policies on labour and multifactor productivity with industry-level data. First and foremost, labour market policies can influence average measured productivity through their impact on employment. Other things equal, employment growth tends to be associated with lower average measured labour productivity growth as more low-skilled workers enter the workforce. However, policies can also have sizeable direct effects on individual productivity levels and/or growth by creating incentives for workers to invest in training, facilitating reallocation of resources to their most productive uses and generating or maintaining high-quality job matches. We find that employment protection legislation, minimum wages, parental leave and unemployment benefits influence productivity through multiple channels, over and above their impact on employment levels.

GROWTH IN GDP PER CAPITA, one of the primary economic policy objectives of OECD countries, can be decomposed into the growth of two components: labour utilisation and labour productivity.[2] During the 1990s, labour productivity growth accounted for at least half of GDP per capita growth in most OECD countries, and a considerably higher proportion in many of them (OECD, 2003). Population ageing in many OECD countries means that continued productivity growth, along with increased labour force participation among currently underrepresented groups, will be crucial to improve living standards in the future.

The impact of labour market policies on labour utilisation is well-documented (see OECD, 2006, for a summary). However, some have argued that certain labour market reforms

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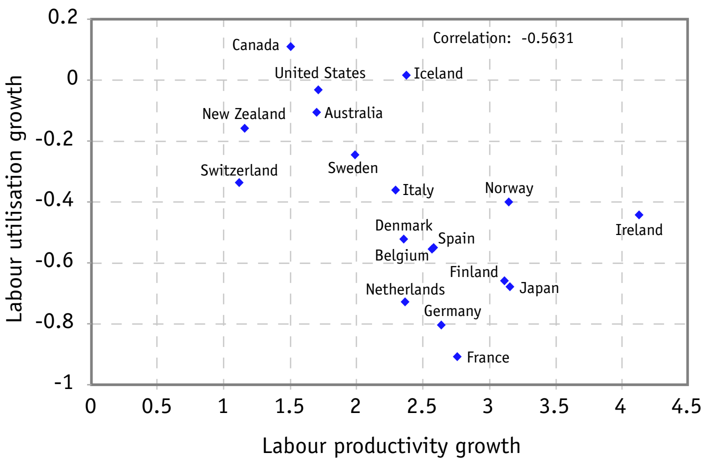
2 Labour utilisation is defined as total hours worked divided by total population. Growth of labour utilisation can result from an increase in the employment rate, an increase in average hours worked by the employed population and/or an increase in the share of the working age population in the total population.

Chart 1
Labour Utilisation Growth and Labour Productivity Growth in OECD Countries, 1970-2005
(average annual growth rates in percentage)



Note: Labour utilisation growth is measured as growth of total hours worked divided by total population. Labour productivity growth is measured as growth of GDP per hour worked.

Source: OECD Productivity database.

that increase labour utilisation may at the same time reduce productivity growth and have a negative long-run impact on living standards, at least as measured by GDP per capita (Heckman, Ljunge and Ragan, 2006). We try to shed some light on this issue by examining the impact of various labour market policies on productivity levels and growth rates. Key channels through which labour market policies affect productivity are identified and assessed empirically.

At an aggregate level, the growth of labour utilisation tends to be associated with lower average measured labour productivity growth. Chart 1 shows that there is a negative correlation between the growth rates of labour utilisation and measured average labour productivity between 1970 and 2005. This phenomenon, referred to herein as a *composition effect*, has several explanations. First, it arises, in part, because conventional measures of labour productivity do not adequately control for changes in the quality of labour. Aggregate employment growth is usually associated with faster employment growth for the poorly-educated than for the highly-educated, so reduces the average level of skills and productivity among the employed (see e.g. Nickell and Bell, 1996; Belorgey, Lecat and Maury, 2006). Thus, an increase in employment with no change in the average productivity per unit of skilled labour and/or individual productivity for those already in employment would lead to a reduction in average measured labour productivity. Second, if employment increases as a result of greater labour supply, labour-intensive (often low-productivity) activities are likely to expand. While the productivity of individual firms or industries could remain unchanged, an expansion of low-productivity production will depress aggregate productivity levels (McGuckin and van Ark, 2004; Dew-Becker and Gordon, 2006). Finally, other things being equal, diminishing returns to labour inputs imply that the marginal impact of higher employment rates (or longer hours of work per worker) on output will be smaller (see e.g. Bourles and Cette, 2005).

In other words, if no other link existed between labour market reforms and productivity, a reform that increased employment would have a less-than-proportionate impact on GDP per capita because of its dampening effect on average measured labour productivity, even with no reduction in the output of workers already in employment prior to the reform. But any slowdown in average measured productivity resulting directly from a change in employment would be, to a large extent, a *statistical artefact* and would not imply a fall in individual productivity. An example is a reduction in the generosity of unemployment benefits, examined later in this article, which encourages more low productivity workers into work, but does not necessarily alter the productivity of existing workers. The implications of such a reform for policy evaluation, therefore, depend on the relative importance placed by society on employment and productivity. Indeed, if society welcomes employment growth as a positive development as the disadvantaged become integrated into society, any accompanying slowdown in measured productivity growth due only to increased employment could be considered a sign of progress. In this sense, productivity growth may be a misleading indicator of whether society is better off.

Pro-employment policy reforms, however, can also directly affect productivity through a number of channels. First, policies that influence incentives for workers or firms to invest in training or education can affect productivity by altering the stock of human capital. Second, policies that encourage the movement of resources between declining and emerging firms, industries or activities can enhance productivity by helping firms respond quickly to changes in technology or product demand. Third, policies that improve the quality of job matches or maintain high-quality job matches for longer can increase the effectiveness of labour resource allocation, increasing the level of productivity. Fourth, policies that make labour more expensive relative to capital can affect the direction and pace of technological change. Finally, policies that reduce social conflict can condition workers' effort and their willingness to align their behaviours with their employer's objectives. Employment-enhancing policies can also have an indirect impact on aggregate productivity by reducing spending on social support and making room for more public or private spending on education, research and development or other productivity-enhancing activities.

From a policy perspective, it is important to be able to estimate both the independent impact of labour market policies on productivity and, whenever productivity effects due to changes in employment (composition effects) are likely to be large, the overall impact on GDP per capita. This article examines the productivity effects of four specific labour market policies (employment protection legislation (EPL), minimum wages, unemployment benefits, and parental leave) using, in most cases, an approach that takes advantage of the fact that labour market policies are more binding in some industries than others and that within-industry composition effects are likely to be relatively small.

The remainder of the article is structured as follows. The next section briefly outlines the method used to estimate the impact of labour market policies on productivity. The following sections examine the existing evidence and present new estimates on the impact of the four policies on productivity growth and/or levels. A brief conclusion follows.

Exploiting Industry-level Differences in the Impact of Policies on Productivity

As discussed above, labour market policies may exert conflicting effects on average measured productivity through composition effects due to their influence on aggregate employment levels and direct effects on productivity or economic efficiency. Composition effects have been shown to be substantial at an aggregate level, however OECD (2007a) shows that within-industry composition effects are likely to be small.[3] This implies that

3 OECD (2007a) estimates that the apparent elasticity of aggregate labour productivity to hours-adjusted employment rates (total hours per person of working age) is in the range of -0.4 to -0.9, which is in line with estimates found in other studies (Bourles and Cette, 2005, 2007; Dew-Becker and Gordon, 2006; Gust and Marquez, 2004). The magnitude of the estimates implies that if the composition effect was the only channel linking labour market policies to productivity, a policy reform that increases total hours per capita by 1 per cent would reduce labour productivity by 0.4 per cent to 0.9 per cent and result in an overall increase in GDP per capita of only 0.1 per cent to 0.6 per cent. In industry-level estimates based solely on within-industry variation, this apparent elasticity slumps to about -0.1 only and even becomes positive when potential endogeneity is taken into account.

industry-level analysis can meaningfully shed light on the impact of selected polices on productivity, over and above any statistical/accounting effect brought about by changes in employment.

Most of the estimates presented in this article use a differences-in-differences estimation technique, which is based on the assumption that the policies examined influence worker or firm behaviour more in some industries (referred to herein as *policy-binding industries*) than others. For example, if stringent EPL reduces productivity by making it more difficult for resources to flow to high productivity activities, reforms to EPL are likely to have a greater impact on productivity in industries where, in the absence of regulations, firms would rely on laying off workers to make changes to staffing levels and organisation, rather than in industries where internal labour markets or voluntary turnover are more important. Likewise, changes in minimum wages or parental leave policies are likely to have a greater impact in industries where employment tends to be dominated by low-wage workers or women, respectively.

We use aggregate cross-country data on labour market policies from a variety of OECD datasets, matched with industry-level data on productivity and capital stock, drawn from the OECD STAN and the GGDC 60-industry databases, for a sample of 18 countries: Canada, Japan, Norway, the United States and pre-enlargement EU countries except Luxembourg (the analysis of minimum wages uses a subset of 11 countries with a statutory minimum wage). The time period covered by the analysis covers the period 1979-2003 (the analysis of EPL covers 1982-2003 due to data availability). The sample covers the ten manufacturing industries (STAN 2-digit breakdown), plus utilities, construction, trade, hotels and restaurants, transport and communications, and finance industries. Data for other industries are excluded either because they include sizeable public sector employment or because it is difficult to measure their productivity accurately. Bassanini and Venn (2007) outline the estimation methods and data sources used in the estimates in this article in more detail.

Employment Protection Legislation

EPL, the set of regulations governing the hiring and firing of workers, could affect production efficiency and productivity growth through several channels. Strict EPL may increase productivity by acting as a signalling device to workers about firm commitment, increasing worker effort and incentives to invest in firm-specific human capital and to cooperate with the implementation of productivity-enhancing work practices or new technologies (Soskice, 1997; Belot *et al.*, 2002) or spur productivity-enhancing investments by incumbent firms in order to avoid downsizing (Koeniger, 2005). Alternatively, by increasing the cost of firing workers, strict EPL could make firms reluctant to hire new workers, impeding flexibility and slowing the flow of labour resources into emerging high-productivity firms, activities or industries (Hopenhayn and Rogerson, 1993; Saint-Paul, 1997, 2002). Stringent EPL also discourages firms from experimenting with new technologies, characterised by potentially higher returns but also greater risk (Bartelsman *et al.*, 2004) and potentially reduces effort (thus productivity) because there is a lower threat of layoff in response to poor work performance or absenteeism (Ichino and Riphahn, 2001).

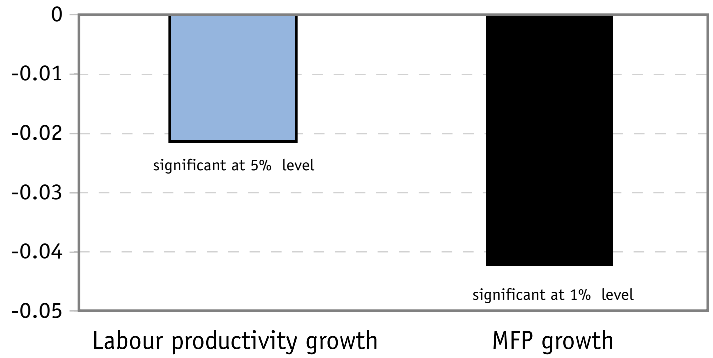
The existing cross-country evidence on the relationship between EPL and productivity growth is inconclusive. Using aggregate, cross-country analysis DeFreitas and Marshall (1998) find that strict EPL has a negative impact on labour productivity growth while Nickell and Layard (1999) and Koeniger (2005) find a weak positive relationship between EPL strictness and both MFP and labour productivity growth.[4] Autor *et al.* (2007) find that restrictions to the employment-at-will doctrine in US states have a positive effect on capital deepening, a negative effect on MFP and no effect on labour productivity. Using an estimation technique similar to that used in this article but for a sample of only 11 OECD countries and a narrower industry coverage, Bassanini, Nunziata and Venn (2008) find a negative relationship between layoff costs and MFP growth adjusted by changes in labour and capital composition. There is also some support for the argument that EPL slows the speed at which job matches are destroyed in declining industries and created in expanding industries (e.g. Burgess *et al*., 2000; Boeri and Jimeno, 2005; Micco and Pages, 2006; Haltiwanger *et al*., 2006; Messina and Vallanti, 2007).

We estimate the impact of EPL for regular contracts using a cardinal index of the stringency of EPL which varies from 0 (least stringent) to 6 (most stringent). We assume that the effect of EPL on productivity is stronger in industries with greater underlying layoff propensity, identified based on layoff rates by industry in the United States, the least regulated country in the sample. Chart 2 shows that EPL on regular contracts has a small but statistically significant negative effect on aggregate productivity growth. A one-point increase in the index of EPL stringency – roughly corresponding to half of the difference between the OECD average and the country with the lowest value of the EPL index (United States) – appears to reduce the annual growth rate of labour productivity by

Chart 2

Impact of Employment Protection Legislation (EPL) on Productivity Growth

Percentage-point impact on labour productivity growth and MFP growth of a one-point increase in the EPL index for regular contracts



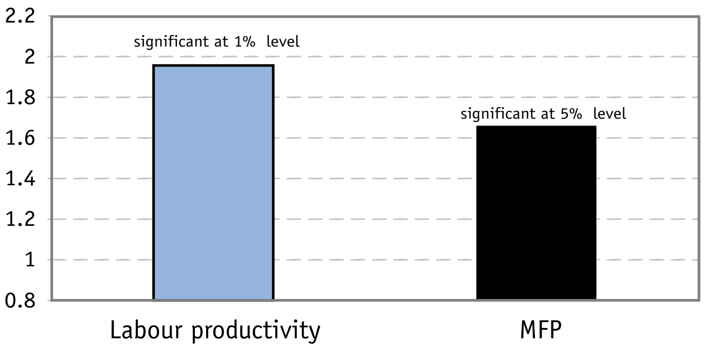
Note: Derived from difference-in-differences OLS estimates. The estimates in this chart are calculated by multiplying the estimated effect of EPL in EPL-binding industries by the share of EPL-binding industries in total GDP. This assumes that there is zero impact of EPL in other industries (and in all industries that are not included in the sample used in the analysis). Therefore, the estimates represent a lower bound of the aggregate impact of EPL on productivity growth. See Bassanini and Venn (2007) for full methodology and results.

at least 0.02 percentage points and the annual growth rate of MFP by at least 0.04 percentage points.[5] The fact that EPL appears to have a stronger effect on MFP growth than labour productivity growth might reflect a positive impact on capital deepening. Although the estimated effect of EPL on productivity is small, it is not negligible from a policy perspective, since it cumulates over time. For instance, if in the mid-1980s Portugal (the country in the sample with the highest value of the EPL index) had liberalised provisions for regular contracts to reflect those of the United States, its labour productivity would be more than 1.5 percentage

4 In Nickell and Layard (1999), the relationship between labour productivity and EPL is not statistically significant once the productivity gap with the United States is included in regressions, but the relationship between MFP growth and EPL continues to hold.

5 The estimated effect on MFP growth is smaller than that measured by Bassanini, Nunziata and Venn (2008). Two main reasons are likely to account for this discrepancy. First, they use a more sophisticated measure of MFP, which controls for labour composition and capital quality. Second, and perhaps more important, they use a semi-structural Schumpeterian growth model estimated in first differences. The latter is not replicated here insofar as it is more data demanding and would lead to excessively small country coverage in the case of the analysis of the productivity impact of statutory minimum wages (see next section).

Chart 3
Impact of Minimum Wages on Productivity
Percentage-point impact on labour productivity and MFP levels of a ten percentage-point increase in the ratio of the minimum wage to the median wage



Note: Derived from difference-in-differences OLS estimates. The estimates in this chart are calculated by multiplying the estimated effect of the minimum wage in low-wage industries by the share of low-wage industries in total GDP. This assumes that there is zero impact of the minimum wage in other industries (and in all industries that are not included in the sample used in the analysis). Therefore, the estimates represent a lower bound of the aggregate impact of the minimum wage on productivity levels. See Bassanini and Venn (2007) for full methodology and results.

points higher than is presently the case. The effect on MFP would be even greater.

Minimum Wages

High minimum wages can reduce demand for unskilled labour, relative to skilled labour, thereby leading to substitution of skilled for unskilled workers and increasing production without any overall change in the employment level (Neumark and Wascher, 2006; Aaronson and French, 2007). If more skilled labour is employed and more unskilled labour is excluded from employment, the aggregate skill level of the workforce will increase, thereby raising average measured productivity. Minimum wages also compress the lower tail of the wage distribution without necessarily affecting individual productivity, thereby increasing employers' incentive to pay for training as they can reap the difference between productivity and wage growth after training (see e.g. Acemoglu and Pischke, 1999 and 2003). Moreover, low-skilled workers could have a greater incentive to invest in human capital to avoid unemployment (Cahuc and Michel, 1996; Agell and Lommerud, 1997; Agell, 1999). On the other hand, by compressing wage relatives between skilled and unskilled jobs, minimum wages could reduce incentives for the low-skilled to invest in training. More importantly, high minimum wages prevent low-wage workers from accepting wage cuts to finance training (Rosen, 1972).

The impact of statutory minimum wages on measured average productivity was estimated based on the assumption that changes in minimum wages have a greater impact on productivity in industries that are more heavily reliant on low-wage labour. In order to reduce bias due to the possible relationship between minimum wages and the distribution of low-wage employment, low-wage industries are identified based on the incidence of low-wage workers by industry in the United Kingdom prior to the introduction of statutory minimum wages in that country in 1999.[6] Minimum wages are measured as the economy-wide ratio of the gross statutory minimum wage to the median wage. Chart 3 shows that an increase of ten percentage points in the ratio of the statutory minimum wage to the median wage (approximately equal to the cross-country standard deviation in minimum wages) is associated with an increase of between 1.7 and 2.0 percentage points in the long-run level of both measured labour productivity and MFP.

It is not clear, however, to what extent the positive impact of minimum wages on productivity is simply due to substitution of skilled for

6 It is possible that the distribution of low-wage workers in the United Kingdom prior to the introduction of the minimum wage reflected economic conditions of the time period examined, rather than an underlying propensity for employing low-wage workers. However, the baseline results appear to be relatively robust to the use of alternative indicators based on the average distribution of low-wage workers by industry across a number of European countries (Bassanini and Venn, 2007).

unskilled workers, increasing the aggregate level of skills and productivity, rather than as the result of improved incentives to invest in training. Competing explanations – that is, training vs. skilled/unskilled substitution effects – have very different policy implications. In fact, while the training story would imply a virtuous link, the substitution story would suggest that the positive productivity effect is purely a statistical artefact and point to undesirable distributional consequences of excessive minimum wages. Although our specification provides no conclusive way of disentangling these effects, further analysis with alternative specifications suggests that minimum wages have a more significant impact on the level of productivity than its growth rate. Insofar as the training channel would likely affect the growth rate as well as the level of productivity, this result provides some, albeit weak, evidence that substitution of high- for low-skilled workers is effectively part of the story. Therefore, the possibility that a large proportion of the productivity effect of minimum wages is due to reduced demand for unskilled workers should be kept in mind when drawing policy implications from these results.

The effect of minimum wages on productivity reported in Chart 3 is estimated assuming that factors other than minimum wages have the same impact on productivity in both low-wage and other industries. Previous research (e.g. Bassanini and Duval, 2006) shows that minimum wages can influence the way in which the tax wedge affects unemployment. The explanation for this may be that higher minimum wages make it more difficult for employers to pass on tax increases to workers, reducing demand for labour. If minimum wages intensify the negative effect of taxes on employment, the lower employment rates that result could induce higher levels of productivity through a composition effect. In this way, the estimated positive impact of minimum wages on productivity could simply be a result of their amplifying the effect of taxes on employment. However, further analysis shows that controlling for an interaction between the tax wedge and the minimum wage had little impact on the baseline results, indicating that minimum wages have an effect on productivity that is independent of any interaction with taxes.

We also find some evidence that generous unemployment benefits may reduce the positive impact of minimum wages on productivity in low-wage industries. The higher the minimum wage relative to the unemployment benefit replacement rate, the greater the opportunity cost of remaining unemployed. If minimum wages increase productivity by reducing demand for unskilled labour and providing incentives for unskilled workers to invest in training to avoid unemployment, high replacement rates could dull this effect by reducing the opportunity cost of remaining unemployed.[7]

Parental Leave

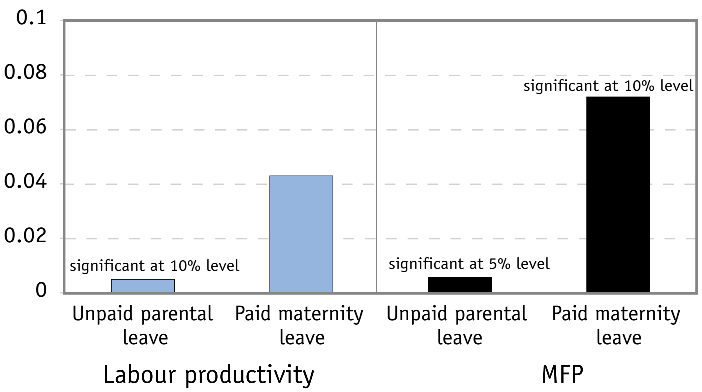
Family-friendly policies, such as parental leave, may help improve parents' morale and work commitment, having a positive impact on productivity by making it easier for parents to balance paid work with family responsibilities. In the absence of family-friendly working arrangements, working parents, particularly women, might leave the workforce completely for extended periods of time, reducing their total work experience and accumulated job-spe-

7 Alternatively, this result could indicate that in low-wage industries, higher minimum wages reduce the positive impact of unemployment benefits on productivity (see the next sections for a full discussion of the possible effects of unemployment benefits on productivity). In short, if unemployment benefits increase productivity by giving the unemployed a buffer of time or resources to find a well-matched job, higher minimum wages will dampen this effect by increasing the opportunity cost for unskilled workers of remaining unemployed and creating an incentive for the unemployed to move quickly into any available job vacancy.

Chart 4

Impact of Parental Leave on Productivity

Percentage-point impact on labour productivity and MFP levels of a one-week increase in unpaid parental leave or paid maternity leave from the sample means[a]



Note: Derived from difference-in-differences OLS estimates. The estimates in this chart are calculated by multiplying the estimated effect of parental leave in female-dominated industries by the share of female-dominated industries in total GDP. This assumes that there is zero impact of parental leave in other industries (and in all industries that are not included in the sample used in the analysis). Therefore, the estimates represent a lower bound of the aggregate impact of parental leave on productivity levels. See Bassanini and Venn (2007) for full methodology and results.

a) The sample means are 64 weeks of unpaid parental leave and 15 weeks of paid maternity leave.

cific human capital. Firms and workers who are assured of an ongoing employment relationship might also be more likely to invest in training. Alternatively, parental leave could impede productivity by reducing parents' access to training and leading to human capital depreciation. Policies that increase the cost to employers of employing parents could lead to discriminatory and inefficient hiring outcomes, whereby highly-skilled women are concentrated in low-skilled jobs. In addition, if new workers lacking in job-specific skills are hired to replace employees taking parental leave, productivity could fall, at least temporarily.

There is very little existing empirical evidence on the direct productivity impact of parental leave. Gray (2002) finds that the provision of paid parental leave has no significant impact on manager-reported measures of labour productivity, financial performance, turnover or absenteeism. To the extent that higher productivity is reflected in higher wages, the literature examining the impact of parental leave on wages provides more evidence on the expected relationship between parental leave and productivity. Time spent out of the workforce after childbirth can have a negative impact on subsequent wages for women due to human capital depreciation or loss of opportunities to accumulate human capital while away from work (Datta Gupta and Smith, 2002). However, a number of studies have shown that the availability and use of parental leave mitigates the negative effects of children on women's wages by increasing the speed at which women return to work following childbirth (Ronsen and Sundstrom, 1996; Berger and Waldfogel, 2004; Dex *et al.*, 1998; Burgess *et al.*, 2008; Joshi *et al.*, 1999) and increasing the likelihood that women return to their pre-birth job, allowing them to capitalise on the benefits of accumulated tenure with their existing employer, such as seniority, training and access to internal labour markets (Baker and Milligan, 2005; Waldfogel 1998; Waldfogel *et al.*, 1999). However, the positive impact of parental leave on productivity may occur only for relatively short periods of leave, whereas long periods of leave lead to substantial depreciation of human capital, even if women eventually return to their pre-birth job (Ruhm, 1998).

We estimate the impact of parental leave on productivity by assuming that the availability of parental leave has a greater impact on productivity in industries where employment is female-dominated. Two variables for parental leave are used in this analysis: total weeks of legislated unpaid parental leave, including child-care leave; and total weeks of legislated paid maternity leave, estimated at average manufacturing worker wages. Chart 4 shows that longer unpaid parental leave is associated with somewhat higher productivity levels. Assuming that there is no impact of unpaid parental leave on productivity in non-female-dominated industries, a one-week increase in the length of available leave is associated with an increase in the level of aggregate labour productivity and MFP of at least 0.005 percentage points. The results for paid maternity leave are more ambiguous: longer periods of available paid maternity leave are associated with higher productivity levels, but the effects are only statistically significant for MFP. Nevertheless, the estimates suggest that the productivity effect of additional paid maternity leave is larger than that for unpaid parental leave.[8]

These results suggest that if countries with no paid maternity leave (such as the United States) introduced this measure at the average OECD level (15 weeks), they could increase their MFP by about 1.1% in the long-run. Further analysis suggests that the impact of additional weeks of leave on productivity is greater in countries with relatively short periods of leave than in countries that already have generous leave entitlements. Increases in the length of unpaid parental leave only appear to be associated with higher productivity in countries where paid maternity leave is short or non-existent. In countries where women already have access to ten weeks or more of paid maternity leave, changes in unpaid parental leave have no significant impact on productivity. It is possible that at least part of the observed impact of parental leave on productivity is due to changes in the level of employment rather than changes in individual productivity. For example, firms could reduce total employment if they think additional parental leave will impose costs on hiring workers, leading to higher productivity through composition effects. Over the longer term, firms might substitute capital for labour in order to reduce the potential cost of parental leave, increasing the capital-to-labour ratio and raising labour productivity. We estimate that employment and composition effects could explain up to half of the productivity effect of paid maternity leave (and a smaller proportion for unpaid parental leave), although this result varies substantially between countries.

Unemployment Benefits

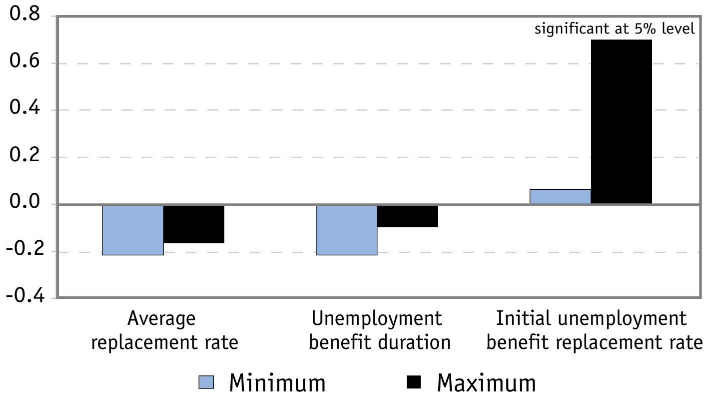
There are a number of channels through which unemployment benefits could affect productivity. First, generous unemployment benefits tend to price low-productivity workers out of jobs in imperfect labour markets (Lagos, 2006), increasing the proportion of high-skilled workers employed and therefore the average productivity level of the workforce. Second, generous unemployment benefits (in terms of either duration, replacement rate or both) may provide a buffer of time and resources to allow the unemployed to find a job that suits their skills and experience, resulting in higher quality, longer-lasting matches between the unemployed and available job vacancies (Marimon and Zilibotti, 1999), increasing productivity by improving the efficiency of resource allocation and increasing incentives for firms and workers to invest in training. Furthermore, it is possible that the provision of generous unemployment benefits encourages the creation of high-risk, high-productivity jobs by making the unemployed more inclined to accept job contracts with a high risk of being terminated quickly (Acemoglu and Shimer, 1999, 2000). Unemployment benefits may also have some adverse effects on productivity. It is well established that generous unemployment benefits can increase the duration of unemployment spells and the level of unemployment (see OECD, 2006, for a survey of recent literature), resulting in lower

8 The statistical significance of the results for both unpaid parental leave and paid maternity leave is somewhat sensitive to changes in the sample of countries included in the analysis, but the point estimates are always positive, indicating that parental leave has either no impact or a positive impact on productivity. There is no evidence that parental leave has a negative impact on productivity.

Chart 5

Impact of Unemployment Benefits on GDP per capita

Percentage-point impact on the steady-state level of GDP per capita of a 10 per cent increase in average replacement rate, unemployment benefit duration and initial benefit replacement rate



Note: Derived from pooled mean group estimates. For each policy, minimum and maximum indicate the smallest and greatest estimate obtained in the specifications reported in OECD (2007a).

productivity through human capital depreciation and inefficient resource use. In addition, by reducing the opportunity cost of unemployment, generous unemployment benefits may lead existing employees to reduce their work effort, thereby lowering productivity (Shapiro and Stiglitz, 1984; Albrecht and Vroman, 1996).

However, it is difficult to pinpoint the industries where unemployment benefits are more binding. Therefore, the difference-in-difference methodology we used for other policies does not have a straightforward application. In contrast with EPL, minimum wages and parental leave, however, there are long and reliable time series on unemployment benefit generosity so we can estimate the direct impact of unemployment benefits on GDP per capita using a structural growth model. Since more generous unemployment benefits are associated with lower aggregate employment rates, the overall effect of higher unemployment benefits on GDP per capita will be negative unless a positive productivity effect compensates fully for the negative employment effect. We can therefore obtain some evidence on the impact of unemployment benefits on productivity from the direct estimation of their overall effect on GDP per capita.

Chart 5 shows that the generosity of unemployment benefits (as measured by an average of gross replacement rates across various earnings levels, family situations and durations of unemployment) appears to have no statistically significant impact, in the long-run, on the level of GDP per capita.[9] These results suggest that any negative impact of unemployment benefits on employment is offset fully by a net positive impact of unemployment benefits on average measured productivity. Furthermore, although point estimates are negative, the long-run elasticity of GDP per capita to changes in benefit generosity appears to be much smaller than the corresponding elasticity of the employment rate.[10] This cautiously suggests that an increase in the generosity of unemployment benefits is likely to have a positive effect on productivity over and above composition effects.

Both of the channels through which unemployment benefits can potentially have a positive influence on productivity over and above composition effects – by improving job-match quality and by encouraging the creation of high-productivity, high-risk jobs – seem to receive

9 These estimates are obtained by fitting the augmented Solow growth model described in Bassanini and Venn (2007), which was made possible by the availability of long time series for average gross replacement rates. The sample covers 18 OECD countries over the period 1970-2002. The countries included in the sample are Australia, Austria, Belgium, Canada, Denmark, France, Greece, Ireland, Italy, Japan, the Netherlands, Norway, New Zealand, Portugal, Spain, Switzerland, the United Kingdom and the United States. Canadian data on gross replacement rates refer only to the Province of Ontario. Yet, eliminating Canada from the sample yields an even less negative point-estimate, thus reinforcing the results.

10 As shown in Chart 5, at the sample average, a 10 per cent increase in average replacement rates would imply a fall in GDP per capita of about 0.15-0.2 per cent, implying an elasticity no greater than -0.02. Such a low elasticity cannot be entirely explained through composition effects.

some support from the empirical evidence. Generous unemployment benefits appear to be associated with higher quality job matches, although the effects are relatively small (e.g. Pollmann-Schult and Buchel; 2005; Centeno, 2004; Belzil, 2001; Addison and Blackburn, 2000; Polachek and Xiang, 2005). Evidence on the relationship between unemployment benefits and the creation of high-productivity/high-risk jobs is less clear, but suggests that more generous unemployment benefits increase the supply of high-wage jobs (Acemoglu, 1997). Further evidence presented in Bassanini and Venn (2007) shows a positive effect of unemployment benefits on relative levels of MFP and labour productivity in high-risk industries compared to low-risk industries.

Overall, the net impact of unemployment benefits on average measured productivity appears to be positive. How much of this positive effect is due to changes in the composition of the labour force as a result of the impact of unemployment benefits on employment remains unclear. Unemployment benefits seem to have some independent positive impact on productivity, by supporting higher quality job matches and facilitating the creation of riskier, higher productivity jobs by providing insurance against future job loss. Yet, the net impact on GDP per capita appears to be small.

Conclusion

The results presented in this article show that labour market policies can have a significant impact on productivity levels and/or growth rates, over and above their impact on employment. Stringent EPL has a small negative impact on long-run productivity growth, most likely by restricting the movement of labour into emerging, high-productivity activities, firms or industries. Increases in the ratio of the minimum wage to the median wage appear to have a positive impact on the aggregate level of measured productivity. The effect may be due to improved incentives for investing in training or come as the result of substitution of skilled labour for unskilled labour. The relative importance of the two interpretations is key for policy purposes, but could not be determined empirically. Additional parental leave appears to increase the level of productivity, in part by allowing workers with family responsibilities to maintain their links to the workforce, although the magnitude of the effect is small and not always statistically significant. Finally, reforms that reduce the generosity of unemployment benefits are likely to reduce the aggregate level of measured productivity by limiting the time and resources available to the unemployed to find a well-matched job vacancy, discouraging workers from taking up – and firms from creating – high-risk, high-productivity jobs and affecting the skill composition of the workforce. However, the overall long-run impact of lowering unemployment benefits on the level of GDP per capita appears to be negligible.

References

Aaronson, D. and E. French (2007) "Product Market Evidence on the Employment Effects of the Minimum Wage," *Journal of Labor Economics*, Vol. 25, No. 1, pp. 167-200.

Acemoglu, D. (1997) "Good Jobs Versus Bad Jobs: Theory and Some Evidence," Centre for Economic Policy Research Discussion Paper No. 1588.

Acemoglu, D. and S. Pischke (1999) "Beyond Becker: Training in Imperfect Labour Markets," *Economic Journal*, Vol. 109, No. 453, pp. F112-F142.

Acemoglu, D. and S. Pischke (2003) "Minimum Wages and On-The-Job Training," *Research in Labor Economics*, Vol. 22, pp. 159-202.

Acemoglu, D. and R. Shimer (1999) "Efficient Unemployment Insurance," *Journal of Political Economy*, Vol. 107, No. 5, pp. 893-928.

Acemoglu, D. and R. Shimer (2000) "Productivity Gains from Unemployment Insurance," *European Economic Review*, Vol. 44, No. 7, pp. 1195-1224.

Addison, J. and M. Blackburn (2000) "The Effects of Unemployment Insurance on Postunemployment Earnings," *Labour Economics*, Vol. 7, No. 1, pp. 21-53.

Agell, J. (1999) "On the Benefits from Rigid Labour Markets: Norms, Market Failures, and Social Insurance," *Economic Journal*, Vol. 109, No. 453, pp. F143-F164.

Agell, J. and K. Lommerud (1997) "Minimum Wages and the Incentives for Skill Formation," *Journal of Public Economics*, Vol. 64, No. 1, pp. 25-40.

Albrecht, J. and S. Vroman (1996) "A Note on the Long-Run Properties of the Shirking Model," *Labour Economics*, Vol. 3, No. 2, pp. 189-195.

Autor, D., W. Kerr and A. Kugler (2007) "Do Employment Protections Reduce Productivity? Evidence from U.S. States," IZA Discussion Paper No. 2571.

Baker, M. and K. Milligan (2005), "How Does Job-protected Maternity Leave Affect Mothers' Employment and Infant Health?," NBER Working Paper, No. 11135.

Bartelsman, E., A. Bassanini, J.Haltiwanger, R. Jarmin, S. Scarpetta and T. Schank (2004) "The Spread of ICT and Productivity Growth: Is Europe Really Lagging Behind in the New Economy?," in D. Cohen, P. Garibaldi and S. Scarpetta (eds.), *The ICT Revolution: Productivity Differences and the Digital Divide* (Oxford: Oxford University Press).

Bassanini, A. and R. Duval (2006) "The Determinants of Unemployment Across OECD Countries: Reassessing the Role of Policies and Institutions," *OECD Economic Studies*, 42, pp. 7-86.

Bassanini, A., L. Nunziata and D. Venn (2008) "Job Protection Legislation and Productivity Growth in OECD Countries," IZA Discussion paper No. 3555, presented at the 48th Economic Policy Panel Meeting in Paris, October.

Bassanini, A. and D. Venn (2007) "Assessing the Impact of Labour Market Policies on Productivity: A Difference-in-Differences Approach," OECD Social, Employment and Migration Working Paper No. 54.

Belorgey, N., R. Lecat and T. Maury (2006) "Determinants of Productivity per Employee: An Empirical Estimation Using Panel Data," *Economics Letters*, Vol. 91, pp. 153-157.

Belot, M., J. Boone and J. van Ours (2002) "Welfare Effects of Employment Protection," CEPR Discussion Paper No. 3396.

Belzil, C. (2001) "Unemployment Insurance and Subsequent Job Duration: job matching versus unobserved heterogeneity," *Journal of Applied Econometrics*, Vol. 16, No. 5, pp. 619-636.

Berger, L.M. and J. Waldfogel (2004) "Maternity Leave and the Employment of New Mothers in the United States," *Journal of Population Economics*, Vol. 17, No. 3, pp. 331-349.

Boeri, T. and J. Jimeno (2005) "The Effects of Employment Protection: Learning from Variable Enforcement," *European Economic Review*, Vol. 49, No. 8, pp. 2057-2077.

Bourlès, R. and G. Cette (2005) "A Comparison of Structural Productivity Levels in the Major Industrialised Countries," *OECD Economic Studies*, Vol. 41, No. 2, pp. 75-108.

Bourlès, R. and G. Cette (2007) "Trend in 'Structural' Productivity Levels in the Major Industrialised Countries," *Economics Letters*, Vol. 95, pp. 151-156.

Burgess, S., M. Knetter and C. Michelacci (2000) "Employment and Output Adjustment in the OECD: A Disaggregate Analysis of the Role of Job Security Provisions," *Economica*, Vol. 67, No. 267, pp. 419-435.

Burgess, S., P. Gregg, C. Propper and E. Washbrook (2008) "Maternity Rights and Mothers' Return to Work," *Labour Economics*, Vol. 15, No. 2, pp. 168-201.

Cahuc, P. and P. Michel (1996) "Minimum Wages, Unemployment and Growth," *European Economic Review*, Vol. 40, No. 7, pp. 1463-1482.

Centeno, M. (2004) "The Match Quality Gains From Unemployment Insurance," *Journal of Human Resources*, Vol. 39, No. 3, pp. 839-863.

Datta Gupta, N. and N. Smith (2002) "Children and Career Interruptions: The Family Gap in Denmark," *Economica*, Vol. 69, No. 276, pp. 609-629.

DeFreitas, G. and A. Marshall (1998) "Labour Surplus, Worker Rights and Productivity Growth: A Comparative Analysis of Asia and Latin America," *Labour*, Vol. 12, No. 3, pp. 515-539.

Dew-Becker, I. and R. Gordon (2006) "The Slowdown in European Productivity Growth: A Tale of Tigers, Tortoises and Textbook Labor Economics," Northwestern University and NBER unpublished manuscript presented at the Conference on "Prospects for Productivity and Growth in Ireland and the Euro Area," Dublin, September.

Dex, S., H. Joshi, S. Macran and A. McCulloch (1998) "Women's Employment Transitions Around Child Bearing," *Oxford Bulletin of Economics and Statistics*, Vol. 60, No. 1, pp. 79-98.

Gray, H. (2002) "Family-Friendly Working: What A Performance! An Analysis of the Relationship Between the Availability of Family-Friendly Policies and Establishment Performance," London School of Economics Centre for Economic Performance Discussion Paper No. 529.

Gust, C. and J. Marquez (2004) "International Comparisons of Productivity Growth: The Role of

Information Technology and Regulatory Practices," *Labour Economics*, Vol. 11, pp. 33-58.

Haltiwanger, J., S. Scarpetta and H. Schweiger (2006) "Assessing Job Flows across Countries: The Role of Industry, Firm Size and Regulations," IZA Discussion Paper No. 2450.

Heckman, J., M. Ljunge and K. Ragan (2006) "What are the Key Employment Challenges and Policy Priorities for OECD Countries," University of Chicago Department of Economics unpublished manuscript, presented at the "Boosting Jobs and Incomes" conference, Toronto, Canada, June.

Hopenhayn, H. and R. Rogerson (1993) "Job Turnover and Policy Evaluation: A General Equilibrium Analysis," *Journal of Political Economy*, Vol. 101, No. 5, pp. 915-938.

Ichino, A. and R. Riphahn (2001) "The Effect of Employment Protection on Worker Effort: A Comparison of Absenteeism During and After Probation," IZA Discussion Paper No. 385.

Joshi, H., P. Paci and J. Waldfogel (1999) "The Wages of Motherhood: Better or Worse?," *Cambridge Journal of Economics*, Vol. 23, No. 5, pp. 543-564.

Koeniger, W. (2005) "Dismissal Costs and Innovation," *Economics Letters*, Vol. 88, No. 1, pp. 79-85.

Lagos, R. (2006) "A Model of TFP," *Review of Economic Studies*, Vol. 73, No. 4, pp. 983-1007.

Marimon, R. and F. Zilibotti (1999) "Unemployment Vs. Mismatch of Talents: Reconsidering Unemployment Benefits," *Economic Journal*, Vol. 109, No. 455, pp. 266-291.

McGuckin, R. and B. van Ark (2004) "Productivity and Participation: An International Comparison," Groningen Growth and Development Centre Research Memorandum GD-78.

Messina, J. and G. Vallanti (2007) "Job Flow Dynamics and Firing Restrictions: Evidence from Europe," *Economic Journal*, Vol. 117, No. 521, pp. F279-F301.

Micco, A. and C. Pages (2006) "The Economic Effects of Employment Protection: Evidence from International Industry-Level Data," IZA Discussion Paper No. 2433.

Neumark, D. and W. Wascher (2001) "Minimum Wages and Training Revisited," *Journal of Labor Economics*, Vol. 19, No. 3, pp. 563-595.

Nickell, S. and B. Bell (1996) "Changes in the Distribution of Wages and Unemployment in OECD Countries," *American Economic Review*, Vol. 86, No. 2, pp. 302-308.

Nickell, S. and R. Layard (1999) "Labor Market Institutions and Economic Performance," in O. Ashenfelter and D. Card (eds), *Handbook of Labor Economics*, Edition 1, Vol. 3, Chapter 46, pp. 3029-3084 (Amsterdam: Elsevier).

OECD (2003) *The Sources of Economic Growth in OECD Countries* (Paris: OECD).

OECD (2006) *OECD Employment Outlook* (Paris: OECD).

OECD (2007a) "More Jobs But Less Productive? The Impact of Labour Market Policies on Productivity: Further Material," *www.oecd.org/els/employmentoutlook/2007*.

Polachek, S. and J. Xiang (2005) "The Effects of Incomplete Employee Wage Information: A Cross-Country Analysis," IZA Discussion Paper No. 1735.

Pollmann-Schult, M. and Buchel, F. (2005) "Unemployment Benefits, Unemployment Duration and Subsequent Job Quality," *Acta Sociologica*, Vol. 48, No. 1, pp. 21-39.

Ronsen, M. and M. Sundstrom (1996) "Maternal Employment in Scandinavia: A Comparison of the After-Birth Employment Activity of Norwegian and Swedish Women," *Journal of Population Economics*, Vol. 9, No. 3, pp. 267-285.

Rosen, S. (1972) "Learning and Experience in the Labor Market," *Journal of Human Resources*, Vol. 7, No. 3, pp. 326-342.

Ruhm, C. (1998) "Economic Consequences of Parental Leave Mandates: Lessons from Europe," *Quarterly Journal of Economics*, Vol. 113, No. 1, pp. 285-317.

Saint-Paul, G. (1997) "Is Labour Rigidity Harming Europe's Competitiveness? The Effect of Job Protection on the Pattern of Trade and Welfare," *European Economic Review*, Vol. 41, No. 3-5, pp. 499-506.

Saint-Paul, G. (2002) "Employment Protection, International Specialization, and Innovation," *European Economic Review*, Vol. 46, No. 2, pp. 375-395.

Shapiro, C. and J.E. Stiglitz (1984) "Equilibrium Unemployment as a Worker Discipline Device," *American Economic Review*, Vol. 74, No. 3, pp. 433-444.

Soskice, D. (1997) "German Technology Policy, Innovation and National Institutional Frameworks," *Industry and Innovation*, Vol. 4, No. 1, pp. 75-96.

Waldfogel, J. (1998) "The Family Gap for Young Women in the United States and Britain: Can Maternity Leave Make a Difference?," *Journal of Labor Economics*, Vol. 16, No. 3, pp. 505-545.

Waldfogel, J., Y. Higuchi and M. Abe (1999) "Maternity Leave Policies and Women's Employment After Childbirth: Evidence from the United States, Britain and Japan," London School of Economics Centre for Analysis of Social Exclusion Paper no. CASE/3.

Why Have Real Wages Lagged Labour Productivity Growth in Canada?

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ABSTRACT

The most direct mechanism by which labour productivity affects living standards is through real wages, that is, wages adjusted to reflect the cost of living. Between 1980 and 2005, the median real earnings of Canadians workers stagnated, while labour productivity rose 37 per cent. This article analyzes the reasons for this situation. It identifies four factors of roughly equal importance: rising earning inequalities; falling terms of trade for labour; a decrease in labour's share of GDP; and measurement issues.

THE MOST DIRECT ROUTE by which labour productivity affects living standards is through gains in real wages, that is, wages adjusted for the cost of living. Yet median real wages have stagnated in Canada since 1980 despite significant productivity gains. The 2006 Census found that median real earnings of individuals working full-time on a full-year basis barely increased between 1980 and 2005. Over the same period, labour productivity rose 37.4 per cent. If median real earnings had grown at the same rate as labour productivity, the median Canadian full-time full-year worker would have earned $56,826 in 2005, considerably more than the actual $41,401(2005 dollars). The objective of this article is to explain this large divergence between median real wage growth and labour productivity growth.

This article is divided into five sections. The first section sets out the analytical framework used in the article and discusses measurement issues. The second section reviews trends in real wages and labour productivity. The third section provides an accounting reconciliation of the gap between between the growth rate of median real earnings and labour productivity in Canada between 1980 and 2005. The fourth section discusses the drivers of this gap. The fifth section concludes.

Analytical Framework and Measurement

At the aggregate level, when defined consistently, long-term growth in average real wages is determined by labour productivity growth. This relationship is mediated by changes in labour's share of income and labour's terms of trade (the

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price of the output produced by workers relative to their cost of living):

1) $\Delta Real\ Wage = \Delta Labour\ Productivity + \Delta Labour's\ Share + \Delta Labour's\ Terms\ of\ Trade$

where Δ indicates a percentage change.

In equation (1) real wages are nominal wages deflated using the Consumer Price Index (CPI).[2] In this equation, real wages are an average rather than a median measure, and therefore do not directly capture the effect of changing earnings inequality, an issue to which we will return below.

The key measurement issue in the relationship between labour productivity and real wages is the appropriate choice of a measure of wages. The theoretical relationship between real wages and labour productivity set out in equation (1) is a relationship between the total compensation paid to labour and labour productivity. A number of wage measures covering different groups and based on different definitions of wages are available from Statistics Canada (Table 1). This choice is important, because the series grow at different rates, and using series that are not comprenhensive tends to underestimate growth in labour compensation.

Table 1
Measures of Nominal Hourly Wages, Canada, Total Economy, 1997-2007
(average annual growth rate, per cent)

Survey of Employment, Payroll and Hours	
Employees paid by the hour	2.07
Salaried employees	2.37
Survey of Labour and Income Dynamics*	3.60
Labour Force Survey	2.73
Major Wage Settlements	2.40
National Income and Expenditure Accounts	3.72
Productivity Accounts	3.62

* 1997-2005

Source: CSLS calculations based on Statistics Canada data.

Wage estimates from the Survey of Employment, Payroll and Hours and the Major Wage Settlements series do not cover all workers, nor do they cover all types of labour compensation. While wage estimates from the Survey of Labour and Income Dynamics and Labour Force Survey cover all types of workers, they do not include supplementary labour income. The "wages, salaries, and supplementary labour income" series from the national accounts does cover all forms of labour compensation, but excludes the self-employed. The labour compensation series from the Canadian Productivity Accounts is the most appropriate series to use in analyzing the relationship between real wages and labour productivity. This series covers the broadest definition of compensation and the broadest definition of workers, including the labour component of self-employed remuneration, and is the measure used for real wages throughout this article.[3]

An important trend has been the growing share of supplementary labour income (SLI) in total labour income. Statistics Canada defines SLI to include employer contributions to pension plans (private or public), supplementary health benefits, Employment Insurance (EI) and workers' compensation. Since 1961, SLI has risen from 4.9 per cent of labour income to 12.9 per cent in 2007 (Chart 1). This increasing importance is attributable primarily to (1) a sig-

2 Or, more formally, $\frac{Y_L}{P_C \times L} = \frac{Y}{P_Y \times L} \times \frac{Y_L}{Y} \times \frac{P_Y}{P_C}$ where Y_L is the sum of all wages paid, P_C is the Consumer Price Index (CPI), L is total hours worked in the economy, Y is nominal output, and P_Y is the GDP deflator. Therefore, $\frac{Y_L}{P_C \times L}$ is the consumption wage, $\frac{Y}{P_Y \times L}$ is labour productivity, $\frac{Y_L}{Y}$ is labour's share of output, and $\frac{P_Y}{P_C}$ is labour's terms of trade.

3 In practice, the labour compensation series from the Productivity Accounts has exhibited very similar trends to the "wages, salaries, and supplementary labour income" series from the Income and Expenditure Accounts over the 1981-2007 period.

Table 2

Labour Productivity and Real Wages in Canada, Total Economy, 1961-2007

	Labour Productivity	Labour Share	Labour's Terms of Trade	Real Wage	Real Wage Gap	Labour's Share of Nominal GDP (per cent)	
	compound annual growth rate (per cent)					in first year of period	in last year of period
Period	[1]	[2]	[3]	[4] = [1]+[2]+[3]	[5]=[4]-[1]	[6]	[7]
1961-2007	1.73	-0.17	0.11	1.67	-0.06	57.5	53.1
1961-1973	3.00	-0.08	0.90	3.87	0.87	57.5	57.0
1973-1981	1.29	-0.11	0.22	1.38	0.09	57.0	56.5
1981-1989	1.15	-0.20	-0.66	0.28	-0.86	56.5	55.6
1989-2000	1.54	-0.38	-0.36	0.79	-0.76	55.6	53.3
2000-2007	1.03	-0.04	0.26	1.24	0.21	53.3	53.1
1980-2005	1.27	-0.27	-0.42	0.58	-0.69	56.5	52.8

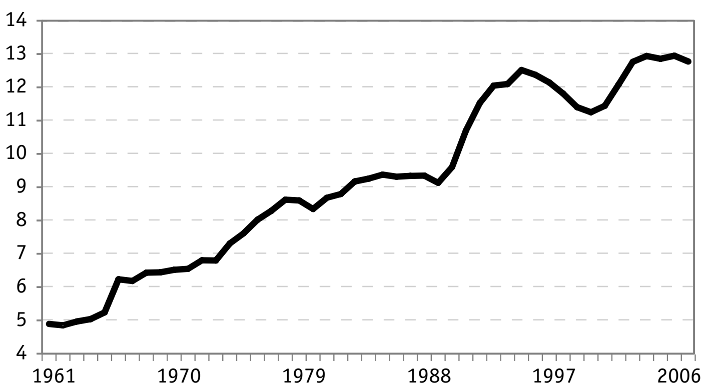
Note: Figures may not sum exactly due to rounding. Apart from 1980-2005, sub-periods are chosen to be cyclically neutral (peak to peak). Real wages and labour share are calculated with the labour compensation series from the Canadian Productivity Accounts.

Source: CSLS calculations based on Statistics Canada data.

Chart 1

Supplementary Labour Income as a Share of Total Labour Income, Canada, Total Economy, 1961-2007

(current dollars, per cent)



Source: Statistics Canada, National Accounts.

nificant increase in contribution rates for the Canada and Quebec Pension Plans, particularly since 1998, and (2) the increasing importance of welfare benefits such as private health and dental benefits plans, which represented 3.0 per cent of labour income in 2005, up from only 1.0 per cent in 1961.[4] All other components of SLI also increased in importance over the 1961-2005 period: private pensions (2.4 to 3.8 per cent); Employment Insurance contributions (0.7 to 1.5 per cent); retiring allowances (0.0 to 0.7 per cent); and workers' compensation payments (0.8 to 1.3 per cent). Any estimate of the growth in wages which does not include SLI is likely to be an underestimate.

Trends in Labour Productivity and Real Wages

Over the 1961-2007 period, growth in real wages (1.67 per cent per year) has been slightly slower than labour productivity growth (1.73 per cent per year) (Table 2 and Chart 2). The real wage gap, that is, the difference between the real wage growth and labour productivity growth reflects trends in the labour's share of income and labour's terms of trade. Labour's share fell 0.17 per cent per year between 1961 and 2007, from 57.5 per cent of GDP to 53.1 per cent (Table 2 and Chart 3). Over the same period, labour's terms of trade improved by 0.11 per cent per year. In sum, growth in real wages lagged growth in labour productivity over the period 1961-2007 because the labour share declined. The real wage gap would have been even greater had it not been for an improvement in labour's terms of trade.

4 Data on the components of SLI are only available up to 2005.

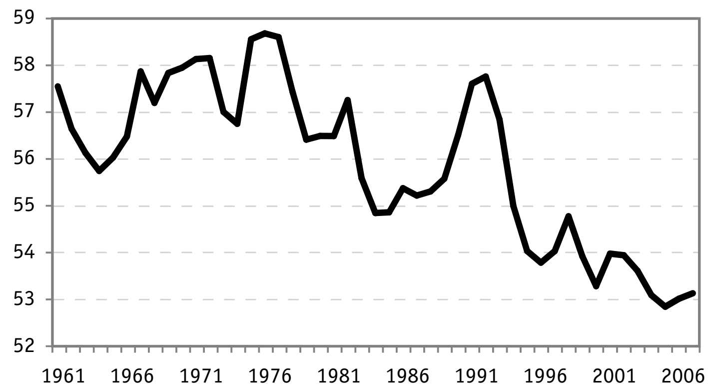
In all sub-periods between 1961 and 2007 the labour share fell. The decline was most pronounced in the period from 1989 to 2000. In fact, the fall in the labour share between 1961 and 2007 was largely due to developments between 1992 and 1996, when the labour share fell from 57.7 per cent to 53.8 per cent of GDP. Since then, the labour share has failed to recover and indeed has further declined. The timing and persistence of this decline in labour share will be discussed in more detail below.

Labour's terms of trade improved slightly from 1961 to 2007, but this improvement concealed major shifts within the period (Table 2 and Chart 4). Labour's terms of trade improved considerably from 1961 to 1973, overcoming the negative effect of the small fall in labour share to push the rate of growth of real wages well above the rate of growth of labour productivity. After further small increases to 1976, labour's terms of trade fell steadily until the early 1990s. This fall resulted in weak real wage growth from 1981 to 1989, which at 0.28 per cent per year was well behind growth in labour productivity of 1.15 per cent per year. From 1989 to 2000, there was a further fall in labour's terms of trade, though less so than in the 1980s. Real wages still failed to keep pace with labour productivity as the labour share also fell sharply. Finally, between 2000 and 2007 there was a turnaround, real wage growth outpaced labour productivity growth for the first time since the 1970s, due exclusively to gains in labour's terms of trade.

Chart 2
Labour Productivity and Real Wages, Canada, Total Economy, 1961-2007
(1961 = 100)

Source: CSLS calculations based on Statistics Canada data.

Chart 3
Labour's Share, Canada, Total Compensation as a Share of GDP, 1961-2007
(current dollars, per cent)



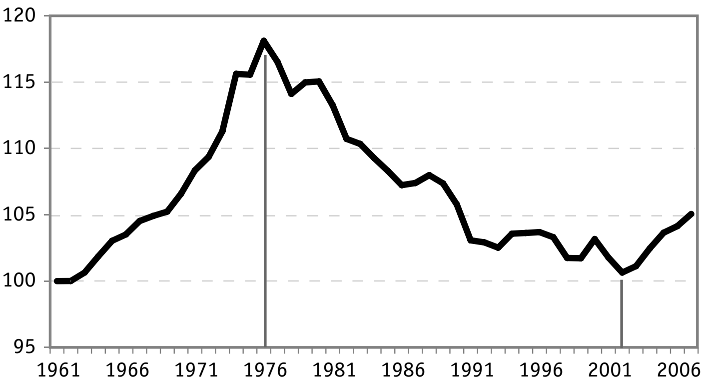
Source: CSLS calculations based on Statistics Canada data.

Trends in labour productivity and real wages in other high-income countries

The relationship between labour productivity and real wages in the United States was broadly similar to that observed in Canada. Over the period 1961 to 2007, labour productivity grew by 1.82 per cent per year on average, while real wages grew by 1.74 per cent per year. The labour share declined by 0.09 per cent per year, from 64.1 per cent of GDP in 1961 to 61.5 per cent of GDP in 2007. Labour's terms of trade were essentially unchanged over this period, and exhibited far less fluctuation than in Canada.

Between 1970 and 2006, the trend among other high-income countries has been broadly similar to that observed in Canada. In nine of 15 countries for which data were available, labour pro-

Chart 4
Labour's Terms of Trade, Canada, 1961-2007
(Index 1961 = 100)



Source: CSLS calculations based on Statistics Canada data.

Table 3
Factors Explaining the Difference between Median Real Earnings and Labour Productivity Growth in Canada, 1980-2005

	Absolute (points)	Relative (per cent)
Median Real Earnings and Productivity Gap, of which:	1.26	100.0
Measurement Issues	0.25	19.8
Inequality	0.35	27.6
Labour's Terms of Trade	0.42	33.3
Labour's Share	0.25	19.8

Source: Table 4.

ductivity growth slightly exceeded growth in real wages. Declines in labour share have been partially offset by improvements in labour's terms of trade. There was notable variation among some high-income countries with the United Kingdom and New Zealand actually experiencing increases in labour share, while Germany, Japan, and South Korea all saw substantial deteriorations in labour's terms of trade.[5]

An Accounting Perspective on the Gap between Median Real Earnings Growth and Labour Productivity Growth

In May 2008 Statistics Canada (2008) reported that the median earnings of full-time, full-year workers in Canada rose only $53 dollars, from $41,348 (2005 dollars) in 1980 to $41,401 in 2005.[6] Over the same period, total economy labour productivity gains were 37.4 per cent. As discussed above, a number of conceptual and methodological hurdles stand in the way of a meaningful comparison of labour productivity and earnings growth. This section provides a decomposition of the gap between stagnant median real earnings and labour productivity growth.

Some of the gap between the growth of median real earnings and the growth of labour productivity is a result of inconsistent measurement. The two measures embody different definitions and concepts that are either not comparable, or cannot be meaningfully compared as they lack consistency. As shown in Table 3, about one fifth of the 1.26 per cent gap between annual median earnings growth and annual labour productivity growth over the 1980-2005 period was due to measurement issues.

First, to make a meaningful comparison between real earnings and labour productivity, the same unit of labour input must be used. While census earnings are reported for full-time full-year workers, productivity is reported for all workers and is best expressed on an hourly basis. In our analysis, the transformation from full-time, full-year workers to hours for all workers was divided in two steps (Table 4). First, the average earnings of full-time full-year workers

5 See the unabdridged version of this article for a more detailed analysis of trends in labour productivity and real wages in the United States and other high-income countries.

6 The analysis contained in this section pertains to the 1980-2005 period rather than the 1961-2007 period, which was the focus of the previous section. We adopted the 1980-2005 period in order for the discussion to remain in the context of the current public debate in Canada about the gap between labour productivity and real wages. The lack of consistent median wage data prior to 1980 also prevented us from extending the analysis further back in time.

grew at about the same rate as the earnings of all earners, where an earner is defined as anyone with earnings during the year. Second, the number of hours worked per earner has increased slightly over the 1980-2005 period, up 2.25 per cent, or 0.09 per cent on an annual basis.[7] Adopting a more appropriate measure of labour input, hours worked, thus increases the gap by 0.10 percentage points (7.9 per cent).

Second, the census definition of earnings excludes supplementary labour income (SLI). On an annual basis, average labour compensation grew 0.35 percentage points faster over the 1980-2005 period than average earnings, in part because labour compensation includes SLI and earnings do not. This difference in growth rates explains slightly more than one-quarter (27.8 per cent) of the gap between the growth in real median earnings and labour productivity.

The use of median earnings instead of average earnings accounted for about one-quarter (27.6 per cent) of the gap between median real earnings and labour productivity growth. This difference reflects increasing earnings inequality in Canada over the period. Median real earnings of the top 20 per cent of full-time full-year earners grew 16.4 per cent, while those of the bottom 20 per cent fell 20.6 per cent (Statistics Canada, 2008). While of great social importance, trends in inequality are largely independent of the relationship between labour productivity and real wages. As such, comparing median earnings and labour productivity may be slightly misleading from the point of view of a consistent statistical framework as it conflates issues of inequality with those of productivity growth.

The use of different price indexes to deflate nominal GDP and labour compensation accounted for one-third of the median earnings/labour productivity growth gap between 1980 and 2005. From a consumer perspective, labour compensation must be adjusted using the CPI in order to obtain an indicator of purchasing power that is comparable over time. Over the 1980-2005 period, the CPI grew faster than the GDP deflator. Yet, for consistency the link between real wages and labour productivity requires that both variables be deflated using the same price index. When both measures are deflated using the GDP deflator, a further 0.42 percentage points, or 33.3 per cent, of the gap is explained. This difference between the rate of growth of the price of output, measured by the GDP deflator, and the rate of growth of the price of consumption goods, measured by the CPI, is known as labour's terms of trade.

The remaining 0.25 percentage points (19.8 per cent) of the median earnings/labour productivity gap was due to the falling labour share. In an

Table 4
Reconciling Growth in Median Real Earnings and Labour Productivity in Canada, 1980-2005

Earnings and Productivity Growth Gap	**Compound Annual Growth Rates**	
Real median earnings of full-time full-year workers	0.01	
Labour productivity (Real output per hour)	1.27	
Total gap	1.26	
Contribution to Median Real Earnings and Productivity Gap	**Absolute (points)**	**Relative (per cent)**
From median to average earnings	0.35	27.6
Change in definition of labour input, of which:	-0.10	-7.9
from full-time full-year earners to all earners	-0.01	-0.6
from earners to total hours	-0.09	-7.3
From earnings to total compensation	0.35	27.8
From CPI to GDP deflator	0.42	33.3
Change in the labour share of nominal GDP	0.25	19.8
Total – All Factors	1.26	100.0

Note: Figures may not sum exactly due to rounding.
Source: CSLS calculations based on Statistics Canada data.

7 The number of hours worked per earner tends to be pro-cyclical, i.e. favorable labour market conditions tend to increase the average number of hours worked for individuals working in a given year. Over the 1980-2005 period, the number of hours worked per earner per year based on monthly averages reached a trough in 1982 at 1,463 hours and peaked in 1998 at 1,593 hours (Labour Force Survey). In this context, the difference between 1980 and 2005 is relatively small at 35 hours per year, from 1,521 hours in 1980 to 1,556 in 2005.

accounting sense, faster growth in the non-wage components of GDP explains the falling labour share. During the 1980-2005 period, average annual growth of nominal wages, salaries and supplementary income was 5.77 per cent, slightly slower than nominal GDP growth of 6.08 per cent per year, and significantly slower than the 6.42 per cent per year rate of increase of nominal GDP excluding wages. Of the six largest non-wage components of income-based GDP (accounting for 97.4 per cent of GDP excluding wages), five grew faster than wages and thus contributed to the faster growth of GDP relative to wages. Profits, growing at a robust 6.59 per cent per year, made a large contribution.[8] In 1980, profits represented 12.2 per cent of GDP. By 2005, the share had risen to 13.8 per cent.

Factors Affecting the Drivers of the Gap between Median Real Earnings Growth and Labour Productivity Growth

This section examines the three most important drivers of the gap between median real earnings and labour productivity growth over the 1980-2005 period: earnings inequality, labour's terms of trade, and labour's share of national income.

Earnings inequality

As noted earlier, the median real earnings of the top quintile increased 16.4 per cent between 1980 and 2005, while those of the bottom quintile decreased 20.6 per cent. Some argue that increased earnings inequality reflects market forces at play and more specifically the growing demand for highly skilled labour. An extreme example of market forces leading to large gains for skilled labour is J.K. Rowling, the author of the Harry Potter series. She was the first person to become a billionaire by writing books, a reality made possible by the new market forces which among other things facilitate the distribution of products across markets.[9] Others make the case that increased earnings inequality reflects governance structures that allow persons in positions of power, such as Chief Executive Officers, to obtain earnings increases not commensurate with their contribution to output.

Saez and Veall (2005) find that the increase in total income since the late 1970s in Canada has been concentrated among the top one per cent of earners, whose share of income increased from 5 per cent in the late 1970s to 10 per cent in 2000. The top 0.1 per cent in turn accounted for much of that increase, with their share going from 1.0 to 4.3 per cent over the period. Saez and Veall suggest that the threat of migration to the United States, where the surge in top income share started earlier (1970), might have spurred the surge in Canada. They support their case with evidence from Quebec where residents have a lower propensity to migrate because of language and cultural differences and where the top income share increase has been much more modest. While the finding of increased income inequality due to the rapid rise of incomes at the top of the distribution has been confirmed in many subsequent studies (Murphy, Michaud and Wolfson (2008) and Heisz

8 Nominal net income of unincorporated businesses including rent grew at a 7.54 per cent average annual growth rate between 1980 and 2005, with capital consumption allowances increasing at a 6.42 per cent average annual rate, and net taxes (taxes less subsidies) at a 7.75 per cent rate. Interest and miscellaneous investment income advanced at only a 3.28 average annual rate. In relative terms, the faster growth of corporate profits account for 34.5 per cent, or 23.1 percentage points, of the 67.1 percentage point difference between the growth of wages and the growth of GDP minus wages for the 1980-2005 period. Net taxes contributed 36.2 per cent, capital consumption allowance 25.9 per cent, unincorporated businesses 29.5 per cent and interest and investment income, which grew much more slowly, had a negative contribution of 51.7 per cent.

9 Other examples include professional athletes, musicians and performers in general.

(2007) for example), the drivers behind this trend still remain poorly understood.

Labour's terms of trade

The Consumer Price Index advanced 3.6 per cent per year between 1980 and 2005 compared to 3.2 per cent for the GDP deflator.[10] The CPI measures changes in the prices of a basket of goods and services purchased by consumers. The GDP deflator is a measure of the change in the prices of all components of output in the economy. It is the weighted average of deflators for personal consumption, government consumption, investment, exports, and imports.

Changes in labour's terms of trade are equal to changes in the GDP deflator less changes in the CPI. For example, if the prices of the goods produced by workers, which are measured by the GDP deflator, rise more quickly than the goods consumed by workers, measured by the CPI, then the workers are better off; their terms of trade have improved.[11]

It is interesting to examine what happened to labour's terms of trade between 1980 and 2005, in order to shed more light on the discussion presented in the previous section. Over this period, labour's terms of trade deteriorated 0.42 percentage points per year (Table 5 and Chart 4). Three-quarters of this deterioration was driven by slower inflation in the price of investment goods, primarily in the 1990s. This trend reflected in large part the falling prices of information and communications technology (ICT) investment goods over that period.

Over the last five years, however, falling ICT prices have been dominated by Canada's improving international terms of trade, a direct consequence of rising commodity prices. As a result, labour's terms of trade have improved steadily after 2002.

Labour's share

Labour's share fell 3.7 percentage points from 56.5 per cent of GDP in 1980 to 52.8 per cen in 2005 (Chart 3). It should be noted that with the large labour income increases of top earners, the labour share of the bottom 80 or 90 per cent of workers fell even more than represented by average figures. The potential causes of the decrease in labour share in Canada since 1980 are multiple. The brunt of the shift in the relationship between labour productivity and real wages finds its source in the 1990s, and especially between 1992 and 1996 when the share fell from 57.7 per cent to 53.8 per cent. The following sub-sections outline an explanation for the downward trend in labour's share in terms of three key drivers: the declining bargaining power of workers, rising commodity prices, and an increasing share of GDP going to capital consumption allowances (CCA).

The declining bargaining power of workers

The fall in labour share in the 1992-1996 period coincided with a major policy shift in Canada. In 1991, the Bank of Canada and Finance Canada adopted an inflation target of 2 per cent. A rise in short-term interest rates was engineered to lower inflation expectations, which contributed to a recession and a prolonged period of stagnation. The unemployment rate reached 11.4 per cent in 1993 and remained above nine per cent until 1998. Since the mid-1990s, real wages failed to make up for the shortfall that occurred

10 It is also possible to use the Personal Consumption Expenditures deflator (PCE) to obtain a measure of real wages. In Canada, the PCE has grown 0.20 percentage points per year slower than the CPI over the 1980-2005 period. If we had used the PCE rather than the CPI, the gap between real median earnings and labour productivity growth over the 1980-2005 period would have been 1.06 percentage points per year rather than 1.26 points per year. Similarly, the absolute contribution of falling terms of trade for labour to the gap between real wages and labour productivity growth would have halved (from 0.42 points to 0.22 points per year). See the unabridged version of the paper for an explanation of reasons behind this divergence.

11 See the unabridged version of this article for a more detailed derivation of this relationship.

Table 5
Decomposition of Labour's Terms of Trade, Canada, Total Economy, 1961-2007

	Labour's Terms of Trade	CPI	Domestic Economy Deflators: GDP	Consumption	Current Government Spending	Investment	International Trade Deflators: Total	Exports	Imports
Compound Annual Growth Rate (per cent)									
1961-07	0.11	4.45	4.57	4.41	5.44	3.89	..	4.05	3.59
1961-76	1.12	4.66	5.83	4.92	7.59	5.69	..	5.66	4.63
1976-02	-0.61	4.59	3.95	4.49	4.51	3.12	..	3.57	4.10
2002-07	1.08	2.76	3.87	1.95	3.52	2.30	..	1.19	-3.32
1980-05	-0.42	3.62	3.19	3.42	3.67	2.16	..	1.85	1.66
Absolute Contribution (percentage points)									
1961-07	0.11	..	..	-0.03	0.17	-0.12	0.11	-0.11	-0.22
1961-76	1.12	..	..	0.15	0.55	0.23	0.21	0.20	-0.01
1976-02	-0.61	..	..	-0.06	-0.02	-0.32	-0.18	-0.33	-0.15
2002-07	1.08	..	..	-0.46	0.15	-0.10	1.53	-0.60	-2.13
1980-05	-0.42	..	..	-0.11	0.01	-0.32	0.01	-0.58	-0.59
Relative Contribution (per cent)									
1961-07	100.0	..	..	-24.2	152.4	-108.1	98.2	-93.6	-191.8
1961-76	100.0	..	..	13.1	47.4	19.8	17.7	17.0	-0.7
1976-02	100.0	..	..	9.0	2.7	49.4	27.9	51.0	23.1
2002-07	100.0	..	..	-41.2	13.3	-8.6	137.6	-54.1	-191.7
1980-05	100.0	..	..	25.3	-2.3	74.5	-1.9	134.8	136.6

Note: Some figures may not add due to rounding and to small exclusions from GDP.
Source: Statistics Canada, National Accounts and Consumer Price Index.

during the period of weak economic growth and high unemployment in the first half of the 1990s. The inability of the labour share to return to pre-1991 levels reflects in part the falling bargaining power of workers.[12]

In Canada, the following factors have eroded the wage bargaining power of workers in recent years:

- Globalization has affected the bargaining power of Canadian workers through reductions in trade barriers and increased competition from low-wage countries. The threat of offshoring has tempered wage demands and driven down the economic rents over which workers had previously been able to bargain.
- In Canada, the unionization rates have exhibted a downward trend since the late 1990s (Chart 5). This trend suggests that workers may be losing some power to bargain for higher wages, resulting in a decline in the labour share.
- Conway, Janod and Nicoletti (2005) find that Canada moved to a less restrictive product regulatory environment between 1998 and 2003. Deregulation of product markets can lead to increasing competition that

12 In a world of perfect competition and constant returns to scale, wage bargaining has no effect on the labour share. Indeed, there is no excess profit (only normal profits) to be shared and labour demands for increases in real wages that exceed average labour productivity gains will remain either unanswered, or will drive the targeted business out of the market. In reality, however, few firms operates in a perfectly competitive market, opening the door to excess profits. This excess profit can be shared between the owners of the firm and labour. This is where wage bargaining can play an important role in affecting the labour share.

reduces excess profits and the ability of workers to obtain higher wages.

- Labour market deregulation also has similar negative effects for the labour share in the short term. In Canada, reduced Employment Insurance benefits, for example, have diminished the capacity of workers to negotiate higher wages as their threat of leaving is less credible.

Commodity prices

In recent years, commodity prices, and particularly oil prices have risen significantly. The direct impact of a demand-induced increase in commodity prices is an increase in economic rent and profits in resource-related industries. For example, in the mining, and oil and gas sector, profits doubled between 2000 and 2006 (Arsenault and Sharpe, 2008).

Higher commodity prices may lead to employment shifts across industries. Between 2000 and 2007, employment in the manufacturing sector fell almost 10 per cent while employment in the mining and oil and gas industry increased about 60 per cent. Because commodity-based industries tend to have larger profit shares and lower labour shares, employment shifts towards these industries lead to a decreasing labour share.

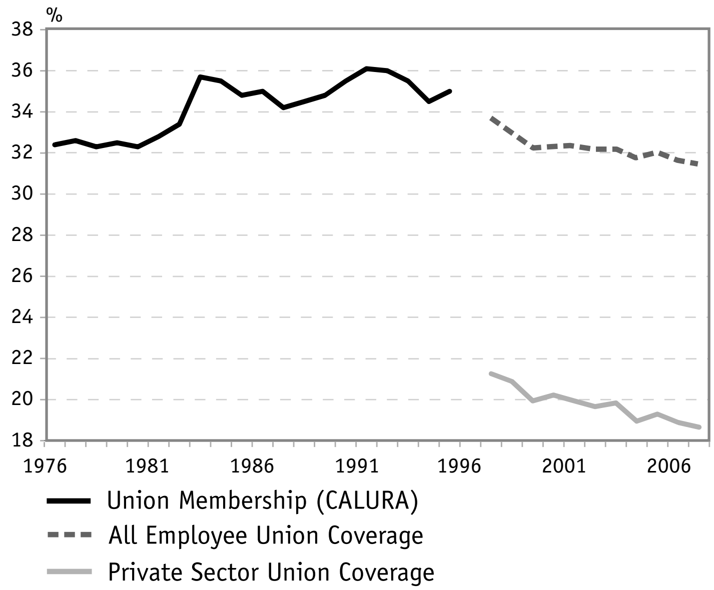
In the long term, the main effect of a permanent increase in commodity prices on labour's share results from changes in industrial structure. While firms, including manufacturers and commodity producers, will eventually adjust to the new set of relative prices at home and abroad, employment shifts towards industries with lower labour share have the potential to translate into a permanently lower labour share at the aggregate economy level.

Capital Consumption Allowances

Between 1980 and 2005, as labour share has declined the shares of several non-wage components of GDP have increased. As was just noted, changing market and insitutional conditions have favored an increase in the profit share, which increased as a share of GDP by 1.5 percentatge points from 1980 to 2005. A less obvious but still important development has been the increase in the share of GDP accounted for by capital consumption allowances (CCA), also called depreciation.

In recent years, the proportion of short-lived capital assets, such as information and communication technologies, has increased significantly as a share of new investment. Because these assets depreciate at at a faster rate, a larger share of current production must be used to replace them. As a result, the share of capital consumption allowance (CCA) in GDP increased by 0.8 percentage points from 1980 to 2005.

Chart 5
Unionization Rate,* Canada, 1976-1995 and 1997-2007



* From 1976 to 1995, the series is derived from CALURA and refers to union-membership. For the 1997-2007 period, data are from the LFS and refers to employees who are members of a union and employees who are covered by a collective agreement or a union contract.

Source: Statistics Canada, Cansim Table 379-0025 and 282-0078. Corporations and Labour Unions Returns Act (CALURA) and Labour Force Survey (LFS).

Conclusion

The median real earnings of Canadians barely increased between 1980 and 2005; over the same period, labour productivity rose by 37.4 per cent. This divergence can be explained by four factors: measurement issues, an increase in earnings inequality, a decline in labour's terms of trade, and a decline in labour's share of national income.

The most important measurement issue is the definition of real wages. The labour compensation series from the Canadian Productivity Accounts covers the widest definition of labour compensation and covers the widest definition of worker. It is therefore used as the measure of real wages in this article. Moving from earnings of full-time full-year workers to labour compensation per hour explains about one-fifth of the real wages and labour productivity growth gap overr the 1980-2005 period.

Rising earnings inequality, as captured by the difference in average and median real earnings growth, accounts for about one-quarter of the gap. The sources of the significant increase in earnings inequality in Canada since the late 1970s are still under investigation, but any convincing explanation will have to focus on the increasing concentration of income among top earners.

Labour's terms of trade deteriorated significantly from 1980 to 2005, and accounted for 33.3 per cent of the gap between the growth in real median earnings and labour productivity. Three-quarters of this deterioration was the result of the quality-adjusted prices of investment goods rising much more slowly than the Consumer Price Index.

The fall in labour's share explained the last fifth of the gap between the growth of real median earnings and the growth of labour productivity over the 1980-2005 period. A substantial fall in the labour share occurred during the recession and prolonged stagnation of the first half of the 1990s. The relationship stabilized after 1996, with real wages growing at roughly the same pace as labour productivity. Yet, the ground lost was never made up.

Workers were unable to recover the same share of income they had enjoyed earlier for three key reasons. First, bargaining power was weakened by declining unionization, deregulation, and increased competition from low-wage countries. Second, a boom in commodity prices led to an increased profit share, particularly in resource-related industries. Finally, the structural shift to short-lived assets such as ICT investment goods increased the share of CCA in GDP.

In some sense, this article raises more questions than answers. Further research is required to understand more fully what has driven changes in earnings inequality, labour's terms of trade, and labour's share. Labour productivity growth is the only way to raise living standards in the long run, and real wages are the most direct mechanism to transfer the benefits of productivity growth to Canadians. It is worrying, therefore, that real median earnings failed to increase from 1980 to 2005, while labour productivity grew 37.4 per cent. If most Canadians are not seeing the benefits of labour productivity growth in the form of higher real wages, why should they support policies favouring productivity growth?

References

Arsenault, J. and A. Sharpe (2008) "An Analysis of the Causes of Weak Labour Productivity Growth in Canada since 2000," *International Productivity Monitor*, No. 15, Fall, pp. 14-39.

Conway, P., V. Janod and G. Nicoletti (2005) "Product Market Regulation in OECD Countries: 1998 to 2003," OECD Economics Department Working Papers, No. 419.

Heisz, Andrew (2007) "Income Inequality and Redistribution in Canada: 1976 to 2004," Cat. 11F0019MIE. Ottawa: Statistics Canada.

Murphy, Brian, Sylvie Michaud and Michael Wolfson (2008) "Income Trajectories of High Income Canadians 1982-2005," paper presented at the IARIW 30th General Conference, Portoroz, Slovenia, August. www.iariw.org/papers/2008/murphy2.pdf

Saez, E. And M. Veall (2005) "The Evolution of High Incomes in North America: Lessons from Canadian Evidence," *American Economic Review*, Vol. 95, No. 3, pp. 831-849, June.

Sharpe, A., J. Arsenault and P. Harrison (2008) "The Relationship between Productivity and Real Wage Growth in Canada and OECD Countries: 1961-2006," CSLS Research Report 2008-8, December.

Statistics Canada (2008) *Income in Canada*, 75-202-X, May.

What Explains the ICT Diffusion Gap Between the Major Advanced Countries? An Empirical Analysis

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Abstract

Over the last few years, a large body of literature has shown that the level of information and communications technology (ICT) diffusion, and, as a result, the favorable effects of this diffusion on productivity, differ greatly between the major advanced countries, with the United States the country where ICT diffusion is strongest. This study aims to explain empirically this gap. Annual macroeconomic panel data are used for the period 1981-2005 and cover eleven OECD countries: Austria, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Spain, the United Kingdom and the United States. The estimates obtained provide insight into the factors determining ICT diffusion and the gaps in this diffusion vis-à-vis the United-States. Compared to the United States, the lower ICT diffusion in the other major advanced countries can be explained by a smaller share of the population with a higher education and/or a higher level of rigidity in labour and product markets.

In recent years, a large body of literature (e.g. OECD 2003) has shown that the level of information and communications technology (ICT) diffusion, and, as a result, the favourable effects of this diffusion on productivity, differs greatly between the major advanced countries, with the United States being the country where diffusion is highest. However, because of difficulties in obtaining the relevant data, only a limited number of empirical investigations have been carried out to account for the differences in ICT diffusion between countries. These studies have found no differences in the price elasticity of demand as an explanatory factor (Cette, Lopez and Noual, 2004 and 2005). They also show that product market regulation, employment protection legislation, and the share of the working-age population with higher education have a relatively substantial impact on ICT diffusion (Aghion *et al.*, 2009). However, the results and lessons drawn from these studies remain to be consolidated and deepened. This is the aim of this article, which summarizes the results from our longer study (Cette and Lopez, 2008).

This empirical investigation uses annual macro-panel data for the 1981-2005 period from eleven OECD countries: the G-7 counties excluding Canada plus Austria, Denmark, Fin-

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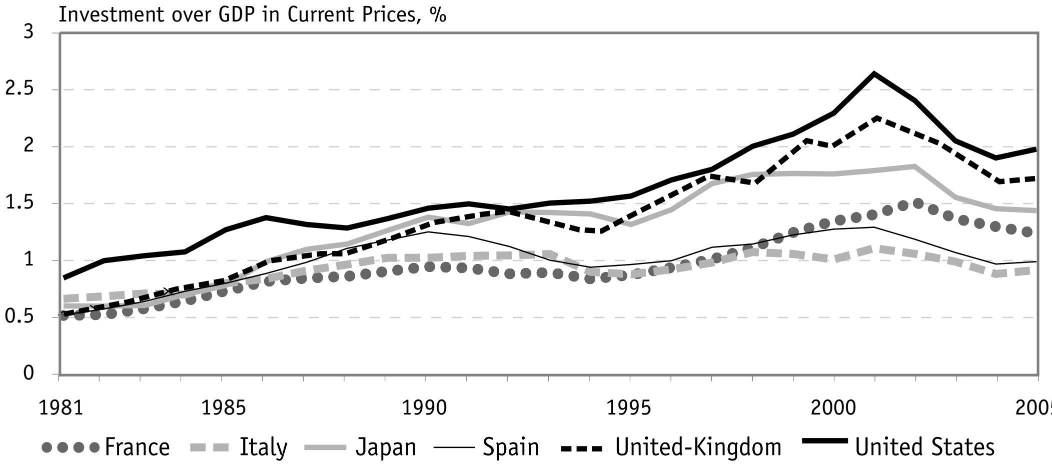
Chart 1

Total Economy ICT Investment Rate, 1981-2005

For six large countries in the analysis



Source: Authors' calculations using the EU-KLEMS database (see Appendix A).

land, the Netherlands, and Spain. The initial data are mainly taken from the EU-KLEMS and OECD databases. Some variables, such as investment price indices, capital stock and the the user cost of capital, are obtained from specific assumptions by country and variable; the methodology used is presented in the appendix.

The article is divided into four sections. After providing an overview of ICT diffusion in the countries under study and the main factors underlying this diffusion, we briefly present the model used to capture the demand for ICT and other factors of production. We then put forward the lessons to be drawn from the results before concluding.

ICT Diffusion: Stylized Facts

ICT Diffusion Gaps

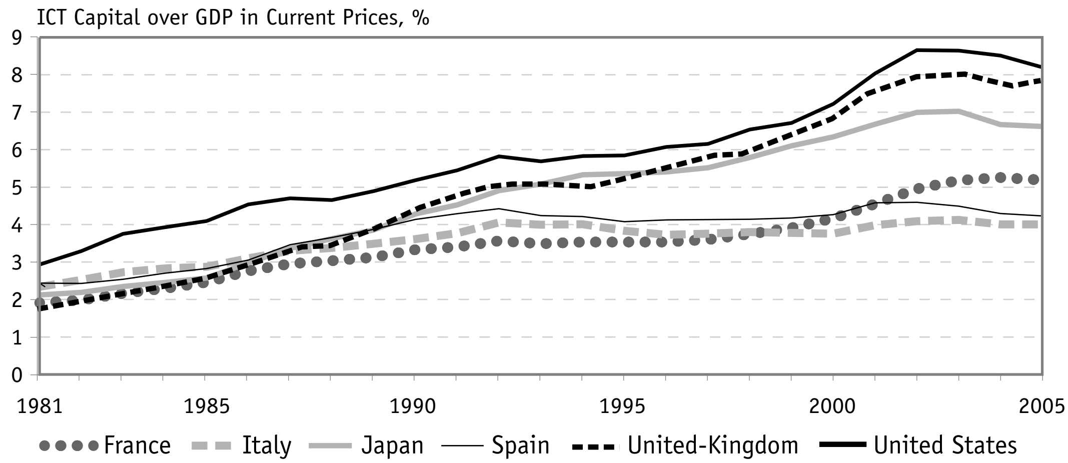
The major advanced countries exhibit large gaps in terms of ICT diffusion manifested by the ICT investment rate, defined as the ratio of ICT investment to GDP in current prices (Chart 1) and the ICT capital coefficient, defined as the ratio of the ICT capital stock to GDP in current prices (Chart 2). Such gaps have been reported in the literature since the early 2000s and confirmed in later research.[2]

Three country groups can be identified:

- The United States is the country with the highest level of ICT diffusion: its ICT investment rate and ICT capital coefficient stand at over 2 and 8 per cent respectively. The lead of the United States in terms of ICT diffusion, expressed by the ICT capital coefficient, can be observed as early as the start of the 1980s;
- At the other end of the spectrum, Italy, Spain, Germany, Austria, France and Finland are the countries with the lowest ICT diffusion: their ICT investment rate and ICT capital coefficient range between 1.0 per cent and 1.5 per cent and 4.0 per cent and 5.5 per cent, respectively (Chart 3);
- The intermediate group includes the Netherlands, Japan, Denmark and the United Kingdom: their ICT investment rate and

2 See Schreyer (2000), Colecchia and Schreyer (2001), Pilat and Lee (2001), OECD (2002 and 2003), and van Ark *et al.* (2002a and 2002b) for the earlier studies and van Ark *et al.* (2008) for later work.

Chart 2
Total Economy ICT Capital Coefficient, 1981-2005
For six large countries in the analysis



Source: Authors' calculations using the EU-KLEMS database (see Appendix A).

ICT capital coefficient range between 1.5 per cent and 2.0 per cent and 6.0 per cent and 8.0 per cent, respectively. In this intermediate group, the situation of the United Kingdom appears to be close to that of the United States.

In all the countries except Spain and Italy, the ICT investment rate and the ICT capital coefficient rose continuously until the end of the 1990s, with a strong acceleration in the second half of this decade. In 2002, the ICT investment rate recorded a sharp fall, which continued in 2003 and 2004. In 2005, the ICT investment rate stabilized in all countries, or even increased slightly. As a result of these trends in the ICT investment rate, the ICT capital coefficient stabilized, or even posted a small decline, in the early 2000s.

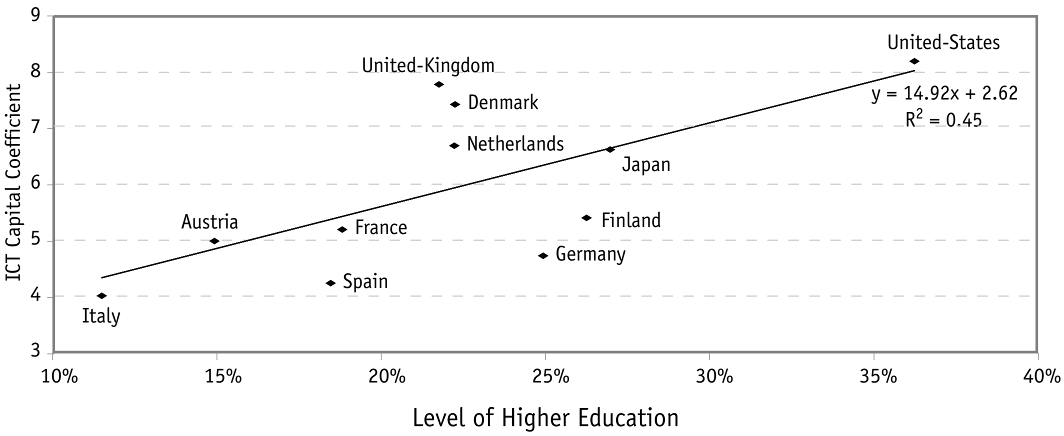
The strong increase in the ICT investment rate in the second half of the 1990s followed by its decline in the period 2002-2004 can be explained in two ways. First, while the emergence of the dot-com bubble in the second half of the 1990s led to the development of ICT-using firms, the bursting of this bubble in the early 2000s inevitably resulted in a decline in the ICT investment rate. Second, ICT investment spending increased in the late 1990s due to the fear of the Y2K bug, then declined. Assuming that there was over-investment in ICT at the end of the 1990s, the corresponding ICT over-accumulation seems to be over, judging by the stabilization, and even the recent small increase, in the ICT investment rate. Because ICT has, by nature, a short lifespan, an over-accumulation can be quickly absorbed.

The stabilization — or even the small decrease — in the ICT capital coefficient in recent years suggests that the rate of advance in ICT diffusion, at least as measured by this indicator, has largely ended in advanced countries. But the extent or level of this ICT diffusion between countries is very different. In particular, the gap between the United States and other countries is substantial.

The Main Factors Underlying the Gaps in ICT Diffusion

Gust and Marquez (2000) suggest that gaps in ICT diffusion between advanced countries, and

Chart 3
Level of Education and ICT Capital Diffusion in 2005



The level of education is the share of the working-age population (25-64 years of age) with a higher education, completed or not (source OECD).

especially the European lag vis-à-vis the United States, is temporary, corresponding to a positive starting position of ICT-producing countries, and that it will gradually disappear. However, the stability — or even the widening — of the ICT diffusion gaps between Europe and the United States, over several decades, puts this approach into question.

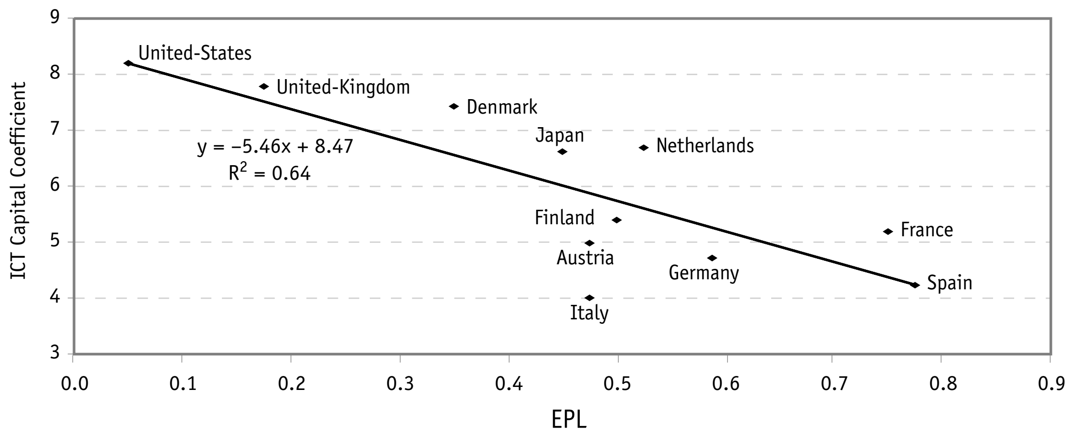
A number of studies (a review is provided in OECD, 2003b) provide alternative explanations for the European ICT diffusion gap vis-à-vis the United States, using descriptive approaches (Antipa *et al*., 2007) or econometric investigations (Gust and Marquez 2004, Aghion *et al*., 2009). Two explanatory factors are often put forward: the level of education and market rigidities.

An efficient use of ICT generally requires firm reorganization and institutional flexibility, which can be restricted by excessively stringent regulations. Moreover, in product markets, rigid regulations can reduce competitive pressure and thus lower the incentives to use the most efficient production techniques. In addition, the use of ICT generally requires labour with a higher degree of skills than other production technologies. In the United States, there are relatively few market rigidities and the share of the working-age population with higher education is greater than in other advanced countries, albeit the market rigidities gap between the United States and other Anglo-Saxon countries remains quite small.

Charts 3, 4 and 5 confirm that ICT diffusion is positively correlated with the level of education and negatively correlated with the level of regulation in labour markets as captured by employment protection (EPL) and in product markets, as captured by regulation in energy, transport and communications (ETCR).

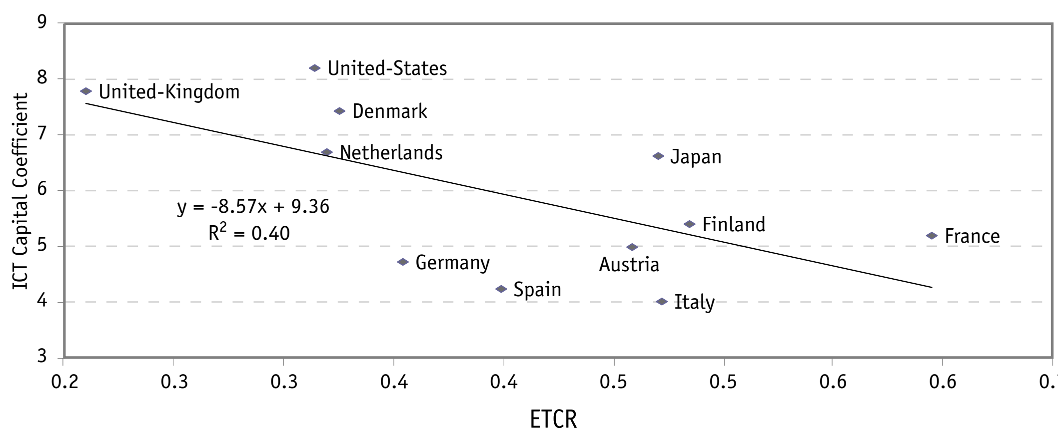
Aghion *et al.* (2009) have conducted the most sophisticated empirical investigation of ICT diffusion at the macroeconomic level for 17 countries over the 1985-2003 period. In the estimated specification, the ICT investment rate is explained by the share of the population with higher education and the function of product and labour market rigidities, these variables being possibly aggregated into a function with the distance from the technological frontier. The capacity utilization rate, which is deemed to have an impact on ICT diffusion via the accelerator effect, and, alternatively, different variables representing capital market rigidities are put

Chart 4
Labour Market Rigidities (EPL indicator) and ICT Capital Diffusion in 2005



Labour market rigidities are represented by EPL (source OECD), detailed in Appendix A.

Chart 5
Product Markets Rigidities (ETCR Indicator) and ICT Capital Diffusion in 2005



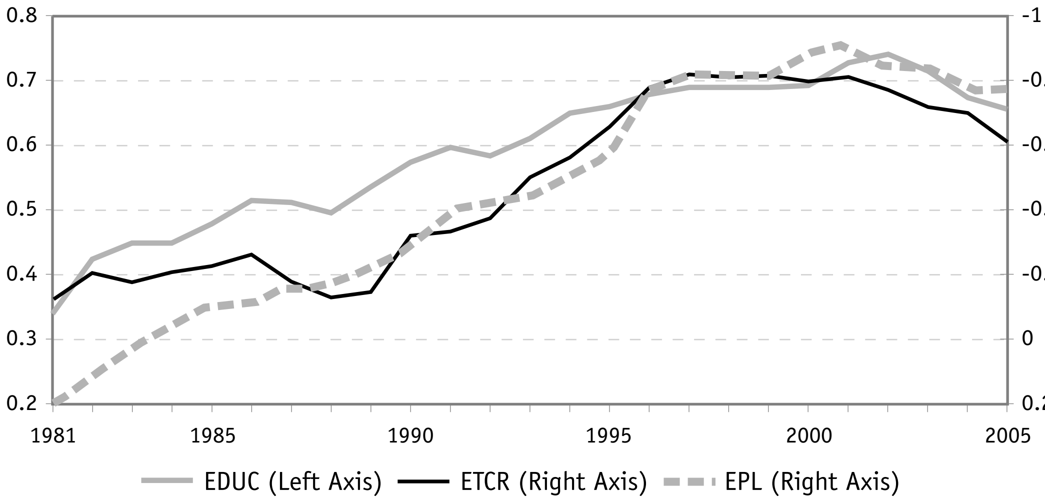
Product market rigidities are represented by ETCR (source OECD), detailed in Appendix A.

forward as explanatory variables. The main results of this analysis are the following: (i) the level of education of the working-age population does not have a significant impact on ICT diffusion in the countries far from the technological frontier. Conversely, for the countries close to the frontier, the impact is significant and positive; (ii) cross-rigidities in the product and labour markets have a significant and negative impact on ICT diffusion, this effect being stronger for countries close to the technological frontier; (iii) the pressures on capital utilization have a significant and positive impact on ICT diffusion.

With respect to the effect of the level of education and market rigidities on ICT diffusion, one important aspect has, to our knowledge, not yet been mentioned in the literature, namely the fact that the effect has changed considerably over time. Chart 6 shows that the correlation of ICT diffusion with the level of education (positive) and with market rigidities (negative),

Chart 6

Total Economy Correlation of the ICT Capital Coefficient with the Level of Education (EDUC) and Product and Labour Market Rigidities (respectively ETCR and EPL)*



* EDUC is the share of the working-age population with a higher education, completed or not. ETCR and EPL are, respectively, composite indicators of product and labour market rigidities. The construction of these three indicators is detailed in the appendix.

increased (in absolute terms) over time and only stabilized in the mid 1990s. This observation suggests a discontinuity in the impact of the level of education and rigidities on ICT diffusion: it increased alongside the generalized increase in ICT diffusion in the different countries, and then stabilized at a certain threshold of ICT diffusion. This simplified specification, which assumes such a discontinuity, is used in the rest of our analysis.

The Model

The selected specification, which we shall briefly present, builds on that of Cette, Lopez and Noual (2004 and 2005).[3] Given the short time dimension, we estimate a static model corresponding to a long-term relationship on the basis of a simple and partially calibrated specification of the demand for factors. Factor demand comes from a very general specification of the production function and from weak assumptions, mainly the local approximation of the production function using a constant elasticity of substitution (CES) and constant returns to scale.

Measurement errors such as white noise or errors corresponding to a simultaneity bias are dealt with, in the estimation, by using appropriate instrumental variables. Other measurement errors are considered in more specific ways:

- National accounting rules on the breakdown of business spending between intermediate and final use differ for each factor from one country to the next; these differences could be considered to be measurement errors. Assuming that these differences are time-invariant, the corresponding measurement errors are taken into account by country-product constants.
- Relative factor costs may also contain important measurement errors. In the construction of our variables, it is assumed that the ratio of every asset price to the GDP

3 See Cette and Lopez (2008) for the detailed presentation of this model.

deflator in every country is the same as that in the United States. The reason for this convention is that the United States uses more advanced methodologies to take account of the quality improvements in goods, especially ICT. Nevertheless, relative prices may also depend on country-specific determinants such as the exchange rate and import and export mark-up behaviour. The measurement error corresponding to these realities is captured by adding as explanatory variables the exchange rate and the average age of the equipment.

- Another source of errors stems from the fact that asset prices may not take proper account of the changes in asset performances, mainly ICT capital. Like the previous measurement errors, this type of error affects the measurement of factor cost and volume in a complex way. This measurement error is taken into consideration, at least partly, by adding the average age of the equipment to the list of explanatory variables.

The estimated factor demand equation is complemented by adding indicators for the level of education and market rigidities to the list of explanatory variables. The preferred variable used to represent the level of education is the share of the population aged between 25 and 64 with at least some higher education (EDUC). In order to take better account of the effect of the level of education on the demand for ICT capital, we use a quadratic specification for this variable. As regards market rigidities, we use the OECD indicator for employment protection legislation (EPL) for the labour market and the OECD indicator for regulation in energy, transport and communications (ETCR) for the product market.

The two indicators of market rigidities are interrelated. This is consistent with an already large body of literature, which suggests that there is an interaction between the effects of regulations across the two markets.[4] We tested different types of crossing. In the end, we selected the maximum function of EPL and ETCR.

In addition, the recent literature highlights the role played by the distance to the technological frontier on the magnitude of the effect of rigidities on productivity and ICT investment (see in particular Aghion and Howitt, 2006, Aghion *et al.*, 2009). These two additional aspects are specified by introducing a threshold effect in ICT diffusion on the parameters corresponding to the impacts on factor demand of the level of education and market rigidities. The threshold used is an ICT capital coefficient of 4 per cent, but estimations made with other thresholds yield very similar results. With the actual data, the proportion of observations above this threshold of 4 per cent is 26.9 per cent over the entire 1981-2005 period, 65.5 per cent over the 1996-2005 period and 100 per cent in 2005.

The estimated model takes into consideration the different types of measurement errors and introduces the indicators of education and rigidities. In the model, the logarithm of the capital coefficient depends, for each factor and country, on: (i) the logarithm of the user cost of the factor relative to the price of all the other factors; (ii) the impact of total factor productivity (TFP); (iii) the error correction variables, i.e. the average age of the equipment for the relevant factor (except labour) and the logarithm of the exchange rate; (iv) the level of education of the working-age population (for ICT factors, the level of education squared) and the level of rigidities; (v) country-product constants; (vi) error terms assumed to be independently and identically distributed.

4 See in particular Amable and Gatti (2006); Koeniger and Vindigni (2003); Blanchard and Giavazzi (2003); Blanchard (2005); and Aghion *et al.* (2009).

It is assumed that the price elasticity of demand for each factor is identical in every country and, for non-ICT factors, time-invariant. As regards ICT, this elasticity is assumed to exhibit a simple quadratic pattern over time, identical in every country. This quadratic trend reflects the fact that ICT diffusion, linked to improved productivity, corresponds both to a widening of the ICT diffusion (ICT equipment is installed in places where there was none before) and an intensification of this diffusion (replacement of obsolete ICT equipment by new and more efficient equipment). Given that the first effect is gradually subsiding while the second is still supporting ICT growth the overall result is a slowdown in ICT diffusion and a decrease (in absolute terms) in the price elasticity of ICT demand. This variability of the price elasticity of ICT demand has been documented by Oulton (2002).

TFP has three components: an annual component identical for all countries and factors; a trend specific to each country; and a cyclical component specific to each country linked to the capacity utilization rate.

What the Estimates Tell Us

Estimates were made using the instrumental variables method on panel data based on: (i) the five production factors: ICT, transport equipment, other equipment, structures and number of employees; (ii) the eleven countries for which the data comparability appeared sufficiently robust; (iii) over the 1981-2005 period which appears sufficiently robust for the different series.

The Role of Education and Rigidities

With respect to education, the greater a country's share of the population with higher education, the greater the ICT diffusion. This effect gradually declines as the level of education rises (the coefficient on the quadratic component is negative). The impact of the level of education on ICT diffusion is greater when ICT diffusion is already important. Thus, the higher the level of ICT diffusion, the greater the need for skilled labour to facilitate ICT diffusion. This result is consistent but more comprehensive than that obtained by Aghion *et al.* (2009). The estimates also show that, while the level of education increases ICT diffusion, it reduces (for a given volume of output) the demand for transport equipment and labour; the latter effect obviously reflects the positive impact of education on productivity.

With respect to market rigidities, ICT demand declines as rigidities increase. This impact is heightened when ICT diffusion is already high. This result is again consistent with that obtained by Aghion *et al.* (2009). Thus, the closer a country is to the technological frontier, the more the productivity improvements, partly driven by the use of ICT, require organizational flexibility in product and labour markets. Rigidities also have a negative impact on the demand for transport equipment but a positive impact on the demand for non-residential structures and, above the ICT diffusion threshold, on the demand for labour. This latter result is also consistent with that of Aghion *et al.* (2009), who show that rigidities have a negative effect on the productivity of the countries close to the technological frontier, unlike for those far from the frontier.

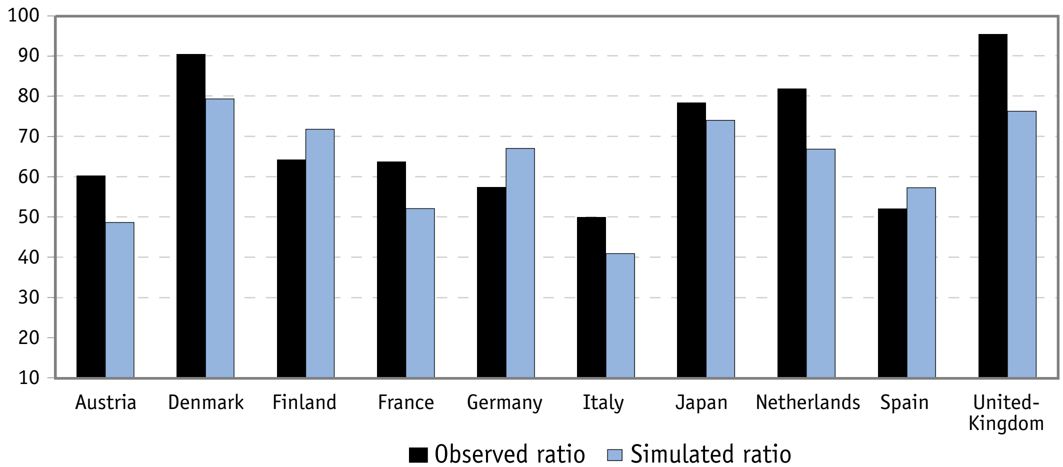
Evidence of ICT Diffusion Gaps

The estimated parameters for price elasticity, the impact of education and the impact of rigidities enable us to explain quite accurately the ICT diffusion gaps between the United States and the ten other countries in our sample (see Chart 7 for 2005).

Chart 7

ICT Diffusion in the Different Countries Relative to the United States, 2005

Ratio of the Domestic ICT Capital Coefficient to the US Coefficient (per cent)

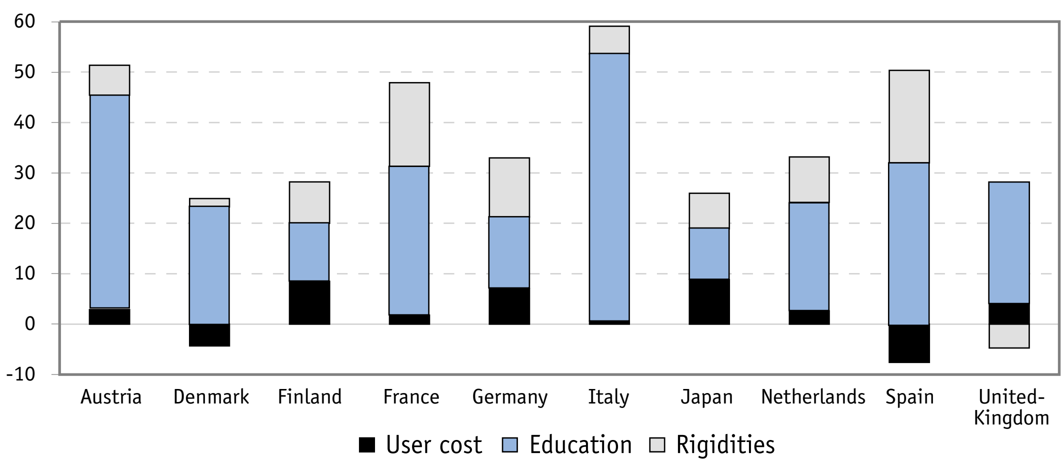


The ratios correspond to the relative level of ICT diffusion. The simulated ratios are calculated using only the estimated values based on the variables of the level of education, rigidities and user cost of ICT capital.

Chart 8

Factors Underlying the Simulated ICT Diffusion Gap vis-à-vis the United States, 2005

(points)



These contributions to the simulated ICT diffusion gap vis-à-vis the United States are calculated on the basis of estimates.

These estimates enable us to break down the simulated ICT diffusion gaps for each country vis-à-vis the United States into three contributions: the effects of the differences in user costs of capital;[5] the effects of education differences; and the effects of differences in mar-

5 The user cost of capital gaps can come from gaps in: (i) real interest rates; (ii) average ICT depreciation rates induced by a different structure in the three ICT components, the average life of computer equipment and software being significantly shorter than that of communication equipment.

ket rigidities. This breakdown for 2005 is shown in Chart 8. The contribution of differences in the user cost of capital is very small in all countries: less than 10 percentage points. The contribution of educational differences is the most important in all countries: from 10 points in Japan to 53 points in Italy. The contribution of rigidities varies considerably across countries: from —5 points in the United Kingdom — where market rigidities were lower than in the United States in 2005 — to 18 points in Spain, where they are relatively strong.

This breakdown of the different contributions to the ICT diffusion gap of different countries vis-à-vis the United States is, to our knowledge, relatively original in the context of the existing literature. It points out the areas where greater efforts are needed, in each country, to reduce the gap. For instance, in France, ICT diffusion is roughly 48 per cent lower than in the United States. More efforts are essentially needed in higher education (which contributes about 29 points to the gap) and, to a lesser albeit still significant extent, with respect to market rigidities (the contribution of which is about 17 points).

Conclusion

The results presented in this article give insight into the political economy of ICT diffusion.They provide a quantification of the expected effects on ICT diffusion, of an increase in the proportion of the working-age population with higher education and of a decrease in product and labour market rigidities. However, the robustness of these estimates, and accordingly their interpretations, should be strengthened by other empirical investigations, carried out using industry-level or firm-level data. Nevertheless, they extend and complete the estimates of previous analyses and seem intuitively plausible.

References

Aghion, P., P. Askenazy, R. Bourlès, G. Cette and N. Dromel (2009) "Education, Market Rigidities, and Growth," *Economic Letters*, forthcoming.

Aghion, P. and P. Howitt (2006) "Joseph Schumpeter Lecture – Appropriate Growth Policy: A Unifying Framework," *Journal of the European Economic Association*, Vol. 4, No. 2-3, April-May.

Amable, B. and D. Gatti (2006) "Labor and Product Market Reforms: Questioning Policy Complementarity," *Industrial and Corporate Change*, Vol. 15, No.1, pp.101-122.

Antipa, P., G. Cette, L. Frey, R. Lecat and O. Vigna (2007) "Evolutions récentes de la productivité: accélération structurelle dans la zone euro et ralentissement structurel aux Etats-Unis ?," *Bulletin de la Banque de France*, No. 164, August.

Blanchard, O., (2005) "European Unemployment: the Evolution of Fact and Ideas," NBER Working Paper 11750, Cambridge, Mass.

Blanchard, O. and F. Giavazzi (2003) "Macroeconomic effects of regulation and deregulation in product and labor markets," *Quarterly Journal of Economics*, August, pp. 879-907.

Cette G. and J. Lopez (2008) "Comportement de demande de TIC: Une comparaison internationale," Document de Travail, Université de la Méditerranée, DEFI, July, posted at http://www.csls.ca/ipm/ipm17.asp.

Cette, G., J. Lopez and P.-A. Noual (2004) "Le comportement de demande en capital TIC: une analyse empirique sur quelques grands pays industrialisés," *Economie Internationale*, No. 98, 2nd quarter.

Cette, G., J. Lopez and P.-A. Noual (2005) "Investment in Information and Communication Technologies: an Empirical Analysis," *Applied Economics Letters*, Vol. 12, No. 5, 15 April.

Cette, G., J. Mairesse and Y. Kocoglu (2002) "Croissance économique et diffusion des TIC, le cas de la France sur longue période," *Revue Française d'Economie*, Vol. XVI, No. 3, January.

Cohen, D., and M. Soto (2007) "Growth and Human Capital: Good Data, Good Results," *Journal of Economic Growth*, Vol. 12, No. 1, March, pp. 51-76.

Colecchia, A. and P. Schreyer (2001) "ICT Investment and Economic Growth in the 1990s: Is the United States a Unique Case?," OECD, DSTI/DOC (2001) 7, October.

Conway, P. and G. Nicoletti (2006) "Product Market Regulation in the Non-Manufacturing Sectors of OECD Countries: Measurement and Highlights," OECD Economic Department Working Paper 530, December.

Gust, C. and J. Marquez (2000) "Productivity Developments Abroad," *Federal Reserve Bulletin*, October.

Gust, C. and J. Marquez (2004) "International Comparisons of Productivity Growth: The Role of Information Technology and Regulatory Practices," *Labour Economics*, Vol. 11.

Koeniger, W. and A. Vindigni (2003) "Employment Protection and Product Market Regulation," IZA Discussion Papers No. 880.

OECD (1999) "Employment Protection and Labour Market Performance," *Employment Outlook*, Chapter 2.

OECD (2002) *Measuring the Information Economy*, OECD Publishing.

OECD (2003) *ICT and Economic Growth: Evidence from OECD countries, industries and firms*, OECD Publishing.

Oulton (2002) "ICT and Productivity Growth in the United Kingdom," *Oxford Review of Economic Policy*, Vol. 18, No. 3.

Pilat, D. and F. C. Lee (2001) "Productivity growth in ICT-producing and ICT-using industries: a source of growth differentials in the OECD?," mimeo, DSTI/DOC (2001) 4, June 18.

Schreyer, P. (2000) "The contribution of information and communication technology to output growth: A study on the G7 countries," OECD, STI Working Paper, 2000/2, March.

van Ark, B., R. Inklaar and R. McGuckin (2002) (van Ark *et al*. (2002b) in the text) "Productivity, ICT and Services Industries: Europe and the United States," mimeo, Groningen Growth and Development Centre, December.

van Ark, B., J. Melka, N. Mulder, M. Timmer and G. Ypma (2002) (van Ark et *al*. (2002a) in the text) "ICT investment and Growth Accounts for the European Union, 1980-2000," mimeo, June.

van Ark, B., M. O'Mahony and M. P. Timmer (2008) "The Productivity Gap between Europe and the United States: Trends and Causes," *The Journal of Economic Perspectives*, Winter, Vol. 22, No. 1., pp.25-44.

Appendix

Data: Sources and Assumptions[6]

The base data come from the EU-KLEMS database of Groningen University, augmented by OECD data and data from other sources where needed. In this appendix, we present only details for variables that are based on assumptions specific to this empirical investigation. For all data expressed in real terms, the reference year is 2000. Because the constant price data from the EU-KLEMS database are at 1995 prices, they have been rebased to 2000 prices.

Investment price series are needed to calculate the volume of investment. These are calculated using US national accounts data, on the assumption that the gap relative to the GDP deflator, for every country and investment component, is the same as that in the United States, according to the method applied in Cette, Lopez and Noual (2004 and 2005).

For each of the seven components and 11 countries, the capital stock is calculated using constant price investment data derived from the perpetual inventory method by the relation: $K_t = (1 - \delta).K_{t-1} + I_t$, where K_t is the volume of capital stock at the end of year t, I_t the volume of investment over the year t and δ the obsolescence rate specific to each asset but assumed to be time-invariant for each asset, and identical across countries.

The obsolescence rates are common and similar — for example — to those used by Cette, Mairesse and Kocoglu (2002), Cette, Lopez and Noual (2004 and 2005) and those used to build the EU-KLEMS database. They are 2.5 per cent per year for non-residential construction, 12.5 per cent for communication equipment, other machinery and equipment and others assets, 17.5 per cent for transport equipment and 30 per cent for computer equipment and software.

The user cost of equipment is obtained using an investor arbitrage model or, as well, an intertemporal profit maximisation model. For each of the four assets and each country, it is calculated on the basis of a common relation: $C = p_{-1}.(i + \delta - \Delta logn(p))$, where p is the

6 See Cette and Lopez (2008) for a more detailed discussion of data sources.

investment price (whose calculation for every country and component is presented above), δ the obsolescence rate (the level of which for each product is presented above) and i the nominal interest rate. Δlogn(p) is the variation of the natural logarithm of price p, and is an approximation of its growth rate. The nominal interest rate used, for every country, is the interest rate on long-term Treasury notes taken from the *OECD Economic Outlook*.

The level of education (EDUC) is represented by the share of the population between 25 and 64 with higher education (whether completed or not). The data come from the OECD and UNESCO Education databases compiled by Cohen and Sotto (2007). These data are decennial and are annualized for the purposes of the estimation by linear interpolation over a decade, which is probably not a strong hypothesis for a relatively stable variable.

The level of rigidities in the employment protection legislation (EPL) corresponds to the composite OECD indicator. For estimations, this indicator is divided by four in order to take on a value between zero and one. For more information see OECD (1999).

The indicator for product market regulation (ETCR) comes from the OECD 'International Regulation' database. It is obtained by aggregating four sub-indicators measuring entry barriers, public ownership, market structure (the market share of the biggest firm in each industry) and vertical integration. These indicators are built by taking account of the level of product market rigidities in seven non-manufacturing industries: gas, electricity, post, telecom, airlines, rail and road. For estimations, the ETCR indicator is divided by six in order to take on a value between zero and one. For more information see Conway and Nicoletti (2006).

ICT Production and Productivity in Sweden and Finland, 1975-2004

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Abstract

This article compares the development of labour productivity in the Swedish and the Finnish business sectors and the role of the information and communication technology (ICT) sector in this process. The results show that the Finnish productivity level has been converging towards the Swedish level, but that there is still a significant difference. This trend has coincided with the growing importance of the ICT sector, especially since the mid 1990s. Due to higher productivity and employment growth, the Finnish ICT sector has contributed to this convergence. This is explained by the electrical engineering industry. The Nokia effect has been stronger than the Ericsson effect.

During the decades after World War II, the Western European countries that are currently members of the EU experienced faster labour productivity (LP) growth than the United States. In the mid 1990s, this convergence turned into divergence. This occurred at the time when the production of information and communication technology (ICT) took off in the United States. Among a few countries that did not follow the European trend were Sweden and Finland. Both small, open economies combining high levels of competitiveness with high welfare ambitions. They are also at the forefront in the transition to the innovative knowledge society. Not the least is this expressed by extensive and advanced ICT production.

Macroeconomic research has tried to quantify how this production has affected productivity developments in Sweden and Finland. However, the two countries have never been compared systematically and thoroughly. The aim of this article is to fill this void. Four main questions will be answered: (1) has the LP level in the Finnish business sector been converging towards the Swedish level? (2) how important has ICT production been for LP growth in the business sector? (3) how important has ICT production been for the relative development of the LP level in the business sector? (4) has structural change in the labour market had any effect on the relative LP level?

In the Finnish context, using a shift-share-method, Jalava (2003) shows that the LP growth in the business sector in the latter part of the 1990s can be explained by a positive reallocation of labour, and that this was primarily a consequence of an increase in the employment share of ICT production. Jalava (2004) shows that over time manufacturing has become dependent on a smaller number of industries, and that LP growth

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in the period 1995-2003 to a large extent can be attributed to the ICT-producing industries. Daveri and Silva (2004) estimate the contribution of ICT production to LP growth in the economy in the period 1978-2000. The results indicate that there has been a gradual increase in this contribution and that it amounted to slightly more than 30 per cent in the period 1992 to 2000. Jalava and Pohjola (2007) estimate that close to 70 per cent of the total factor productivity (TFP) growth in manufacturing can be attributed to ICT production in the years 1995-2005.

In the Swedish context, Lind (2002) shows that the contribution of ICT production to LP growth in the business sector increased from 28 to 60 per cent between 1994-1997 and 1998-2001. Lindström (2003) finds that the high TFP-growth in the business sector in the period 1993-1999 is explained by the ICT-producing industries. According to Lind (2003), LP growth in the Swedish manufacturing industry exceeded the average in OECD countries between 1960 and 2001. This is explained by a favourable trend since the beginning of the 1990s. Using a shift-share-method, this upturn was found to be a combined consequence of high LP growth in ICT production and an increase in its employment share.

In an international, comparative perspective, van Ark (2001) shows that among ten OECD-countries, the contribution of ICT production to LP growth in the economy was largest in Finland in the latter part of the 1990s. Using a shift-share-method, it is shown that an important explanation for this is the favourable employment trend in the ICT-producing industries. Van Ark *et al.* (2002) increased the number of countries studied. They show that the trend in the OECD is an increase in LP growth in the ICT-producing industries in the 1990s. In a comparison among 16 countries, the contribution of ICT production was second largest in Finland in the latter part of the 1990s (Ireland came first). The Swedish contribution was more modest and amounted to somewhat less than the EU-average. Timmer and van Ark (2005) compare the development in the United States and the European Union between 1995 and 2001. Their results show that only in Ireland was the contribution of ICT production to the aggregate TFP-growth larger than in Finland and Sweden. In absolute terms, the Finnish contribution was somewhat larger than in Sweden, but in a relative perspective ICT production was more important in the latter country.

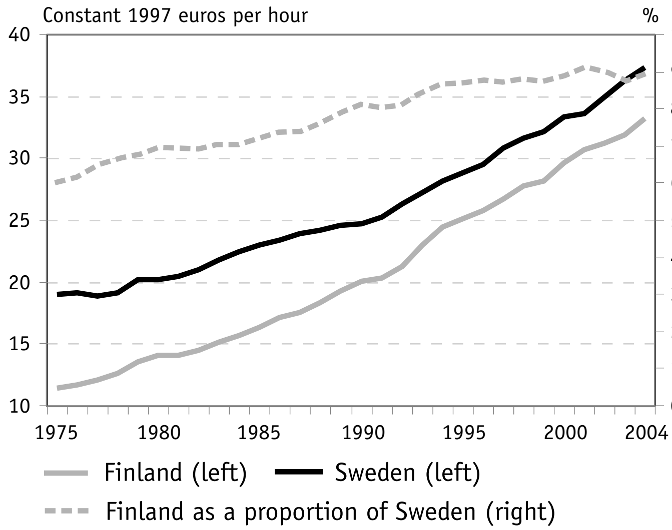
In this article labour productivity is defined as real value added per hour worked. Against the background of growing employment in ICT production, it is central to capture this structural change in the analysis. This is done using a shift-share method, in which the LP level is not only determined by the level within industries, but also by reallocation of labour between industries. The period studied is 1975-2004.[2] The statistics are from the EU KLEMS database.[3] The focus is on the business sector, but the part of the business sector that is most similar to activities in the public sector is excluded. Thus, the market-oriented part of the economy is defined in SNA-terms as sectors 01-74 and will be denoted as the business sector. According to the OECD (2002), ICT production is defined as the industries (1) office machinery and computers; (2) electrical engineering; (3) precision and optical instruments; (4) post and telecommunication; and (5) computer services. The first three belong to manufacturing, the latter two to the service sector. Together, they constitute the ICT sector.

2 After this article was completed data became available for 2005. Given the medium to long-term nature of the analysis, these new figures have no effect on the conclusions drawn.

3 See van Ark et al (2007) and Timmer *et al.* (2007) for a description of the database.

Chart 1

Business Sector Labour Productivity (LP) Levels in Sweden and Finland,1975-2004



Source: EU KLEMS and author calculations.

The article is divided into seven sections. The first section analyses the LP levels of the business sector in Sweden and Finland and how the relative level between the two countries has developed over time. The second section gives a comprehensive picture of the ICT sector in both countries, and in the third, the LP level in the ICT sector and its relation to the business sector are illustrated. Section four examines the LP level and LP growth in the different industries in the ICT sector. Section five presents estimates of the contribution of the ICT sector to LP growth in the business sector and section six analyses the importance of the ICT sector for the convergence of Finnish business sector labour productivity toward the Swedish level. The final section, discusses the productivity challenges faced by Finland and Sweden and proposes a future research agenda.

Has Finland Caught Up with Sweden?

What is the LP level in the Swedish and Finnish business sector and how has it developed over time? Chart 1 shows that the LP level in the Swedish business sector was 19 euros per hour worked in 1975 (constant 1997 euros). In the same year, the Finnish level was 11.5 euro. Thanks to a significantly higher average yearly Finnish LP growth in the period 1975-95, the difference in LP levels between the two countries decreased. In relation to Sweden, Finland was in a period of convergence.

However, there has been no further decrease in the absolute gap in productivity levels between Sweden and Finland in the last ten years. Instead, it increased by 0.3 euros between 1995 and 2004. This change is explained by the fact that the Swedish LP growth — after two weak decades both in relation to its own history and in comparison to other countries — increased after the crisis years at the beginning of the 1990s. At the same time the Finnish LP growth slowed down.

In 2004, the Swedish LP level was 37.3 euros and the Finnish level to 33.2 euros — a difference of 4.1 euros. This means that the LP level increased by 95 per cent in Sweden and by 190 per cent in Finland between 1975 and 2004. The average Swede today produces almost twice as much per hour as 30 years ago and the average Finn has almost tripled hourly production in the same period.

The third curve in the chart shows the Finnish LP level as a proportion of the Swedish level. Thirty years ago, this relative was 60.2 per cent, in 1995 to 86.8 per cent and in 2004 to 89.1 per cent. Despite the fact that the absolute difference has increased somewhat since 1995, the Finnish relative has — as a consequence of growing levels — increased by 2.3 percentage points.

Does the LP level difference between Sweden and Finland reflect reality or is it a statistical construct? With a difference of 11 percentage points, it should, even when error margins are taken into account (Schreyer, 2005), reflect reality — the LP level in the business sector is somewhat higher in Sweden than in Finland.[4]

Table 1
ICT Sector Share of the Business Sector in Sweden and Finland, Nominal Value Added and Hours Worked, 1975, 1995 and 2004

	Sweden			Finland		
Nominal value added	**1975**	**1995**	**2004**	**1975**	**1995**	**2004**
ICT sector	7.2	8.0	9.8	4.1	8.2	14.1
Of which manufacturing industry						
Office machinery and computers	0.3	0.2	0.2	0.1	0.2	0.02
Electrical engineering	2.3	2.2	1.5	1.6	3.3	6.3
Precision and optical instruments	1.1	1.0	1.1	0.2	0.6	0.7
Total ICT manufacturing	3.7	3.4	2.8	1.9	4.1	7.0
Of which service sector						
Post and telecommunication	2.8	3.1	3.5	1.8	2.9	4.6
Computer services	0.7	1.5	3.5	0.4	1.2	2.5
Total ICT services	3.5	4.6	7.0	2.2	4.1	7.1
Hours worked						
ICT sector	6.7	8.2	8.9	4.0	7.1	9.1
Of which manufacturing industry						
Office machinery and computers	0.3	0.2	0.1	0.07	0.02	0.01
Electrical engineering	2.2	2.4	2.2	1.5	2.5	3.1
Precision and optical instruments	1.0	1.0	0.9	0.3	0.6	0.7
Total ICT manufacturing	3.5	3.6	3.2	1.9	3.1	3.8
Of which service sector						
Post and telecommunication	2.6	3.0	2.7	1.8	2.7	2.5
Computer services	0.6	1.6	3.0	0.3	1.3	2.8
Total ICT services	3.2	4.6	5.7	2.1	4.0	5.3

Source: EU KLEMS and author calculations

A Comprehensive Picture of the ICT Sector

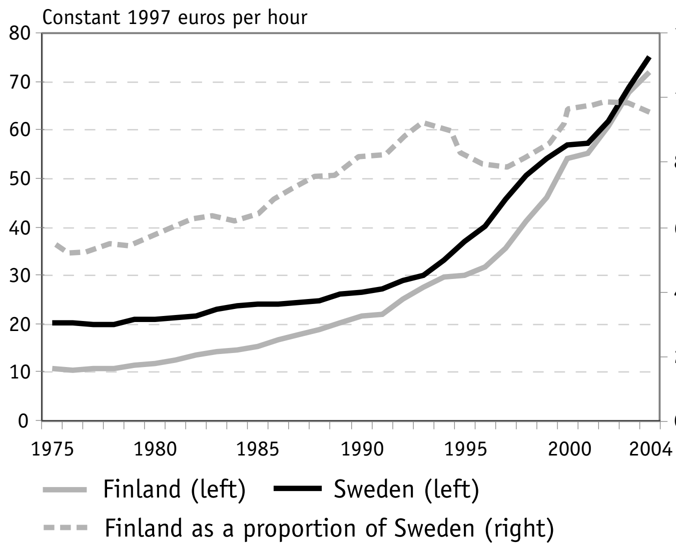
What role has the ICT sector played in the convergence of the Finnish business sector LP level toward the Swedish level? Has it changed over time, both in absolute and relative terms? A comprehensive picture of the ICT sector is a necessary condition for carefully prepared answers to these questions.

The ICT sector's share of business sector value added and hours worked is presented in Table 1. In 1975, the ICT sector's share of the Swedish business sector's nominal value added was 7.2 per cent and it has since grown to 9.8 per cent by 2004. With a share of 4.1 per cent, the Finnish ICT sector was considerably smaller than its Swedish counterpart in the mid 1970s. However, it has caught up with and overtaken its Swedish equivalent over the last 30 years. In 2004, the Finnish ICT sector's share of value added in the business sector was 14.1 per cent.

As is also shown, there has been a decrease in the manufacturing-related share of the Swedish ICT sector in the business sector between 1975 and 2004 — from 3.7 to 2.8 per cent. The opposite trend occured in Finland — the share of ICT manufacturing increased from 1.9 to 7.0 per cent. In both cases, it is electrical engineering that explains the major part of these diverging patterns. Both in Sweden and Finland, the

4 This conclusion seems reasonable, since OECD's calculations on the difference in GDP per hour do not deviate from the results presented here in any unreasonable way.

Chart 2
ICT Sector Labour Productivity Levels (LP) in Sweden and Finland, 1975-2004



Source: EU KLEMS and author calculations.

service-related ICT-industries have increased their share of business sector value added in the last 30 years. In Sweden, this means an increase from 3.5 to 7.0 per cent, in Finland from 2.2 to 7.1 per cent. Thus, the Finnish service-related industries were smaller than the Swedish ones in 1975, but today the shares are approximately the same. This means that the smaller Swedish ICT sector is explained by the manufacturing industries — and electrical engineering is the relevant industry among these.

The lower part of Table 1 presents the ICT sector and its industries shares of the business sector's hours worked. A few points are worth mentioning. First, in terms of share of hours worked it is clear that the size difference between the two countries' ICT sectors disappears. With shares around nine per cent in 2004 they are of equal importance. Second, between 1975 and 2004 the share of hours worked in the ICT manufacturing in Sweden fell, while at the same time it doubled in Finland. Third, the very rapid LP growth which occurred in both the Swedish and the Finnish electrical engineering-industry, as we will discover later on in this article, went together with an increased share of hours worked in Finland in this industry, but not in Sweden. Thus, the greater importance of ICT manufacturing in Finland is, again, explained by electrical engineering. Finally, in contrast to valued added shares, the share of hours worked in ICT services was in 2004 slightly larger in Sweden than in Finland.

The ICT Sector's Labour Productivity Level

How productive are the Swedish and the Finnish ICT sectors? Together with their relative shares of hours worked and value added, productivity levels provide the basis for assessing the contribution of the ICT sector to LP growth in the business sector, and the role the ICT sector has played in the Finnish productivity convergence.

Chart 2 presents the LP levels of the ICT sector between 1975 and 2004. It shows that the LP level of the Swedish ICT sector was slightly more than 20 euros in 1975. In the same year, the Finnish level was slightly more than half this amount — 11 euros.

Up to the early 1990s there was a significant reduction in the gap in ICT sector LP levels between Sweden and Finland. In 1993, the Finnish level was 93 per cent of the Swedish level. After 1993 the Swedish LP growth increased and there was an increase in the LP gap. Yet, the gap decreased once again later in the decade and, after 2000, the gap had disappeared almost entirely.

Average annual LP growth in the ICT sector in the period 1995-2004 was two percentage points higher in Finland than in Sweden — 10.2 and 8.2 per cent, respectively. Due to these extraordinary growth rates, the LP levels in 2004 amounted to 75.3 euros in Sweden and 73.8 euros in Finland. This means that the LP level in the Finnish ICT sector was slightly more than 95 per cent of the

Table 2
Labour Productivity Levels and Growth in ICT Industries in Sweden and Finland

	Sweden			Finland		
LP level (constant 1997 euros per hour)	**1975**	**1995**	**2004**	**1975**	**1995**	**2004**
Office machinery and computers	20.5	28.6	66.0	3.3	21.1	41.6[1]
Electrical engineering	9.0	20.7	85.3	10.7	37.6	129.2
Precision and optical instruments	22.4	31.5	47.0	9.9	28.4	21.0
Total ICT manufacturing	13.9	24.4	68.4	10.3	35.4	118.6
Post and telecommunication	35.5	79.9	148.0	9.8	26.2	67.6
Computer services	47.0	34.9	32.6	28.4	24.9	25.8
Total ICT services	37.8	65.4	90.1	13.0	25.8	53.1
LP growth (compound annual average)	**1975-2004**	**1975-95**	**1995-2004**	**1975-2004**	**1975-95**	**1995-2004**
Office machinery and computers	4.1	1.5	9.7	11.2	11.3	18.5[1]
Electrical engineering	8.1	3.2	17.1	9.0	6.8	14.7
Precision and optical instruments	2.6	1.9	4.6	2.6	5.6	-3.3
Total ICT manufacturing	5.7	2.9	12.2	8.8	6.4	14.4
Post and telecommunication	4.0	3.7	7.1	6.9	5.2	11.1
Computer services	-1.2	-1.4	-0.8	-0.3	-0.1	0.4
Total ICT services	3.0	2.8	3.6	5.0	3.5	8.3

1 There is no real value added in this industry after 1999. For this reason, this is the 1999 year level. In a similar way, average yearly LP growth in the lower part of the table is the average for the period 1995-99. The average for 1975-2004 is the average for the period 1975-99.

Source: EU KLEMS and author calculations.

Swedish level. Accounting for established margins of error, one should be careful in deriving far-reaching conclusions from this. What is obvious, however, is that LP growth has been considerably faster in the ICT sector than in the business sector since 1975. The LP level in the ICT sector was on the same level as in the business sector in that year; in 2004, the level measured in constant 1997 euros is more than twice as high in both Sweden and Finland.

LP Levels and LP Growth in the ICT Industries

What have been the trends in LP levels and growth rates in the five industries that make up the ICT sector? As is clear from Table 2, electrical engineering, at 9.0 euros per hour worked, had the lowest LP level in Sweden in 1975. The highest level, 47.0 euros, was found in computer services. This means that the LP level in electrical engineering was about half that of the business sector, while the level of LP in computer services was more than twice as high. Average LP growth of 8.1 per cent per year between 1975 and 2004 resulted in a LP level in electrical engineering of 85.3 euros in 2004. This substantial increase occurred primarily in the last ten years — with an average yearly LP growth rate of 17.1 per cent. Thus, the LP level of this industry increased more than nine times since 1975 and more than four times in the last decade.

Computer services showed an opposite trend. Table 2 shows an average LP decline of 1.2 per cent per year between 1975 and 2004. The LP level fell from 47.0 to 32.6 euros. The performance of other industries fell between these extremes.

The LP level of the ICT manufacturing industries increased from 13.9 euros to 68.4 euros between 1975 and 2004. During the last decade alone the level almost tripled — from 24.4 euros to 68.4 euros. In the services sector LP growth has been more modest, but the level still increased by almost 40 per cent since 1995.

In comparison with Sweden, the Finnish LP level in 1975 was lower in all industries except in electrical engineering. This pattern still holds 30 years later. The higher LP growth in the Finnish ICT sector — an implication of the convergence in Chart 2 — has not resulted in any industries overtaking their Swedish counterparts. In 2004, the Finnish LP level was less than 50 per cent of the Swedish level in precision and optical instruments and in post and telecommunication. In sum, without the high LP level in electrical engineering, which also generates the high LP level for the aggregate ICT manufacturing industries, there would have been a considerable deterioration in the relative position of the Finnish ICT sector. Not only due to its size, but also in terms of LP, electrical engineering is crucial for the interpretation of the picture of the ICT sector.

As in Sweden, the Finnish computer services industry experienced negative LP growth between 1975 and 2004. In the period 1995-2004, LP growth in the Finnish ICT sector was highest in office machinery and computers, closely followed by electrical engineering. With an average of -3.3 per cent per year, the trend since the mid 1990s has been particularly unfavourable for precision and optical instruments. In electrical engineering, the Finnish LP level is currently more than 40 euros higher than the Swedish level.

The ICT Sector's Contribution to LP Growth in the Business Sector

The previous sections have shown that the importance of the ICT sector for the business sector LP growth has grown since 1975, and especially since the mid 1990s. But more precisely, how important is this sector for the business sector?

According to OECD (2001), this question can be answered using equation (1). The LP growth of the business sector, ΔLP, is defined as the weighted sum of the LP growth of the industries, where the weights, $\bar{w}_i$, consist of the industries' shares of the nominal value added of the business sector (Thörnqvist index). The contribution of the ICT sector to the LP growth of the business sector is defined as the sum of the contributions of the ICT-producing industries.

1) $$\Delta LP = \sum_i \overline{w}_i \Delta LP_i \,.$$

Let us start by analysing the period 1975-2004. From Table 3, it appears that the average LP growth of the Swedish business sector — estimated from equation (1) – was 1.9 per cent per year in this period. The average yearly contribution of the ICT sector was 0.35 percentage points. This means that 18.4 per cent of the LP growth of the business sector can be attributed to the ICT sector (0.35/1.9). In Finland, the average LP growth of the business sector was 3.1 per cent per year in the same period. The contribution of the ICT sector amounted to 0.52 percentage points, but due to the higher LP growth of the business sector, the share was only 16.8 per cent (0.52/3.1).

As concerns the industries in the ICT sector, the picture is similar in both countries. Electrical engineering and post and telecommunication were the only industries with substantial impacts. In both countries, the former was the industry that contributed most in the period 1975-2004.

In a comparison between the two subperiods, one finds since 1995 a sharp increase in the contribution of the ICT sector to the LP growth in the business sector. In Sweden, the contribution more than tripled between the periods — from 0.19 to 0.64 percentage points. In Finland, the contribution was multiplied by four — from 0.31 to 1.25 percentage points. This increased importance means that 22.1 per cent of the LP growth in the Swedish business sector since the mid

1990s can be attributed to the ICT sector. In a similar way, the contribution amounts to 41.7 per cent in Finland. This means that for Finland, 12 per cent of the value added of the business sector — calculated as the average for the period 1995-2004 in Table 1 — has generated more than 40 per cent of the LP growth. In both absolute and relative terms, the contribution of the ICT sector has been about twice as large in Finland as in Sweden between 1995 and 2004.

Table 3 also shows, once more, that it is electrical engineering and post and telecommunication that explain these results. In Sweden, there was a fivefold increase in the contribution from electrical engineering — from 0.07 to 0.35 percentage points. This means that this industry on its own contributed 12 per cent to the LP growth in the business sector between 1995 and 2004 (0.35/2.9). The contribution doubled for post and telecommunication. In Finland, there was a sevenfold increase in the contribution from electrical engineering — from 0.12 to 0.83 percentage points. This means that over the 1995-2004 period 28 per cent of the LP growth in the business sector can be attributed to this industry (0.83/3.0) and thus, that this industry is more important for the Finnish LP growth than what the entire ICT sector is for Sweden.

Table 3

The Contribution of the ICT Sector to Business Sector Labour Productivity Growth in Sweden and Finland

(Annual percentage point change unless otherwise noted)

Sweden	**1975-2004**	**1975-95**	**1995-2004**
LP growth in the business sector	1.9	1.5	2.9
Contribution of the ICT sector	0.35	0.19	0.64
Of which			
Office machinery and computers	0.01	0.00	0.02
Electrical engineering	0.17	0.07	0.35
Precision and optical instruments	0.03	0.02	0.05
Post and telecommunication	0.16	0.11	0.24
Computer services	-0.02	-0.01	-0.02
Contribution Share of the ICT sector (%)	18.4	12.7	22.1
Finland			
LP growth of the business sector	3.1	3.3	3.0
Contribution of the ICT sector	0.52	0.31	1.25
Of which			
Office machinery and computers	0.02	0.03	0.02
Electrical engineering	0.28	0.12	0.83
Precision and optical instruments	0.01	0.02	-0.02
Post and telecommunication	0.21	0.14	0.42
Computer services	0.00	0.00	0.01
Contribution Share of the ICT sector (%)	16.8	9.4	41.7

Source: EU KLEMS and authorcalculations.

The Contribution of the ICT Sector to the Finnish Productivity Convergence

According to the shift-share method, the difference in business sector LP levels between countries at a given point in time is either explained by differences in levels *within* industries or by differences in the employment structure *between* industries. In the latter case, this relates to how employment is distributed between high- and low-productivity level industries. Timmer and Szirmai (1999) show that this can be analysed using equation (2). The difference in LP levels between the Swedish and the Finnish business sectors, $LP^S - LP^F$, is defined as the sum of two terms. In the first, the industry-wise difference in LP levels is weighted with the average employment share (L) of the industry $\frac{1}{2}(L_i^F + L_i^S)$. In the second, the difference in employment shares in the business sector is weighted with the average LP level $\frac{1}{2}(LP_i^F + LP_i^S)$.

$$2)\quad LP^S - LP^F = \sum_{i=1}^{n}(LP_i^S - LP_i^F)\frac{1}{2}(L_i^F + L_i^S) + \sum_{i=1}^{n}(L_i^S - L_i^F)\frac{1}{2}(LP_i^F + LP_i^S)$$

If the first term after the equals sign — the LP effect — is zero, then the entire difference in LP levels is due to differences in the employment structure. If the second term — the employment effect — is zero, then the entire LP gap is explained by differences in LP levels between industries.

Table 4
The Finnish Productivity Convergence and the Contribution of the ICT Sector
(Average annual percentage points unless otherwise noted)

1975-2004	**LP effect (1)**	**Employment effect (2)**	**Contribution to convergence (1)+(2)**	**Share of convergence (%)**
ICT sector	0.28	5.36	5.62	19.5
Of which				
Office machinery and computers	0.18	0.14	0.31	1.1
Electrical engineering	3.38	3.44	6.82	23.6
Precision and optical instruments	-0.16	0.45	0.28	1.0
Post and telecommunication	-3.02	0.67	-2.35	-8.1
Computer services	-0.10	0.66	0.56	1.9
Business sector	23.4	5.5	28.9	
1995-2004				
ICT sector	0.69	2.07	2.76	123.2
Of which				
Office machinery and computers	0.04	-0.02	0.02	0.7
Electrical engineering	1.24	1.76	3.00	133.8
Precision and optical instruments	-0.35	0.20	-0.16	-7.1
Post and telecommunication	-0.21	-0.02	-0.23	-10.4
Computer services	-0.02	0.15	0.14	6.1
Business sector	-0.15	2.39	2.24	

Source: EU KLEMS and author calculations.

Using equation (2) as the starting point, the contribution of the ICT sector to the percentage convergence — from 60.2 to 89.1 per cent of the Swedish level between 1975 and 2004 — of the Finnish business sector can be estimated. The difference between the Finnish share of the Swedish business sector at two points in time is, in accordance with equation (3), explained by how the LP effect and the employment effect in equation (2) relate to the Swedish LP level at the two points in time.

$$3)\ \frac{LP^{F,T}}{LP^{S,T}}-\frac{LP^{F,0}}{LP^{S,0}}=\frac{Intra^{0}}{LP^{S,0}}-\frac{Intra^{T}}{LP^{S,T}}+\frac{Struc^{0}}{LP^{S,0}}-\frac{Struc^{T}}{LP^{S,T}}$$

$$Intra = \sum_{i=1}^{n}(LP_i^{S}-LP_i^{F})\frac{1}{2}(L_i^{F}+L_i^{S})$$

and

$$struc = \sum_{i=1}^{n}(L_i^{S}-L_i^{F})\frac{1}{2}(LP_i^{F}+LP_i^{S})$$

How is the Finnish convergence distributed between the LP- and the employment effect and what has the contribution of the ICT sector looked like? In Table 4, calculations using equation (3) show that 23.4 percentage points of the Finnish business sector productivity convergence of 28.9 percentage points between 1975 and 2004 can be attributed to the LP effect — that is to a decrease in the difference in LP levels within industries.[5] The remaining share, 5.5 percentage points, can be attributed to changes in relative employment shares. Structural change on the Finnish labour market — sometimes defined as creative destruction — has thus reduced the LP gap; almost a fifth of the convergence can be explained by these shifts in employment.

5 The calculations according to equation (3) never exactly correspond to the trend in Chart 1. Thus, the statistics in Table 4 have been normalised.

The contribution of the ICT sector was 5.62 percentage points. This corresponds to 19.5 per cent of the decreased LP gap. Almost all of this, or 5.36 percentage points, is explained by the employment effect. This implies that the positive employment effect of the Finnish business sector is due to a favourable relative structural change in the ICT sector. Note that the share of ICT hours worked increased from 4.0 per cent to 9.1 per cent between 1975 and 2004. The LP effect is not as favourable; only 0.28 of 23.4 percentage points in convergence can be attributed to the ICT sector. This means that a decreased LP gap between the Finnish and Swedish ICT sectors has not been of any decisive importance for the Finnish productivity convergence toward the Swedish level.

At the industry level, it is clear that more than the entire contribution of the ICT sector can be attributed to electrical engineering. On its own, the contribution of this industry amounts to 6.82 percentage points. This corresponds to 23.6 per cent of the productivity convergence of the Finnish business sector toward the Swedish level and is the result of both a favourable LP and employment effect. More than 60 per cent of the employment effect in the business sector can be attributed to electrical engineering (3.44/ 5.5). As concerns the LP effect, 14 per cent can be attributed to the same industry (3.38/23.4). The other ICT industries have not contributed to the convergence in any substantial way, even if the employment effect is positive for all industries. The negative LP effect in post and telecommunication is a consequence of an increased Sweden-Finland gap in the LP level of that industry from 26 euros in 1975 to 80 euros in 2004.

In the mid 1990s, there was an acceleration in the pace of growth of the ICT sector. In both countries, the share of valued added of the ICT sector and its LP grew faster than in earlier periods. The pattern was more accentuated in Finland, resulting in a greater relative importance of the ICT sector to the convergence since 1995 than in 1975-1995.

The lower part of Table 4 also shows this to be the case. Of the 2.24 percentage points productivity convergence of the Finnnish business sector toward that of Sweden between 1995 and 2004, -0.15 percentage points can be attributed to the LP effect and 2.39 percentage points to the employment effect. In the former case, this means that there was an increase in the difference in the LP level within industries in the business sector, and hence that the entire convergence can be attributed to a positive Finnish structural change on the labour market.

The ICT sector contributed 2.76 percentage points to the business sector productivity convergence between Finland and Sweden in 1995-2004. Thus, more than the actual fall in thegap (2.24 points) — or 123.2 per cent — can be explained by this sector. Without this contribution, the convergence would have turned into divergence. This is the result of a positive LP effect of 0.69 percentage points and a positive employment effect of 2.07 percentage points. Once more, it was the ICT sector that constituted almost all of the positive structural change in the Finnish business sector from 1995 to 2004.

Electrical engineering is crucial for these results. The LP effect for this industry was 1.24 percentage points or almost twice as much as the contribution of the entire ICT sector. If the relationship between the LP levels in this industry had been constant between the countries — and the LP effect had been zero — the LP effect for the business sector would have deteriorated to -1.39 percentage points. In the same way, there would have been a dramatic reduction in the employment effect if the positive contribution from electrical engineering were to have been excluded. A crucial part of the positive structural change on the Finnish labour market can be attributed to electrical engineering. Altogether, 133.8 per cent of the 2.2 percentage points productivity convergence between 1995 and 2004 is explained by this industry alone. This implies that the other ICT industries have negatively contributed to the LP gap.

Conclusion

This article confirms that in both Sweden and Finland the ICT sector has become increasingly important for aggregate productivity growth, and that it has played a crucial role since the mid 1990s. When comparing the two countries, it is obvious that in absolute terms, the sector has been more important in Finland than in Sweden. This is a conclusion that also finds support in earlier research. Partly as a consequence of different definitions, methods and time periods, research has, however, not succeeded in establishing any uniform answer to the question of how important the ICT sector has been in relative terms. This article indicates that, also from this perspective, the ICT sector has played a larger role in Finland than in Sweden since the mid 1990s. This leads to the conclusion that Finland is unambiguously more dependent on ICT production than Sweden, and that the main explanation for this is the electrical engineering industry.

The larger relative importance of the Finnish ICT sector is also reflected by the convergence in LP levels in the business sector. The explanation for this is not primarily faster LP growth, but rather a more positive structural change on the labour market in Finland than in Sweden. This means that a growing Finnish ICT sector has, since the mid 1990s, lead to a continuation of the convergence process, although at a much slower pace. However, only the telecom equipment manufacturing industry is hiding behind this aggregate. The Nokia effect has been stronger than the Ericsson effect.[6]

The large dependence on these firms — and the high-technology clusters by which they are surrounded — is an interesting stepping stone for a future research agenda. How long can we rely on this technical paradigm? Are enough resources invested in moving the research frontier forward? How are we affected by the increased share of services and by the fact that manufacturing tends to offshore? Can this uncertainty be compensated by more efficient ICT use? Is there a hidden productivity growth potential in the service sector? Does such growth require further complementary investments in in-service training and organisational change? Does this require that a new, more ICT-oriented generation becomes established on the labour market? Without claiming to have the correct answers, we should — in conclusion — give a thought to the employees in the telecom industry who in a crucial way have contributed to the favourable LP growth since the mid 1990s.

References

Daveri, F. and O. Silva (2004) "Not Only Nokia: What Finland Tells Us About New Economy Growth," *Economic Policy*, April, pp 117-163.

Jalava, J. (2003) "Den Nya Ekonomin i Finland: Produktion och Användande av IKT," *Ekonomiska Samfundets Tidskrift* No. 1.

Jalava, J. (2004) "Productivity in Finnish Manufacturing Industry, 1975-2003," Labour Institute of Economic Research, Discussion Paper No 209.

Jalava, J. and M. Pohjola (2007) "ICT as a Source of Output and Productivity Growth in Finland," *Telecommunications Policy*, Volume 31, Issue 8-9, pp. 463-472.

6 In Finland attempts have been made to estimate the direct contribution of Nokia to the aggregate development. Between 1995 and 2000 around 80 per cent of the contribution from the ICT sector to GDP growth can be attributed to Nokia. Nokia's share of GDP was around 3 per cent in the beginning of the 21st century. Nokia also accounted for around 20 per cent of total exports and a third of total investment in research and development during the same years. Finally, Nokia's employment share was one per cent and in 2006 the revenues exceeded the state budget. Sources: http://info.worldbank.org/etools/docs/library/145283/IC_for_Finland.pdf and http://en.wikipedia.org/wiki/Nokia.

Lind, D. (2002) "Tillväxtens Drivkrafter: Produktion och Användande av Informationsteknologi i Svensk Ekonomi," *Ekonomisk Debatt*, årgång 30, nr 7.

Lind, D. (2003) "Svensk Industriproduktivitet under Fyra Decennier: Vad Kan Vi Lära Av 1990-talet", *Ekonomisk Debatt*, årgång 31, nr 5.

Lindström, T. (2003) "The Role of High-Tech Capital Formation for Swedish Productivity Growth," Working Paper No. 83, The National Institute of Economic Research.

OECD (2001) *Measuring Productivity: OECD Manual*.

OECD (2002) Measuring the Information Economy 2002, OECD STI.

Schreyer, P. (2005) "OECD/IVIE/BBVA Workshop on Productivity Measurement. International Comparisons of Levels of Capital Input and Productivity."

Timmer, M.P. and A. Szirmai (1999) "Comparative Productivity Performance in Manufacturing in South and East Asia, 1960-93," *Oxford Development Studies*, Vol. 27, No 1.

Timmer, M.P. and B. van Ark (2005) "Does Information and Communication Technology Drive EU-US Productivity Growth Differentials?" *Oxford Economic Papers* Vol. 57, pp. 693-716.

Timmer, M.P., M. O´Mahony and B. van Ark (2007) "EU KLEMS Growth and Productivity Accounts: An Overview," *International Productivity Monitor*, Number 14, Spring 2007, pp.71-85.

van Ark, B. (2001) "The Renewal of the Old Economy: An International Comparative Perspective," OECD STI Working Papers, 2001/5, OECD.

van Ark, B., R. Inklaar and R.H. McGuckin (2002) "Changing Gear. Productivity, ICT and Service Industries: Europe and the United States," Research Memorandum GD-60, Groningen Growth and Development Centre, December 2002.

van Ark, B., M. O´Mahony and G. Ypma (2007) The EU KLEMS Productivity Report, Issue No 1, March.

The Measurement of TFP in Argentina, 1990-2004: A Case of the Tyranny of Numbers, Economic Cycles and Methodology

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Abstract

The aim of this study is to examine the main sources of growth in Argentina for the period 1990-2004 in order to identify the dominant growth profile: either extensive, which is associated with factor accumulation and utilisation, or intensive, which is based on productivity gains. The study proposes a methodology for identifying gains in total factor productivity (TFP) net of short-run fluctuations in relative prices and cyclical changes in factor utilisation. When applying this methodology to Argentina in the period 1990-2004, we find that economic growth appears to be extensive during the whole period, biased towards capital accumulation and utilisation during the 1990s and biased towards labour input after the 2002 devaluation. These results raise doubts as to whether the Argentine economy is able to generate long-run productivity gains independent of composition and quality effects and cyclical changes in factors utilisation, gains that are needed to achieve sustainable long-run growth.

During the 1990s, labour productivity grew at a robust pace in Argentina. It is widely believed that much of the labour productivity growth was due to the growth of total factor productivity (TFP), i.e. associated exclusively with positive shifts in the production function, or in other words with improvements in the organization of the production process that were independent from the accumulation and utilisation of labour and capital.

However, as will be shown in this article, the interpretation of TFP as a production function

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shift may be incorrect if measured TFP (a necessarily residual variable) includes the impact of short-run economic phenomena that are not necessarily related to shifts in the production function. The most important short-run phenomena are cyclical changes in factor utilisation (labour intensity and capital utilisation), intersectoral reallocation of factors and substitution effects in production reflecting normal adjustments to changes in relative prices and changes in input quality that are not related to improvements in the organization of the productive process. These factors seem to have been particularly important over the 1990-2004 period.

As pointed out by Galiani, Heymann and Tomassi (2003), the accurate identification of the sources of economic growth can help to determine the long-term sustainability of the growth process and the magnitude of permanent income or wealth perceived by economic agents on which investment decisions depend. Canavese and Gerchunoff (1996) have highlighted the central role of TFP in long-term sustainability, not only for growth but also for the real exchange rate.

This study investigates the sources of economic growth in Argentina during the period 1990-2004. Following the recommendations of the literature on productivity measurement, sources of growth are analysed by means of index number theory. This allows filtering TFP from the so-called intersectoral substitution effects in production and quality and composition effects in inputs. In addition, TFP is disaggregated to identify procyclical changes in input utilisation as a consequence of the business cycle: changes in labour intensity and in capital utilisation.

The article is divided into five parts. The first section provides a brief qualitative review of economic developments in Argentina over the 1990-2004 period. The second section proposes a methodology for identifying gains in TFP net of short-run fluctuations in relative prices and cyclical changes in factor utilisation. The third section presents the main results of the use of this methodology and analyses the different sources of growth in Argentina between 1990 and 2004. The fourth section analyses the results in terms of labour productivity and TFP (strict and apparent) growth and identifies the growth profile of the Argentine economy for the period 1990-2004. In the fifth and final section, conclusions are drawn.

A Review of Economic Development in Argentina between 1990 and 2004

During the last fifty years, the Argentine economy exhibited very slow trend growth (3 per cent annually), with high volatility relative to other emerging economies. Significant political and macroeconomic instability is the most common explanation among economists for Argentina's poor long-term growth.

It is notable that Argentina has experienced periods where the investment share has exceeded 20 per cent of GDP, a proportion close to that observed in major developed countries. While Argentina's investment as a share of GDP has been similar to other Latin American economies, it has been lower than in the newly industrialised countries of East Asia. In Argentina, these periods of a high investment share coincided with the implementation of successful stabilization plans that resulted in notable improvements in macroeconomic stability, export performance, and economic growth. Unfortunately, none of these positive developments could be sustained in the long run.

One of the periods characterized by these short-term positive developments was the era of the Convertibility Plan, from 1991 to 2001, which saw significant economic growth. Growing international liquidity for emerging economies, macroeconomic stability, and a set of structural reforms fostered significant capital inflows that allowed for an increase in credit for the public and private sectors, leading to higher domestic investment, consumption and public expenditure.

At the beginning of the 1990s Argentina privatized public utilities and introduced reforms favouring greater deregulation of markets and improved trade and financial openness. These reforms appeared to have produced an increase in the productivity of the Argentine economy in spite of a large real appreciation of the domestic currency.[2] Productivity gains allowed for significant cost savings, partially compensating for the competitive disadvantage created by the real appreciation. Evidence of this effect can be found in the notable growth of the tradables sector, especially the manufacturing industry, which translated into higher domestic output and, in particular, higher exports.

However, over time the real appreciation of the domestic currency became unsustainable, in large part because productivity gains were based on short-term fluctuations rather than underlying technological change. After overcoming the external "tequila" shock in 1995, the Argentine economy did not recover rapidly from the shock produced by the Brazilian devaluation of mid 1998. The Argentine economy could not internally generate the necessary increase in both domestic savings and productivity to compensate for the negative effects of the external shocks. The extent of the exchange and financial imbalances accumulated by the end of the 1990s led to the inevitable collapse of the convertibility regime in the early 2000s. The collpase of the convertibility regime resulted in significant capital flight, a major devaluation, and a deep external and financial crisis with effects that can still be felt today.

At the beginning of 2002, the domestic currency experienced a significant devaluation. However, due to the freezing of all bank accounts — the so-called "corralito" — and the recession, the pass-through of devaluation to prices was very limited initially, avoiding hyperinflation. The doubling of the real exchange rate ($Argentinos/$US) fostered import substitution and exports. Growth in aggregate demand, together with reduced labour costs and excess installed capacity, allowed employment to recover to pre-devaluation levels. The unemployment rate declined almost ten percentage points. The substantial underutilisation of installed capacity, after an almost five-year depression, meant that growing aggregate demand could be met without spiralling inflation.

Accounting for Growth in Argentina

Because Argentina is a developing country with an unstable economy, an investigation of the sources of growth raises a number of analytical and statistical challenges. To surmount these challenges, this article proposes a methodology for disaggregating economic growth into its main sources by adapting the most recent development or innovation in the economic literature on the subject.

The identification of a country's economic growth profile consists of estimating the contributions to economic growth from the factors of production (movements along the production function) and from TFP (positive shifts of the production function). The standard approach estimates TFP by subtracting the weighted growth of factors of production (labour and capital) from overall economic growth.

But the standard approach does not take into account other important economic phenomena that can affect economic growth and labour productivity. Accounting for these phenomena is especially important in an economy characterized by deep structural changes

2 The real appreciation of the currency resulted from the adoption of the convertibility exchange regime and the growing inflow of external savings.

and considerable volatility in relative prices and aggregate demand. Changes in the composition or quality of key macroeconomic aggregates (output, labour or capital) as a result of changes in relative prices may have considerable effects on the measurement of economic growth. Moreover, cyclical changes in aggregate demand may induce changes in the use of productive factors. Thus, an ideal measure of TFP (i.e. one measuring positive shifts of the production function) should account for changes in the composition of output; changes in labour and capital; quality changes in primary factors; and cyclical changes in factor utilisation as captured by labour intensity (hours worked per job) and capital utilisation.

Changes in the composition and quality of macroeconomic aggregates may be of considerable magnitude in Latin American countries, including Argentina, where the instability of relative prices has been the rule over the last 30 years. For example, changes in the real exchange rate may lead to large substitution effects in production across the tradables and non-tradables sectors, affecting their contributions to GDP growth. Something similar happens with labour and capital inputs, not only by industry but also by types or attributes: qualification, age, etc.

Changes in labour intensity and in capital utilisation may also have a certain effect along the business cycle. In general, if we consider labour input as a quasi-fixed factor, its skill composition may be affected by the business cycle (through labour hoarding), and cycles may also produce changes in labour intensity (hours worked per job). Moreover, the existence of adjustment and transaction costs, as well as sunk costs, mean that the quantity of capital input cannot be easily adjusted to reflect changes in aggregate demand, leading to changes in capital utilisation. Thus, taking into account the considerable fluctuations in aggregate demand in Latin America (especially in Argentina during the period analysed in this study), adjusting for factor utilisation is of critical importance when investigating the growth profile of the Argentine economy.

Failure to adjust TFP for changes in capital utilisation and labour intensity generates a strongly procyclical behaviour that could be incorrectly attributed to shifts in the production function. Given that in this study TFP gains are understood as technological progress (positive shifts in the production function), the adjustment of labour and capital for changes in their use becomes essential.

We propose a methodology for estimating TFP which disentangles the influence of changes in relative prices (quality and composition effects) and cyclical changes in factor utilisation to obtain a measure we hereafter call "strict TFP," which represents a positive shift in the production possibilities frontier.[3] Our methodology accounts for economic growth as follows:[4]

1) $$\Delta Y^O = \bar{S}_K \Delta K^O + \bar{S}_L \Delta L^O + \Delta A^S$$

Where the main variables are measured as follows:

ΔY^O = Optimal output growth measured by Tornqvist index

$\bar{S}_i$ = average share of primary input in GDP using period beginning and end point

ΔA^S = "strict TFP" growth

2) $$\Delta L^O = (\Delta L^U + \Delta L^Q + \Delta L^C + \Delta L^{ul})$$

where the optimal labour input growth measured by Tornqvist index (L^O) is defined as the sum of the following effects: hours or undifferentiated labour growth (L^U); the quality effect

3 Hulten (1986) distinguishes TFP in even stronger terms: true TFP and false TFP (without adjusting for capital utilisation).

4 For more details, see the unabridged version posted at www.csls.ca.

(L^Q) expressed as the difference between labour input growth by Laspeyres index and hours growth; the composition effect (L^C) expressed as the difference between the Laspeyres and Tornqvist index of labour input growth; and the utilisation or labour intensity effect (L^{ul}) expressed as the difference between hours and jobs growth.[5]

3) $\Delta K_P^O = (\Delta K_W^B + \Delta K^Q + \Delta K^C + \Delta K^{u\kappa})$

where capital services growth measured by Tornqvist index (K_P^O) can be decomposed into capital stock growth measured by the Laspeyres index of wealth stock (asset prices as weights of types of capital) (K_W^B); the quality effect (K^Q) expressed as the difference between the Laspeyres index of wealth stock and the Laspeyres index of capital services (taking user cost as weights by type of asset);the composition effect (K^C) expressed as the difference between the Laspeyres index of capital services and the measurement by Tornqvist index; and the utilisation effect (K^{uk}) expressed as the difference between the measurement of original or "potential" capital services and capital services adjusted by utilisation.[6]

It thus follows that for labour productivity:

y = labour productivity

k = capital/labour ratio

4) $\Delta y = S_K \Delta k + \Delta A^S$

where all its components are measured optimally.

The traditional methodology consists of the measurement of apparent TFP without identification of quality, composition and adjustment effects in the input contribution side.

5) $\Delta Y^B = \bar{S}_K \Delta K_W^B + \bar{S}_L \Delta L^U + \Delta A^A$

where ΔA^A = apparent TFP growth

And from it follows the traditional version of labour productivity:

6) $\Delta y = S_K \Delta k + \Delta A^A$

where output growth is measured by Laspeyres or another fixed-base index, capital input growth represents the growth of wealth stock measured by Laspeyres, and labour input growth is measured using unadjusted hours growth.

The Measurement of the Sources of Growth in Argentina, 1990-2004

The purpose of this section is to briefly present the methodology, sources and results of the estimates of the components of productivity growth for Argentina during the period 1990-2004, following the recommendations of section two.[7] Our analysis of the productivity drivers and productivity performance of Argentina over the 1990-2004 period focuses on the following sub-periods: 1990-1994, the initial boom of the Convertibility Plan; 1995, the tequila effect which was characterized by significant capital flight triggered by a widespread loss of confidence of foreign investors after the collapse of the Mexican peso; 1995-1998, the second positive phase of the Convertibility Plan; 1998-2001, the negative phase and the end of the currency board; the

5 It is worth mentioning that self-employed and unpaid family workers are included in labour input, in addition to employees. Income for these types of workers is called mixed income given that it includes compensation for both labour and capital. In order to identify labour remuneration, returns to labour of this type were imputed at the industry level based on the wages of employees as recommended by OECD (2001b).

6 The adjustment of capital services by their effective utilisation in productivity measurement has been discussed extensively in the economic literature. There is agreement that this phenomena has to be taken into account in growth accounting and productivity studies but there is no agreement about how to make the adjustment. Taking into account the volatility of the economic cycle in Argentina, we follow the methodology of Basu *et al.* (2001) in the explicit tradition of Solow (1957), Jorgenson and Grilliches (1967), and Denison (1969), but with specific utilisation indicators by factor in a growth accounting context.

7 The impact on productivity of each variable and the growth profile are analyzed in the following section.

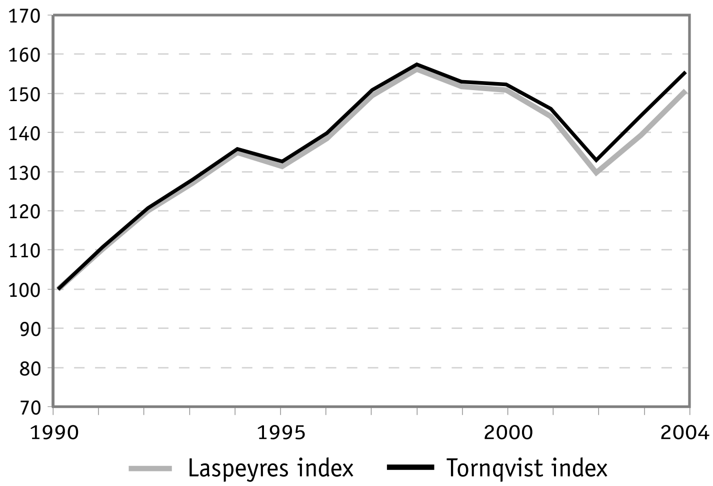
2002 crisis (default, "corralito", devaluation); and 2002-2004, the new positive phase of the business cycle.

Gross Domestic Product

Gross domestic product (GDP) estimates in this article are from the National Accounts Area (DNCN) of the National Statistical and Census Bureau (INDEC).[8] Official GDP estimates include non-registered activity by industry in the base year. Sectoral value added is estimated at producer prices, that is, excluding non-deductible value-added tax as well as import taxes and intermediation margins.[9] The GDP series was calculated using a Tornqvist index, which accounts for the large changes in relative prices since 2000.[10]

Chart 1 presents the GDP series by index type. In 1990s both indices exhibit a near identical trend. However, since 2000, and especially after the 2002 crisis, the two series have diverged (Table 1). As a consequence of the substantial devaluation of the domestic currency in 2002, the tradable goods producing sectors (agriculture, mining and manufacturing) increased their share of GDP (from 25 per cent to 40 per cent) and their contribution to GDP growth (Chart 2). This important change in relative prices is captured in the Tornqvist physical volume index, representing a substitution effect in production of approximately one percentage point for 2002 and of 0.4 percentage points on average for the following years (Table 1).

Chart 1
Real Gross Domestic Product in Argentina, 1990-2004
(1990=100)



Source: Author´s estimation based on National Accounts, INDEC.

On the other hand, differences between the two indices were substantially smaller at the beginning of the period. Prior to adopting the Convertibility Plan, devaluation was almost neutral with respect to relative prices as nominal devaluation was entirely passed through to prices (even more than proportionally). After the adoption of the Convertibility Plan in April 1991, currency appreciation resulted only in a small reduction in the share of the tradables sector, slightly increasing the gap between the indexes.[11]

8 For the period 1993-2004, the base year is 1993. For the period 1990-1993, the series at the one-digit level of ISIC 3rd rev. were linked with the series of the former base year, 1986. This match is provisional given that it was not carried out standardizing the methodology used to calculate the physical volume indexes of the industries that form GDP.

9 A more accurate measurement of productivity should use the basic prices valuation criterion. This criterion provides a superior estimate of the price at the exit of the factory, because it removes direct taxes, income tax and exports taxes; however, these estimates at current and constant prices by industry are not officially available.

10 For the definition and methodology of ideal or optimal indexes, see Diewert (1976, 1978 and 1995), OECD (2001b) and ISWGNA (1993). The estimates for Argentina are explained in Coremberg (2002 and 2004a); results using different types of ideal index are similar to the one presented here.

11 The impact of devaluation on relative prices of tradable goods during the hyperinflation period with respect to the post-Convertibility devaluation can be demonstrated by analyzing the ratio between the implicit deflators of value added of the tradables and non-tradables sectors. Between 1990 and 2001, the relative prices of tradable goods in terms of non-tradable goods decreased 17.5 per cent, whereas after devaluation relative prices of tradable goods increased 92 per cent (2001-2004).

Table 1

Real Gross Domestic Product in Argentina, Selected Periods, 1990-2004

(annual or average annual growth rates)

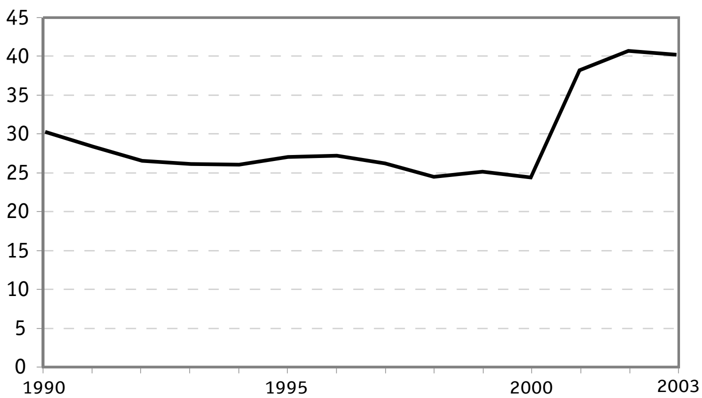
Type of Index	1990-1994	1995	1995-1998	1998-2001	1990-2001	2002	2002-2004	1990-2004
Laspeyres93	7.78	-2.62	5.94	-2.65	3.38	-10.02	7.77	2.97
Tornqvist	7.96	-2.36	5.86	-2.46	3.50	-8.96	8.15	3.20
Substitution Effect	0.17	0.26	-0.08	0.19	0.12	1.06	0.38	0.23

Source: Author´s estimation based on National Accounts, INDEC.

Chart 2

Share of Tradables Industries in the Argentine GDP, 1990-2004

(current prices)



Source: Author´s estimation based on National Accounts, INDEC.

If this production substitution bias were not taken into account, GDP growth would have been underestimated by an average of 0.23 percentage points annually in the 1990-2004 period. As noted earlier, after the 2002 devaluation, the difference would have been an average of 0.4 percentage points annually. These differences are not minor. If this bias were not taken into account, GDP growth and, therefore productivity gains, would have been significantly underestimated.

Labour Input

Output, wages and labour input (captured by hours and jobs series) by industry during the 1993-2004 period, come from the National Accounts (DNCN-INDEC, 2006). The functional distribution of income estimated in the National Accounts is based on information from a variety of sources in order to achieve exhaustive estimates by industry consistent with the ISWGNA (1993) recommendations.[12]

The availability of data from a single statistical source ensures the necessary methodological consistency of employment and GDP data by industry, which is especially important given that production and labour data include a sectoral adjustment for the non-registered economy. This allows a consistent analysis of sectoral and aggregate labour productivity, including employment and wages of primary sectors underestimated in the Household Survey, and includes an adjustment for under-declaration of factor income consistent with the rest of the National Accounts.[13]

The quality of labour by sector was determined using the implicit differentiation approach proposed by OECD (2001a), which assumes a correlation between the sectoral characteristics of labour and the rest of the

12 As noted earlier, the labour input also includes the contribution of self-employed and non-paid family workers, using wages similar to those of the industry where they are employed as recommended by OECD (2001b).

13 The National Accounts labour and wage series for the period 1993-2004 are available at the one-digit level of ISIC 3rd rev. (16 sectors), and are compatible with the disaggregation of the GDP accounts and an own estimate based on the Household Permanent Survey (EPH) of INDEC for 1990-1993.

Table 2

Labour Input in Argentina*, Selected Periods, 1990-2004

(annual or average annual growth rates)

Labour Input Indicator	1990-1994	1995	1995-1998	1998-2001	1991-2001	2002	2002-2004	1990-2004
Jobs	2.44	-2.87	3.76	-0.34	1.54	-5.68	6.33	1.67
Hours Worked	4.09	-3.64	3.27	-1.60	1.57	-10.60	10.46	1.86
Labour Intensity	1.64	-0.77	-0.49	-1.25	0.03	-4.92	4.13	0.19

Source: Author´s estimation based on National Accounts, INDEC.

* Labour input in terms of undifferentiated positions or hours worked.

workers characteristics. This method implies an inherent differentiation for the rest of the non-observable characteristics, by assuming a correlation between the sectoral relative wages and the rest of the attributes of the workers, capturing in part the change in the quality of workers. Any change in workers' attributes not correlated with sectoral characteristics of the labour input is incorporated in the residual TFP.

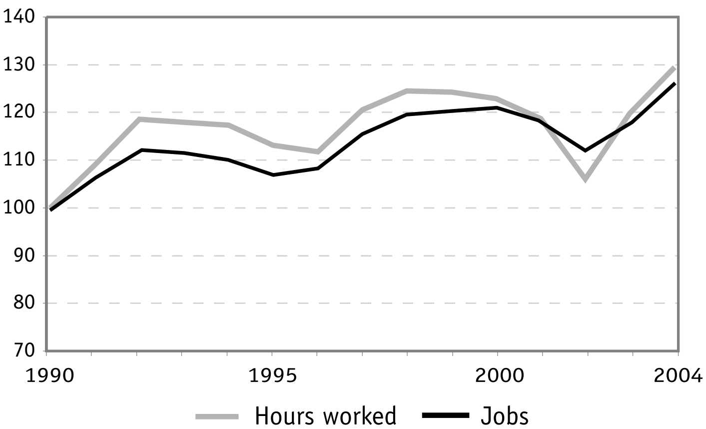
According to Table 2, in Argentina during the 1990-2004 period, the rate of growth of hours worked was slightly faster than the rate of growth of jobs. Trends in labour input showed procyclical behaviour over this period. These cyclical movements were independent of the indicator used (Chart 3) and occurred in spite of both variables being stock rather than flows. This cyclicality was more pronounced for hours worked than for jobs, a difference that may be attributed to the greater flexibility of hours worked than jobs or to labour hoarding.

As shown in Table 3, the most relevant differences appear at the beginning of the positive phases of the economic cycle (1990-1994 and 2002-2004), in which quality and composition effects jointly average 0.18 per cent and -0.83 per cent respectively as a consequence of the changes in relative wages generated by the important appreciation of the domestic currency at the beginning of the 1990s and the devaluation in 2002.

Chart 3

Labour Input in Argentina by Indicator, 1990-2004

(1990=100)



Source: Author´s estimation based on National Accounts, INDEC.

To sum up, adjusting for labour utilisation is crucial in the measurement of the contribution of the labour input to economic growth. The Tornqvist series of hours worked exhibited highly procyclical behaviour, as well as more volatility than jobs.

Capital Services

The capital stock series used corresponds to the author's recent estimates at National Bureau of National Accounts-INDEC (National Statistics Institute).[14]

Table 3
Hours Worked in Argentina, Selected Periods, 1990-2004
(annual or average annual growth rates)

Labour Input Indicator	1990-1994	1995	1995-1998	1998-2001	1991-2001	2002	2002-2004	1990-2004
Undifferentiated	4.09	-3.64	3.27	-1.60	1.57	-10.60	10.46	1.86
Quality Effect	0.11	0.06	-0.04	0.10	0.06	0.10	-0.19	0.03
Laspeyres93	4.19	-3.58	3.23	-1.50	1.63	-10.50	10.28	1.89
Composition Effect	0.07	0.14	0.03	0.17	0.09	0.46	-0.64	0.03
Tornqvist	4.26	-3.43	3.26	-1.33	1.72	-10.03	9.64	1.92
Total Effect	0.18	0.21	-0.01	0.27	0.15	0.57	-0.83	0.06

Source: Author´s estimation based on National Accounts, INDEC.

Composition and Quality Effects on Capital Services in Argentina

To obtain the (potential) productive capital stock, user costs or rental prices for each of the typologies were estimated so as to express the net capital stock in terms of annual capital services. To identify the different effects of changes in relative prices on capital services, the composition effect on the net capital stock was first identified, and then adjusted by changing the weights to obtain the quality effect, in line with OECD (2001b). Table 4 summarizes the main results.

The following conclusions can be drawn from an analysis of the results:

- The composition effect is positive for the aggregate stock and its two components. This effect, expressed as the difference between the Laspeyres and Tornqvist volume indexes of net capital stock, was almost one percentage point per year on average. This represented the weighted effect of durable equipment (0.41 percentage points) and construction (1.03 percentage points). In other words, the growth of the wealth capital stock is underestimated by traditional indexes.
- The quality effect, the difference between net capital stock and capital services (both measured by Tornqvist indexes), was negative for the aggregate stock, -0.50 percentage points. The quality effect represents the weighted sum of a positive effect for durable equipment (0.76 points) and a negative effect for construction (-1.05 points). The weighting by user cost is proportionally higher for durable equipment since, in having a shorter average service life, it provides a relatively greater share of annual services.

14 The estimation methodology is explained in Coremberg (2002 and 2004b), following the methodological recommendations of the literature on capital measurement, and in particular the discussions of the OECD Canberra Group for the Measurement of Non Financial Assets, OECD (2001b) and the experience of IVIE in Spain presented in Mas, Perez and Uriel (2005). The main characteristics of the Capital Stock and Capital Services estimation are the following: (i) perpetual inventory method (PIM) adjusted by (a) empirical verification of the average service life and depreciation profile by means of an econometric assessment of the prices of the cohorts in the used capital goods market, similar to Hulten and Wyckoff (1981), (b) benchmarking of census data and (c) matching-model in case of availability of information on stock and prices by cohort and model; (ii) disaggregated in more than 100 types; (iii) internal consistency with investment data of National Accounts by activity with a ISIC 5-digit level of disaggregation; (iv) macroeconomic consistency; and (v) Capital services are measured through endogenous approach taking user costs as weights as recomended in Jorgenson, Gollop and Fraumeni (1997) and OECD (2001a) (estimations through exogenous approach provided similar results). Hofman (1991, 2000) presents standardized purchasing power parity (PPP) Perpetual Inventory Method (PIM) estimates of capital stock disaggregated in three types for seven Latin American economies, including Argentina for the 1950-1994 period with similar capital-output ratios as our series for the period 1990-2004.

Table 4
Real Capital Stock Services in Argentina,1990-2004
Annual Average Growth Rates

	Total	Durable Equipment	Construction*
Laspeyres Capital Stock	2.03	1.84	2.09
Composition Effect	0.93	0.41	1.03
Tornqvist Capital Stock	2.96	2.25	3.11
Quality Effect	-0.50	0.76	-1.05
Tornqvist Capital Services	2.46	3.01	2.06
Total Effect	0.43	1.16	-0.03

Source: Author´s estimation based on National Accounts-INDEC.

However, although the quality effect on durable equipment stock is positive, it is outweighed by the negative effect from construction given the much larger weight of construction in the aggregate capital stock (both net and productive), even when weighted by user cost.

- The total net effect of adjusting for changes in relative prices and weighting by user cost is 0.43 percentage points for the aggregate capital stock, 1.16 percentage points for the production durable equipment stock and nil for the construction stock.

Chart 4 shows the alternative capital series for the period 1990-2004. The total effect of adjusting for the quality and composition of the capital stock is significant and growing. Using the most common measure of net capital stock, the Laspeyres volume index, underestimates the contribution of capital to economic growth and leads to an overestimation of TFP growth.[15]

Capital Utilisation in Argentina

Empirically, there are a number of alternatives methods of adjusting the productive capital stock for effective utilisation: (i) the output gap as proposed by Okun (1962); (ii) the employment rate; (iii) hours worked; (iv) energy consumption; and (v) surveys on installed capacity use. All of these variables present theoretical and statistical problems summarized in Table 5.

Potential output can be econometrically estimated, implicitly assuming that there exists a potential product upon which the output gap can be estimated. This usually assumes (but not necessarily) the existence of a natural unemployment rate, the measurement of which is inevitably controversial.[16]

The following three alternatives require the assumption that both factors of production are used in constant proportion over time, in other words, that there exists complementarity in the production process between the use of capital and labour. This assumption may be questionable in a context of important changes in relative factor prices or productive restructuring, both of which could involve factor substitution and, therefore, that both factors of production are not being used in constant proportion. However, substitution between factors could be less important in the short run as a consequence of technological rigidities, sunk costs and transaction costs; thus in the aggregate, substitution

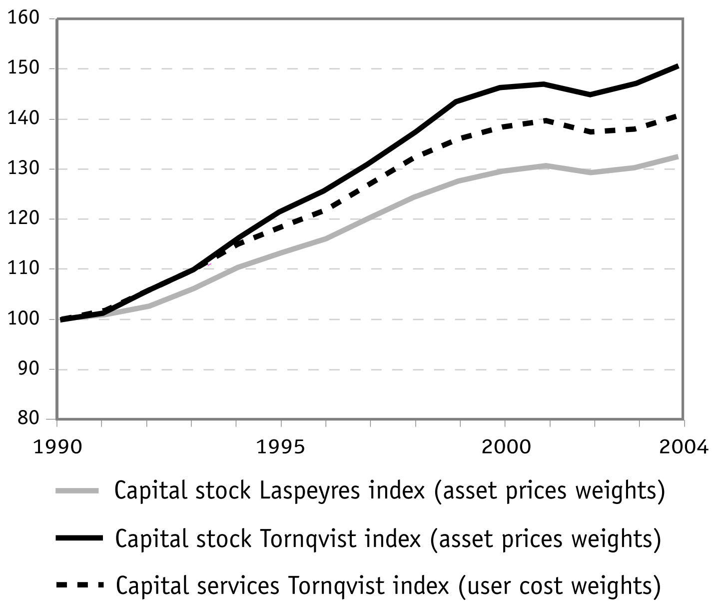
15 Similar measurement problems are studied by Schreyer (2001) for a set of OECD countries and by Mas, Perez and Uriel (2005) for Spain.

16 The output gap can also be estimated using the growth accounting approach, but the potential growth of the economy itself, i.e. the sum of factors at full utilisation plus the contribution of technical progress, is a determinant variable of the indicator that we are estimating.

Table 5
Proxy Indicators of Capital Utilisation

	Assumption	Statistical Coverage in Argentina
Output Gap	Usual interpretation of Okun: Natural Unemployment Rate	Reflects the analyst's subjectivity, econometric estimations
Employment Rate	Complementarity	By household surveys in urban areas
Hours Worked	Complementarity	
Energy Consumption	Complementarity	Energy Demand
Surveys	Representativity	Indicators usually limited to Manufacturing Industry

Chart 4
Capital Services in Argentina, 1990-2004
(1990=100)



Source: Author´s estimation based on National Accounts, INDEC.

may result from the birth and death process of firms or due to intersectoral output reallocations rather than to factor substitutions within them.

The employment rate should not be used as an indicator of the contribution of labour and capital growth to GDP growth, because the appropriate indicator when measuring the sources of economic growth is hours worked and not the number of jobs or workers.[17] Indeed, hours worked is more appropriate as it efficiently captures part-time employment, extra hours, and persons holding multiple jobs in the labour input.

Using hours worked as a proxy for capital utilisation is also problematic, because over the period analysed the Argentine economy experienced important changes of relative factor prices. This may have induced factor substitution, invalidating the assumption that labour hours and machine hours are complementary.

The use of electricity as a proxy for capital utilisation, as in Foss (1963) or Jorgenson and Grilliches (1967), has been criticised by Denison (1969) and other authors. Indeed, firms can adopt production processes that substitute energy for other factors. Moreover, the relationship between machine hours used and energy is not stable, given that the productivity of capital with respect to energy is inversely correlated with energy costs.

Econometric techniques or proxy indicators such as those just discussed should only be used in the absence of extensive surveys that capture changes in capital utilisation by industry. But the problem of statistical coverage is important in Argentina. In fact, the only available survey of capital utilisation for the period 1990-2004 corresponds to the capital utilisation index in the manufacturing industry prepared by FIEL (2002).[18]

17 Using the employment rate as a proxy of capital use introduces a distortion as changes in the condition of activity of the population. would now be reflected as changes in capital use.

18 Fundación de Investigaciones Económicas Latinoamericanas.

Table 6
Capital Services Utilisation in Argentina, Selected Periods, 1990-2004
(annual or average annual growth rates)

Indicator	1990-1994	1995	1995-1998	1998-2001	1990-2001	2002	2002-2004	1990-2004
Potential Capital Services	3.55	3.01	3.75	1.83	3.08	-1.59	1.14	2.46
Capital Services. Adj. By Manuf. Indicator	9.84	1.89	3.24	-2.02	3.97	-7.12	7.40	3.62
Utilisation Effect	6.29	-1.11	-0.52	-3.85	0.89	-5.52	6.26	1.15

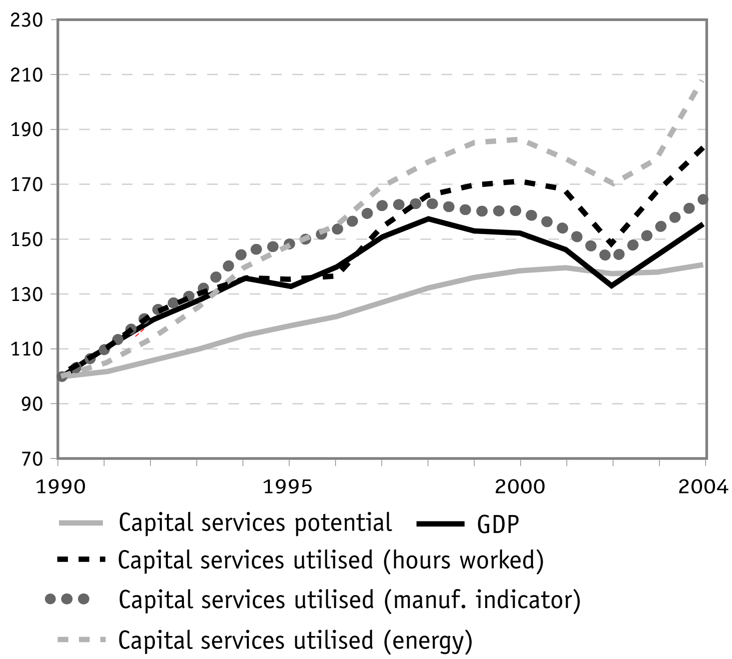
Source: Self made on the basis of data from National Accounts INDEC and FIEL.

Comparatively, the latter indicator exhibits the greatest correlation with changes in aggregate demand (Chart 5) and for that reason is used in this article. The use of the other indicators would have led to an over-adjustment of capital services and would have significantly changed its trend.

The results of the adjustment of productive capital stock by utilisation are presented in Table 6. The series on capital services effectively used presents clear procyclical behaviour. The adjustment for utilisation has a stronger effect in the changes of phase of the business cycle, and the absolute value of the adjustement peaks at the beginning of the two important cycles of the Argentine economy: the beginning of the Convertibility Plan (1990-1994) and the growth cycle that started after devaluation (2002-2004). In both cases, adjusting for capital utilisation increases capital services growth by 6.3 percentage points.

The adjustment for capital utilisation shows that if unadjusted potential capital services were used for the growth analysis, the contribution of capital input to GDP growth during positive phases of the business cycle would be underestimated and inversely in the recessive stages. Therefore, TFP would be overestimated at the beginning of the positive phase of the business cycle and underestimated in the negative phases.

Chart 5
Capital Services: Adjustment by Utilisation Indicators, 1990-2004
(1990=100)



Source: Author's estimation based on National Accounts, INDEC.

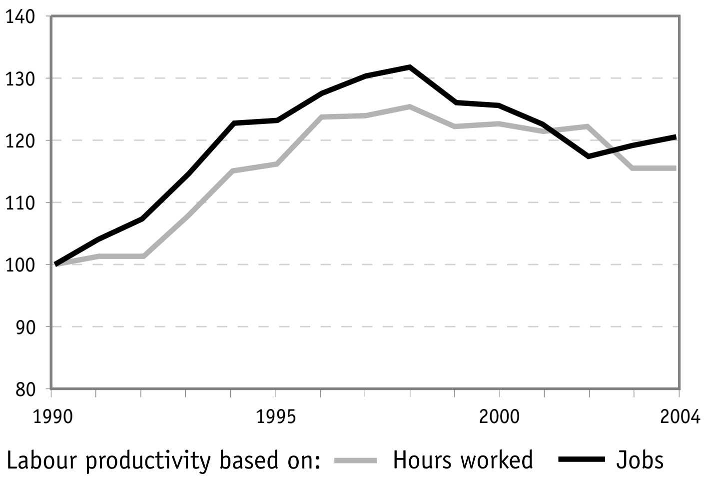
Table 7
Labour Productivity in Argentina* by Type of Labour Input Indicator, Selected Periods, 1990-2004
(annual or average annual growth rates)

Labour Input Indicator	1990-1994	1995	1995-1998	1998-2001	1990-2001	2002	2002-2004	1990-2004
Jobs	5.28	0.25	2.17	-2.31	1.86	-4.34	1.44	1.34
Hours Worked	3.56	1.02	2.58	-1.06	1.78	0.58	-2.76	1.04
Labour Intensity Effect	-1.72	0.77	0.41	1.25	-0.07	4.92	-4.20	-0.31

Source: Author´s estimation based on National Accounts-INDEC

* Labour productivity based on labour input measured in terms of jobs or undifferentiated hours worked

Chart 6
Labour Productivity in Argentina, 1990-2004
(1990=100)



Source: Author´s estimation based on National Accounts, INDEC.

Productivity in the Argentine Economy, 1990-2004
Labour Productivity

This section analyses trends in labour productivity during the period 1990-2004.[19] First, in order to assess the effect of adjusting for labour intensity (hours worked per job) we discuss the differences between trends in labour productivity measured by GDP per job (job labour productivity) and GDP per hour worked (hour labour productivity). Second, we analyse the quality and intersectoral composition effects mentioned earlier using the Tornqvist index to measure hour labour productivity.

The Adjustment by Labour Intensity

According to Chart 6, for the period 1990-2004 labour productivity exhibited a positive trend whether measured as job labour productivity or hour labour productivity. By 2004, job labour productivity had increased 20.5 per cent over the level of 1990, while hour labour productivity had increased by 15.5 per cent.

According to Table 7, between 1990 and 2004, job labour productivity grew on average at a rate somewhat higher than hour labour productivity, 1.34 per cent and 1.04 per cent respectively.

Both indicators of labour productivity exhibited procyclical behaviour. In general, in periods of economic recovery, changes in labour productivity become positive while in recessionary periods they present null or negative values. Yet, although long-term trends in labour productivity for the period 1990-2004 and the signs of annual growth are similar for both job and hour labour productivity, there were substantial differences in the magnitude of the rates of change in the short run (Chart 7).

The large differences in the short-run growth rates of both series were due to changes in labour intensity. Changes in labour

19 One of the main earlier analysis on Latin America is Elías (1992), where traditional growth accounting was applied to Argentina for the 1944-1985 period.

intensity are a result of either the greater adjustment flexibility of hours compared to jobs or to labour hoarding. According to Chart 6, the overstatement of productivity gains that is produced by the jobs indicator becomes notable particularly at the beginning of the positive phases of the cycle: the Convertibility Plan (1990-1994) and the "Post devaluation" (2002-2004).

The Adjustment by Quality and Composition of the Labour Input

Other important effects to take into account in analysing labour productivity trends are the impact of sectoral composition and quality on labour input. Using undifferentiated hour labour productivity instead of adjusted hour labour productivity produces different biases over the period 1990-2004 (Table 8). The magnitude of these biases becomes relevant only for the period 2001-2004, mainly as a consequence of the impact of changes in relative prices and wages on the sectoral composition of GDP and labour input. For this period, the Tornqvist indicator of labour productivity suggests faster growth than the traditional indicator, indicating a potential understatement of labour productivity during this period.

Capital Intensity

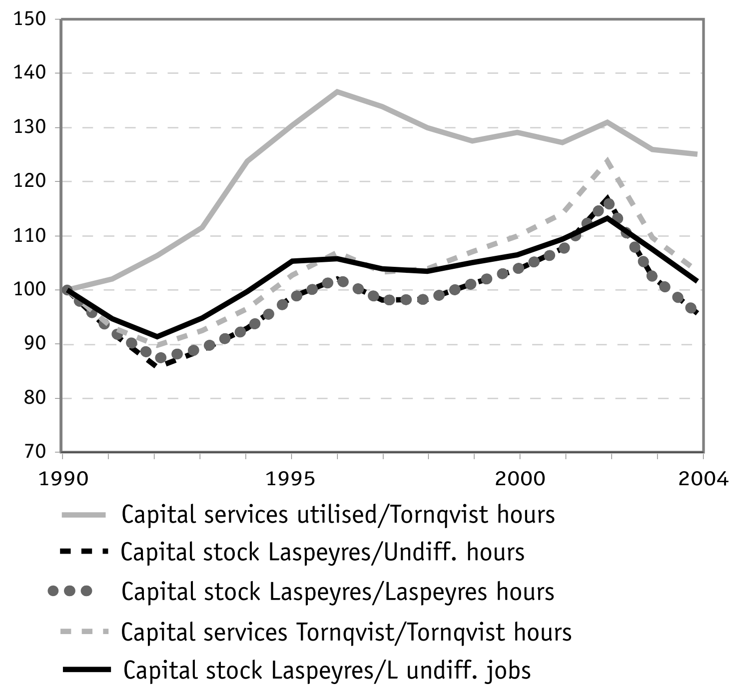
One of the main sources of labour productivity growth is capital intensity growth (equation 1). All else equal, when capital intensity grows faster, it explains a larger share of economic growth, and the importance of TFP as an explanation of economic growth falls. Chart 8 presents capital intensity in Argentina between 1990 and 2004 using five different methodologies.

A visual analysis suggests that the five capital intensity indicators can be separated into two groups. The four series using potential capital

Chart 7
Labour Productivity Growth in Argentina, 1990-2004
(annual growth rate, per cent)

Source: Author´s estimation based on National Accounts, INDEC.

Chart 8
Capital Intensity in Argentina by Index and Indicator, 1990-2004
(1990=100)



Source: Author´s estimation based on National Accounts, INDEC.

Table 8
Labour Productivity in Argentina by Methodology, Selected Periods, 1990-2004
(annual or average annual growth rates)

Method	1990-1994	1995	1995-1998	1998-2001	1990-2001	2002	2002-2004	1990-2004
QLaspeyres/L Undiff.	3.56	1.02	2.58	-1.06	1.78	0.58	-2.76	1.04
QLaspeyres/L Laspeyres	3.51	0.96	2.61	-1.15	1.74	0.48	-2.57	1.03
Q Tornqvist/LTornqvist	3.62	1.08	2.51	-1.13	1.77	1.07	-1.52	1.25
Total Effect	0.06	0.06	-0.06	-0.07	-0.01	0.49	1.24	0.21

Source: Author´s estimation based on National Accounts-INDEC.
L: Labour input based on the hours worked indicator.

Table 9
Capital Intensity in Argentina by Methodology, Selected Periods, 1990-2004
(annual or average annual growth rates)

Method	1990-1994	1995	1995-1998	1998-2001	1990-2001	2002	2002-2004	1990-2004
K^W Laspeyres/L Undiff. Jobs	-0.08	5.58	-0.56	1.84	0.81	3.66	-5.31	0.11
K^W Laspeyres/Undiff. Hours	-1.84	6.35	-0.17	3.09	0.67	8.58	-9.51	-0.31
K^W Laspeyres/Laspeyres hours	-1.86	6.29	-0.13	3.00	0.64	8.48	-9.32	-0.31
K^{Serv} Tornqvist/ Tornqvist Hours	-0.89	6.44	0.39	3.16	1.20	8.44	-8.56	0.24
K^{Serv} utilised/ Tornqvist Hours	5.48	5.33	-0.12	-0.69	2.21	2.92	-2.27	1.61
Total Effect	5.55	-0.25	0.44	-2.53	1.40	-0.75	3.04	1.50

Source: Author´s estimation based on National Accounts-INDEC.
K^W: net capital stock or wealth. K^{Serv}: potential capital services except for the last row corresponding to the adjustment by installed capacity utilisation.

services declined between 1990 and 1993, increased until 2002, and then declined again. In contrast, capital intensity with effective factor utilisation grew between 1990 and 1996, and then slowly declined until 2004, down to the level achieved in 1994.

The main difference between the two groups is the adjustment for factor utilisation. As seen earlier, failure to adjust an input series for utilisation leads to growth being underestimated at the beginning of the positive phases of the cycle and overestimated in the negative phases. These biases are reflected most clearly in capital intensity, because the adjustment to capital is on average larger than the adjustment to labour.

According to Table 9, during the 1990s the adjustment of both capital and labour for changes in relative prices and quality of labour, leads to a significant increase in the average growth rate of capital intensity: from an annual average of 0.81 per cent to 1.20 per cent. The adjustment for capital utilisation increases the procyclicality of the series, especially at the beginning of the 1990s, and translates into an increase in capital intensity growth to an average of 2.21 per cent annually between 1990 and 2001.

From 1990 to 2004, the trend in the capital intensity using utilised factor services can be explained by faster growth in capital services (3.62 per cent per year) than hours worked (1.92 per cent per year) (Chart 9 and Table 10).

However, factors that explain the trends in capital intensity differ significantly over the business cycle. According to Table 10, growth in

Table 10

Components of the Capital Intensity Growth*, Selected Periods, 1990-2004

Factor	1990-1994	1995	1995-1998	1998-2001	1990-2001	2002	2002-2004	1990-2004
K	9.84	1.89	3.24	-2.02	3.97	-7.12	7.40	3.62
L	4.26	-3.43	3.26	-1.33	1.72	-10.03	9.64	1.92
K/L	5.48	5.33	-0.12	-0.69	2.21	2.92	-2.27	1.61

Source: Author´s estimation based on National Accounts-INDEC.

* Measured in terms of Tornqvist indexes for the capital services effectively utilised and labour input in hours worked.

capital intensity during the 1990s was due mainly to faster growth in capital than labour. On the other hand, the capital-labour ratio appears to have decreased during the positive phase following the 2001-2002 crisis, with labour input growing slightly faster than utilised capital services.

Total Factor Productivity (TFP)

This section presents TFP estimates using the methodology outlined in Section two, which correctly measures the contributions of factor inputs to economic growth. This methodology allows us to interpret TFP as a shift in the production function as it accounts for several effects that cannot be attributed to the performance of strict TFP, such as: (i) the composition or substitution effect in output; (ii) the sectoral composition effect in labour input; (iii) the quality effect in labour input; (iv) the quality effect in capital input; (v) the composition effect by types in capital input; and (vi) changes in the functional distribution of income. These effects are derived from productive efficiency gains as a result of normal adjustments of the productive and factorial allocation to changes in relative prices.[20] Moreover, our measures of factor inputs account for their effective utilisation:

- Labour input is measured as hours worked
- Capital input is measured as capital services effectively utilised in production

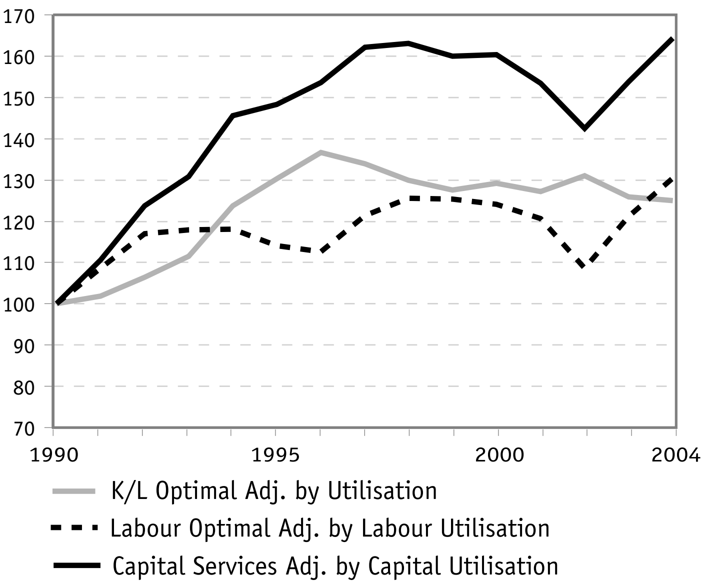
In this way, the impact of fluctuations in factor costs and demand as a result of the business cycle are incorporated in the input contributions rather than attributed to TFP.

The traditional methodology generally used in Latin America, especially in Argentina, is the TFP1 (Table 11), which measures the apparent

Chart 9

Capital Intensity and Factor Input in Argentina by Components, 1990-2004

(1990=100)



Source: Author's estimates based on National Accounts, INDEC.

20 It is worth noting that the measurement of TFP must also use a Tornqvist index if its measurement is to remain consistent with that of its components. This allows adjusting the contribution itself of the inputs to growth by changes in the functional distribution of income due to changes in inputs' quantities and relative prices.

Table 11
Optimal Measurement Methodology for TFP in Argentina

Index Type	GDP	Capital	Labour	Income Shares
TFP1 (traditional Latinamerican research)	Laspeyres	Laspeyres/ wealth capital	Laspeyres/ undifferentiated workers	fixed in the base year
TFP2	Laspeyres	Laspeyres/ wealth capital	Laspeyres/ undifferentiated hours worked	fixed in the base year
TFP3	Laspeyres	Laspeyres/ wealth capital	Laspeyres/ undifferentiated hours worked	Tornqvist
TFP4	Laspeyres	Laspeyres/ wealth capital	Laspeyres/ differentiated hours worked	Tornqvist
TFP5	Tornqvist	Tornqvist/ productive capital services (potential)	Tornqvist/ differentiated hours worked	Tornqvist
TFP6 (Optimal method.)	Tornqvist	Tornqvist/ utilised productive capital services	Tornqvist/ differentiated	Tornqvist

TFP in a very basic way: all physical volume indexes of GDP and inputs by Laspeyres index, capital input measured by net capital or wealth and labour input by worker. The following analysis compares the optimal measurement methodology of strict TFP with different methodological alternatives, including the traditional indicator which is most commonly used in Argentina.

Intermediate methodologies incorporate some of the adjustments mentioned in the economic literature, while the best-practice methodology of strict TFP (TFP6) includes all of them: all physical volume indexes of GDP and inputs by Tornqvist indexes, capital input measured by productive capital services adjusted by the effective utilisation in output and the labour input by hours worked differentiated by industry. Chart 10 presents estimates of TFP produced using the alternative methodologies. Clearly, the results of using strict TFP in Argentina during the period 1990-2004 suggest much less growth than other methodologies.[21]

Table 12 presents average annual growth rates of TFP by sub-period using the six different methodologies. All methods that do not adjust input contribution for effective factor utilisation (all but TFP6) exhibit clear procyclical behaviour that is notably reduced when this adjustment is included. The adjustment is particularly important in the periods of change of phase of the economic cycle, 1990-1994 and 2002-2004.

The adjustment of the labour input using hours worked instead of jobs (TFP1 versus TFP2) reduces average annual TFP growth by one percentage point in the first cycle (beginning of the Convertibility Plan) and by 2.5 percentage points in the post-devaluation cycle. The adjustment for the utilisation of capital services reduces TFP growth further,

21 Examples of TFP estimations for Argentina with the traditional measurement may be found in Kydland and Zarazaga (2002), SPEyR-MECON (1999) and DNCPM-MECON (2001). Generally in these studies an important contribution of TFP to economic growth, similar to the traditional calculation replicated herein for the 1990s, is detected. As explained in this study, the differences are the consequence of not only the type of index number used, but also of the adjustment of primary inputs for utilisation, as well as of the use of self estimations of wealth capital instead of productive capital (different from the figures of INDEC used here), and of the use of labor input in terms of workers instead of hours worked, generally using non exhaustive labour series corresponding to the Greater Buenos Aires and not all the country.

Table 12

Total Factor Productivity in Argentina by Methodology, Selected Periods, 1990-2004

(annual or average annual growth rates)

Method	1990-1994	1995	1995-1998	1998-2001	1990-2001	2002	2002-2004	1990-2004
TFP1	5.3	-2.1	2.4	-3.1	1.5	-5.9	3.7	1.2
TFP2	4.3	-1.7	2.7	-2.4	1.5	-3.0	1.3	1.1
TFP3	4.6	-2.0	2.7	-2.5	1.5	-4.2	2.5	1.2
TFP4	4.6	-2.0	2.7	-2.6	1.5	-4.3	2.5	1.2
TFP5	4.2	-2.0	2.3	-2.6	1.2	-3.7	3.2	1.1
TFP6	1.1	-1.5	2.6	-0.8	0.7	-0.6	-0.3	0.5

Source: Author´s estimation based on National Accounts-INDEC.

by an average of 3.1 percentage points in the first phase and 3.5 percentage points in the second phase.

Composition and quality effects become particularly important in the 2001-2004 period. Adjusting for composition and quality (TFP2 versus TFP5) decreases TFP growth 0.7 percentage points during the 2002 crisis and increases it almost two percentage points in the 2002-2004 cycle as a result of the effect of devaluation on relative input and output prices.

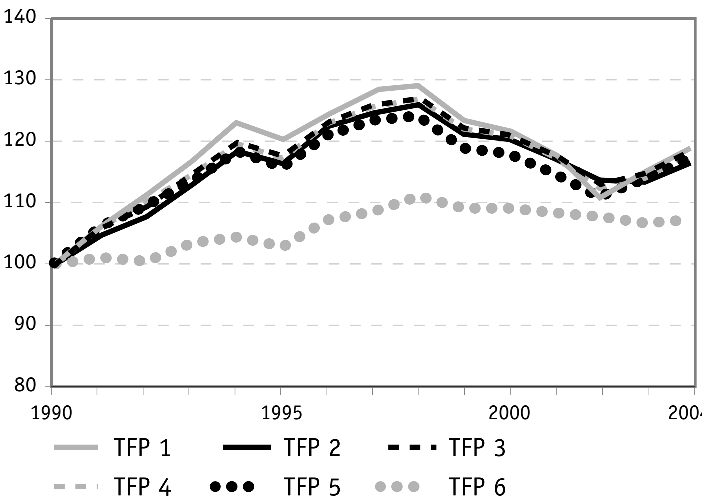
As noted earlier, the most important adjustment is for capital utilisation. Interestingly, if other indicators of capital utilisation had been used, strict TFP, that is TFP6, would grow even more slowly for the whole period 1990-2004, including for the 1990s.[22]

Strict TFP increased in the 1990s, stabilized, and then fell slowly during the economic depression that began in 1998. In the initial phase of the Convertibility Plan (after the economic depression and hyperinflation of the previous decade), strict TFP grew on average one per cent per year between 1990 and 1994, substantially more slowly than apparent TFP of 5.3 per cent. The less procyclical behaviour of strict TFP is also evident during the years of economic depression (except for 1995). Both during the period 1998-2001, as well as during the 2002 crisis, the fall of strict TFP was smaller than TFP estimated using other methodologies.

Chart 10

Total Factor Productivity in Argentina, 1990-2004

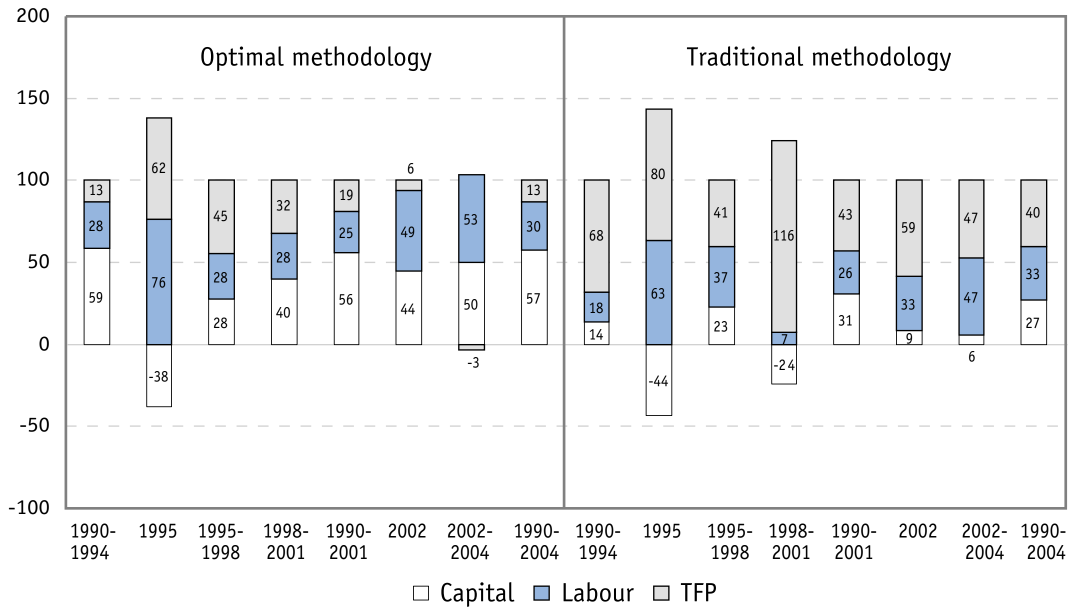
(1990=100)



Source: Author´s estimation based on National Accounts, INDEC.

22 In case of using the adjustment for utilised capital services by the hours worked proxy variable, TFP would have a null trend; and a negative trend in the case of energy. Even for the period 1995-1998 in which the strict TFP series with FIEL's indicator is similar to the apparent TFP growing an annual 2.6 per cent average; in the case of energy and hours worked, strict TFP is reduced to a 0.5 per cent and 0.8 per cent average annual growth respectively.

Chart 11
Sources of Economic Growth in Argentina, Selected Periods, 1990-2004
(contribution to average annual GDP growth, per cent)



Source: Author´s estimation based on National Accounts, INDEC.

Strict TFP grew again only in 2004, by 0.5 per cent,[23] although apparent TFP (with Tornqvist index) grew in 2003 (3.16 per cent) and 2004 (3.15 per cent).[24] The slower growth in strict TFP during the post-devaluation period is a result of the significant growth of labour demand provoked by the effects of devaluation on labour costs. This was more important in terms of hours than jobs. Nonetheless, the level of both strict and apparent TFP in 2004 was below that of 1998.

To sum up, between 1990 and 2004, strict TFP in Argentina was less procyclical and grew more slowly than apparent TFP, mainly as a consequence of including cyclical variations in the use of primary inputs.

The Growth Profile in Argentina 1990-2004

The results presented so far allow us to estimate the contributions of labour, capital, and TFP to economic growth, and help us to understand the type of growth experienced in Argentina between 1990 and 2004. Chart 11 presents the contributions to growth of labour, capital and TFP and compares the growth profiles generated by the optimal methodology and the traditional methodology. Using the optimal methodology, the Argentine economy has an extensive profile based on factor accumulation and utilisation rather than on a positive shift in the production function. Strict TFP (optimal methodology) accounts for only 13 per cent of economic growth over the period 1990-2004,

23 If the demand for energy or hours worked would have been used as proxy variables for capacity utilisation, strict TFP in 2004 would have been -0.35 per cent and nil respectively.

24 Preliminary data for 2005-2006 obtained after this paper was written, would confirm the recovery of the strict TFP growth cycle but at a slow performance.

while apparent TFP (traditional methodology) accounts for 40 per cent.

The 1990s present an extensive economic growth profile based on capital accumulation and utilisation, with capital contributing 56 per cent, labour 25 per cent and strict TFP explaining the remaining 19 per cent. In contrast, over the same period, apparent TFP contributed 43 per cent.

The period after devaluation, 2002-2004, also presents an extensive growth profile but more focused on labour demand. Labour contributed 53 per cent, capital 50 per cent and strict TFP contributed negatively (-3 per cent). During this period, apparent TFP represented an important positive contribution, 47 per cent, labour another 47 per cent and capital only 6 per cent.

If we had used the traditional methodology, the growth profile would have been wrongly diagnosed as intensive, that is, based mainly on the TFP contribution, both in the Convertibility cycle and after devaluation. As seen before, this diagnosis follows mainly from the fact that the traditional methodology fails to adjust for effective utilisation of labour and capital. In other words, it does not take into account either hours worked or changes in capital utilisation. But in fact, the positive shock to GDP growth at the beginning of the positive phase of the business cycle was the result of the procyclical contribution of the increments in labour intensity and capital utilisation and not from growth in strict TFP.

In terms of labour productivity, the extensive growth profile is also confirmed. During the whole period 1990-2004, the growth of labour productivity, according to the optimal methodology, was generated by growth in capital intensity (65 per cent). Instead, in the case of the traditional methodology, apparent TFP explained almost all of the growth in output per hour worked during the 1990-2004 period, with similar conclusions for both the 1990s and after the 2002 devaluation.

It can be concluded from this analysis that the growth profile presented by the Argentine economy from 1990 onwards is of the extensive type, based on factor accumulation and utilisation: capital during the 1990s and capital utilisation and labour for the period after the 2002 devaluation. This finding is consistent with the important growth of apparent TFP in the 1990s, which reflected a phenomenon of average cost reduction associated with cyclical factors and normal adjustments to changes in relative prices rather than genuine technological progress.

Conclusion

The purpose of this study was to investigate the sources of economic growth in Argentina during the period 1990-2004, and to identify the prevalent growth profile: extensive, associated with trends in productive factors, or intensive, linked to productivity gains.

Taking into account the important changes in relative prices and the amplitude and volatility of the business cycle of the Argentine economy, the study proposed a methodology for disentangling from residual TFP the effects of changes in relative prices and of cyclical utilisation of productive factors. In this way, the study sought to identify strict TFP, i.e. TFP which more closely represents a long-run shift in the production function linked to technology, independent of short-run phenomena. It was distinguished from apparent TFP, which expresses a cost reduction phenomenon but is not necessarily linked to long-term changes in the growth path of the economy.

The main results of the application of this methodology were the following.

- The usual fixed-base indexes used for measuring GDP growth at constant prices underestimate economic growth and productivity gains.

- The quality and composition effects on GDP (substitution in output) and on inputs had a moderate magnitude during the whole period 1990-2004, being especially important in the period after the 2002 devaluation. Not taking them into account would produce a slight underestimation of TFP in the strict sense.
- The traditional use of a Laspeyres index net capital stock would underestimate the contribution of capital services to economic growth in Argentina, thus producing an overestimate of TFP growth over the period as a whole.
- The correction for labour input utilisation due to changes in labour intensity plays a fundamental role in the measurement of the contribution of labour input to growth since the hours worked series is strongly procyclical. Were these effects not corrected for, TFP and labour productivity would be overestimated in expansionary periods of the business cycle and underestimated in contractionary periods.
- Similarly, the lack of adjustment for capital utilisation would generate an underestimate of the contribution of capital to growth during expansions and an overestimate in contractions. Therefore, strict TFP would be overestimated at the beginning of positive phases and underestimated in negative phases of the business cycle.
- During the period 1990-2004, strict TFP grew substantially more slowly and was less procyclical than apparent TFP, mainly as a result of adjustments in the cyclical variations in factor utilisation. Similar conclusions are derived for labour productivity adjusted by labour intensity. Moreover, the adjustment by cyclical factor utilisation reduces significantly residual TFP gains, both during the 1990s as well as after the 2002 devaluation.
- Both in terms of labour productivity and total factor productivity, the growth profile of the Argentine economy was extensive during the whole 1990-2004 period, biased towards the utilisation and incorporation of capital during the 1990s and biased towards the labour factor in the post-devaluation period.

The importance of short-run competitive gains of the Argentine economy revealed through improvements in apparent cyclical TFP, generated both during the 1990s and after the 2002 devaluation, is unquestionable. However, doubts arise about the ability of the Argentine economy to generate productivity gains in the long-run independent of composition and quality effects and cyclical variations in factor utilisation, gains necessary to maintain sustainable long-run growth.

In 2004, both TFP and labour productivity were below 1998 levels. While this article focuses primarily on measurement issues, we could affirm that the poor performance in terms of TFP growth in Argentina was due to the inconsistent macro policies and the instability of the business cycle. The extensive growth profile exhibited by the Argentine economy, especially during the 1990s, contrasts with assessments of other authors and institutions based on the traditional methodology which does not adjust for relative price effects and factor utilisation. On the contrary, our results are analogous to the evidence found by Young (1995), Krugman (1994) and Timmer and Van Ark (2000) for newly industrialised countries.

This conclusion is based not only on what Young (1995) called the "tyranny of numbers", by assessing strictly the consistency of the country statistical information, but also a consequence of the "tyranny of the economic cycle, macroeconomic and methodological consistency."

References

Basu, Susanto, Fernald, John G. and Shapiro, Matthew D. (2001) "Productivity Growth in the 1990's: Technology, Utilization, or Adjustment?," NBER Working paper No. 8359, July (Cambridge, Mass: National Bureau of Economic Research).

Canavese, Alfredo J. and Pablo Gerchunoff (1996) "Reformas Estructurales, Productividad y Tipo de Cambio," *Desarrollo Económico Número Especial*, Volume 36, Summer.

Coremberg, Ariel (2002) "Capital Stock Contribution to the Productivity of the Argentine Economy During the 1990s," paper presented at the 27th General Conference of the International Association for Research in Income and Wealth, http://www.h.scb.se/scb/Projekt/iariw/program/8Acapital_stock.pdf.

Coremberg, Ariel (2004a) "TFP growth in Argentina, A Stylized Fact?," paper presented at the 28th General Conference of the International Association for Research in Income and Wealth, http://www.iariw.org/papers/2004/coremberg.pdf.

Coremberg, Ariel (2004b) "Estimación del Stock de Capital en Argentina, Series a Precios Corrientes y Constantes 1990-2003," Fuentes, Métodos y Resultados, Dirección de Cuentas Nacionales-INDEC, www.mecon.gov.ar/secpro/dir_cn/stock_capital.htm, www.indec.gov.ar (Capital Stock series of Argentina-National Accounts) English Version presented at OECD Canberra Group II: On Measurement on Non Financial Assets.

DNCN-INDEC (2006) "Generación del Ingreso e Insumo de Mano de Obra," Dirección de Cuentas Nacionales, INDEC, http://www.mecon.gov.ar/secpro/dir_cn/ingreso.htm.

DNCPM-MECON (2001) "El Stock de Capital y La Productividad Total de los Factores en la Argentina," Dirección Nacional de Coordinación de Políticas Macroeconómicas, Secretaría de Política Económica y Regional, Ministerio de Economía.

Denison, Edward F. (1969) "Some Major Issues in Productivity Analysis: An Examination of Estimates by Jorgenson and Griliches," *Survey of Current Business*, Volume 49, No. 5, pp. 1-27

Diewert, Erwin W. (1976) "Exact and Superlative Index Numbers," *Journal of Econometrics*, Volume 4, pp. 115-145.

Diewert, Erwin W. (1978) "Superlative Index Numbers and Consistency in Aggregation," *Econométrica*, Volume 46, pp. 883-900.

Diewert, Erwin W. (1995) "Price and Volume Measures in the System of National Accounts," NBER Working paper No. 5103, May (Cambridge, Mass: National Bureau of Economic Research).

Elías, Victor (1992) *Sources of Growth: A Study of Seven Latin American Economies*, International Center For Economic Growth, (San Francisco, California: ICS Press)

FIEL (2002) "Productividad, Competitividad Y Empresas, Los engranajes del crecimiento," Fundación de Investigaciones Económicas Latinoamericanas (FIEL).

Foss, Murray (1963) "The Utilisation of Capital Equipment: Post-war Compared with Pre-war," *Survey of Current Business*, Volume 43, No. 6, pp. 8-16.

Galiani, Sebastian, Daniel Heymann and Mariano Tommasi (2003) "Expectativas Frustradas: el ciclo de la convertibilidad," *Desarrollo Económico*, Volume 43, No. 169.

Hulten, Charles (1986) "Productivity Change, Capacity Utilization and The Sources of Efficiency Growth," *Journal of Econometrics*, Volume 33, No. 1-2, pp. 31-50.

Hulten, Charles and Frank Wyckoff (1981) "The Estimation of Economic Depreciation using Vintage Asset Prices," *Journal of Econometrics*, Volume 15, No. 3, pp. 367-396.

Hofman, André A. (1991) "The Role of Capital in Latin America: A Comparative Perspective of Six Countries for 1950-1989," Working Paper No. 4, ECLAC, UN, December.

Hofman, André A. (2000) "Standardised capital stock estimates in Latin America: a 1950-94 update," *Cambridge Journal of Economics*, Vol. 24. No.1, January.

ISWGNA (1993) "System of National Accounts," The Inter-Secretariat Working Group.

Jorgenson, Dale (1995) *Productivity Volume 2: International Comparisons of Economic Growth* (Cambridge: MIT Press).

Jorgenson, Dale W. and Zvi Grilliches (1967) "The Explanation of Productivity Change," *Review of Economic Studies*, Volume 34, No. 99, July.

Jorgenson, Dale W., Frank M.Gollop and Barbara M.Fraumeni (1987) *Productivity and US Economic Growth*, (Cambridge, Mass:: Harvard University Press).

Krugman, Paul (1994) "The Myth of Asia's Miracle," *Foreign Affairs*, November-December.

Kydland, Finn and Carlos Zarazaga (2002) "Argentina's recovery and excess capital shallowing of the 1990's," Mimeo, Carnegie Mellon

Mas, Matilde, Francisco Pérez and Ezequiel Uriel (2005) "El Stock y Los Servicios Del Capital en España (1964-2002) Nueva Metodología," Fundación BBVA.

OECD (2001a) *Measuring Productivity: OECD Manual on Measurement of Aggregate and Industry-Level Productivity Growth*, OECD Publications, France.

OECD (2001b) *Measuring Capital: OECD Manual on Measurement of Capital Stocks, Consumption of Fixed Capital and Capital Services*, OECD Publications, France.

Okun, Arthur M. (1962) "Potential GNP: Its Measurement and Significance," *Proceedings in the Business and Economic Statistics Section*, American Statistical Association, pp.98-104.

Solow (1957) "Technological Change and the Aggregate Production Function," *Review of Economics and Statistics*, Volume 39, pp. 312-320.

Schreyer, Paul (2001) "Measurement of capital services: preliminary results for eight OECD countries," presented at Medición del Stock de Capital Workshop, Nuevas Aportaciones, November, Valencia, IVIE.

SPEyR-MECON (1999) "Crecimiento potencial y productividad en Argentina," Secretaría de Política Económica y Regional, Ministerio de Economía, Argentina.

Timmer, Marcel P. and Bart van Ark (2000) "Capital Formation and Productivity Growth in South Korea and Taiwan," paper prepared for the 26th General Conference of the International Association for Research in Income and Wealth (IARIW), Krakow, Poland.

Young, Alwyn (1995) "The Tyranny of Numbers: Confronting the Statistical Realities of the East Asian Growth Experience," *Quarterly Journal of Economics*, Volume 110, No. 3, August, pp. 641-680.

Improving US National Accounts Integration and Consistency: A Review Article on *A New Architecture for the U.S. National Accounts*

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J. JOSEPH BEAULIEU AND ERIC J. Bartelsman introduce Chapter 8 of this book by a French proverb: "A man with one watch knows what time it is; a man with two watches is never quite sure." The pending question is about that man without a watch; is he entitled to tell what time it is? With this addition, the proverb covers various problems faced by National Accounting which are the subject of this book.

In general, data users should aim to have a better understanding of the national accounts. This volume, entitled *A New Architecture for the US National Accounts* and edited by Dale W. Jorgenson of Harvard University, J. Steven Landelfeld of the US Bureau of Economic Analysis and William D. Nordhaus of Yale University,[2] contributes to this better understanding by providing an excellent overview of the many facets of this rapidly evolving subject. As the title indicates, it focuses on new developments in the U.S. National Accounts. Yet, the contributors also provide an overview of the system of accounts currently used in the United States, drawing parallels with the 1993 System of National Accounts (SNA93) in use elsewhere, especially in European countries. The United States. has taken the lead in terms of the development of the national accounts, and the work done by American institutions and agencies is of paramount interest. As such, we cannot do anything but strongly recommend that all macroeconomists closely examine the various chapters of this volume.

All systems of national accounts aim at providing users with comprehensive and consistent information about economic developments. This being said, a given system of accounts is composed of different parts which have been gradually developed for specific purposes, and may not be fully integrated with each other. One characteristic of the U.S. statistical system is that it is largely decentralised, involving *inter alia* the Bureau of Economic Analysis (BEA), the Bureau of Labor Statistics (BLS), the Bureau of Census, the Board of Governors of the Federal Reserve System, among others. Hence, despite the progress already achieved by these institutions, certain gaps and inconsistencies still

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remain between.the various programs. To promote further progress, a conference was held at the Board of Governors of the Federal Reserve System in Washington D.C. in April 2004, with the view of initiating the development of a comprehensive and fully integrated system of U.S. national accounts. This volume contains the proceedings of the conference. Participants had the opportunity to present a broad overview of the state of the art in their field, together with a review of the work already completed as well as the efforts required to achieve a higher degree of integration and consistency.

The review article first presents a brief overview of each chapter, focusing on the main contributions of the respective authors. This does not fully do justice to their work since these chapters include much more than can be considered here, but it will provide a useful summary of the main topics addressed idea of the various sections of the book. We then single out and discuss some of the most important implications of these new developments from the point of view of data users.

Overview of the book

The book includes twelve chapters which cover several dimensions of the proposed new architecture for the U.S. National Accounts. In Chapter 1, Dale W. Jorgenson and J. Steven Landefeld (*Blueprint for Expanded and Integrated U.S. Accounts: Review, Assessment and Next Steps*) propose an original way to derive a system of national accounts for the United States that fully integrates the BEA National Income and Product Accounts (NIPAs), the BLS productivity accounts, and the balance sheets provided by the Federal Reserve Board. Their proposal for a symmetric treatment of investment goods production and capital income relies heavily on the systematic utilisation of imputed rental prices for capital assets. They propose that these imputed revenues be included in GDP, which translates into a 10 per cent increase in GDP in 2002 compared to the NIPAs estimate. In addition, the proposed Domestic Income and Product Account should allow for the ready identification of the sources of growth by providing both constant and current price series. Similarly, the Income and Expenditures Account should also present current and constant prices estimates. Finally, they suggest a Domestic Capital Account which would link the other two sets of accounts to the accumulation of wealth presented in the Wealth Account.

In Chapter 2, Karen Wilson (*The Architecture of the System of National Accounts: A Three-Way International Comparison of Canada, Australia and the United Kingdom*) first provides an overview of the System of National Accounts 1993 (SNA93). She then compares the systems of accounts of Canada, Australia and the United-Kingdom, which are all based on SNA93. In contrast to the United States,, these countries have highly centralised statistical systems and their accounts are highly integrated. They all include financial accounts, balance sheets and balance-of-payments statistics. Yet, some differences remain in the application of the SNA93 across countries and the sequence in which the accounts are presented differs significantly. One interesting point is that all three countries record statistical discrepancies between net lending/borrowing and financial requirements. Rather than a lack of integration between the various data sources, this information is viewed as a way to measure their quality.

The next two chapters make the case for an augmented sequence of accounts, namely for a system that would be extended to include economic non-market activities. This includes natural resources, the environment, unpaid work and investment in education and health. In Chapter 3, William D. Nordhaus (*Principles of National Accounting for Nonmarket Accounts*) recommends a structure of accounts for non-market activities that would parallel those of market based activities, using the principles developed for environmental accounts as a reference. This would allow for the full integration of the augmented system of accounts. The author suggests that the activities covered could be restricted to near-market activities, that is those involving goods and services that can also be subject to market activities. A more ambitious programme would involve goods and services for which no market transaction exists. In the latter case, the evaluations would primarily focus on valuing the time used for these activities. In the United States, the American Time Use Survey (ATUS) initiated by the BLS would be the main source of information.

Katharine G. Abraham and Christopher Mackie in Chapter 4 (*A Framework for Nonmarket Accounting*) identify volunteer and home production, education, health, and environmental improvement and degradation as potential non-market activities that could be included in the SNAs. Accounting in this respect should adopt double-entry bookkeeping in a satellite system of accounts. This approach would help clarify a number of issues regarding the measurement of "production", "inputs" and even some business cycles considerations. But, as mentioned in the previous chapter, the most challenging issue would remain the measurement and valuation of the time used for non-market activities.

Charles R. Hulten introduces Chapter 5 (*The "Architecture" of Capital Accounting": Basic Design Principles*) by noting that a number of important problems in national accounting (including the treatment of non-market activity) are severe, but conceptually well understood. In these cases, the main difficulties relates to their implementation. Conversely, issues related to the Capital Accounts are more conceptual: we do not exactly know how to treat them. The use of a circular flow model (CFM) favours the reference to the functional activity (namely production and consumption) over the institutional sectors. This way, capital is more a stock of productive assets for producers (where it is used) and, at the same time, a store of wealth for consumers (where it is owned). In terms of flows, savings increases wealth for consumers, and mirrors investment which increases the capital stock used by producers. In such a framework, investments are expenditures which will increase future consumption – rather than current consumption – which conceptually requires us to consider R&D, as well as other intangible forms of investment, as part of capital. In the same vein, it also requires a full integration of the user cost of capital into the production account.

The three subsequent chapters deal with the integration of the industry accounts and the NIPAs. In Chapter 6, Ann M. Lawson, Brian C. Moyer, Sumiye Okubo and Mark A. Planting (*Integrating Industry and National Economic Accounts: First Steps and Future Improvements*) review the challenge, tackled by the BEA, that is the integration of GDP-by-industry, annual input-output and benchmark input-output programs with the industry accounts. They then review the integration of the industry accounts with the NIPAs . The key issue faced by the BEA is not a lack of data, but rather the unevenness in the quality and coverage of the various data sources. To deal with this issue, the BEA has developed a method to properly weight the various sources of information relevant for estimating the annual I-O and GDP-by-industry accounts.

In Chapter 7, Brian C. Moyer, Marshall B. Reindorf and Robert E. Yuskavage (*Aggregation Issues in Integrating and Accelerating the BEA's Accounts: Improved Methods for Calculating GDP by Industry)* review another aspect of the integration of the GDP-by-industry accounts and the NIPAs. The authors try to identify the reasons behind differences in the measures of real GDP growth between the two sources, and conclude that the two main contributors are differences in data sources and differences in methodologies. In comparison, differences in the statistical treatment of discrepancies, in the aggregation methods or in the formulas used for computing contributions play a more muted role. The authors show that, provided that the sources of data are the same, using the Fisher Ideal aggregation procedure used by the BEA to measure real GDP would lead to a full reconciliation. Likewise, the use of the NIPA "exact contribution" formula could also be applied at the industry level. This result underlines the need for improving the data quality at the industry level in order to obtain a better match between the two approaches.

In Chapter 8, J. Joseph Beaulieu and Eric J. Bartelsman (*Integrating Expenditure and Income Data: What to Do with the Statistical Discrepancy?*) deal with another discrepancy in the measures of GDP: the difference between the supply and use of goods and services (*GDP*) and the sum of factor and nonfactor payments paid to input provider (Gross Domestic Income, GDI). Conceptually, these two measures should correspond, but in practice they differ. The authors employ industry estimates of final demand and value added to identify the possible sources for the discrepancy. In doing so, they show that data from some specific industries (namely machinery and instruments, trade, and finance and insurance) may be the cause since, for those industries, data from the income side give markedly different estimates of the production of goods and services than those obtained from the expenditure side. The authors explore the possibility of combining data from the expenditure and the income accounts in order to produce a consistent and integrated set of estimates.

In Chapter 9, Barbara M. Fraumeni, Michael J. Harper, Susan G. Powers and Robert E. Yuskavage (*An Integrated BEA/BLS Production Account: A First Step and Theoretical Considerations*) note that differences in the measures of output produced by the BEA and the BLS stem in part from the different objectives of these respective measures. Each has its own strengths and the authors seek to combine the best features of each data set in order to obtain a consistent and integrated measure. They construct a production account using guidelines not perfectly in line with those found in the SNA93. Indeed, the SNA93 makes no reference to any capital services measure, which is a key concept for productivity measures, and in particular for constructing multifactor productivity (MFP). In their framework, which is based on data by industry, the authors show that the BEA and BLS measures can be better integrated. They also suggest that the conversion of the NIPAs and the productivity statistics to the North American Industry Classification System (NAICS) would facilitate better integration in the future.

In Chapter 10 John R. Baldwin and Tarek H. Harchaoui (*The Integration of the Canadian Productivity Accounts within the System of National Accounts: Current Status and Challenges Ahead*) show how the Canadian Productivity Accounts (CPA) are integrated into the Canadian System of National Accounts (CSNA) so as to provide a consistent set of productivity estimates. At the expense of some minor differences, productivity measures follow the recommendations of the OECD "productivity manual", which itself refers to outputs and inputs data consistent with the SNA93. As a consequence, in Canada labour productivity and multifactor productivity measures are consistent with the CSNA.

In Chapter 11 Albert M. Teplin, Rochelle Antoniewicz, Susan Hume McIntosh, Michael G. Palumbo, Genevieve Solomon, Charles Ian Mead, Karin Moses and Brent Moulton (*Integrated Macroeconomic Accounts for the United States: Draft SNA-USA*) provide a diagnosis of the current level of integration of the U.S.

income and financial accounts and propose ways to improve it. In the United States. the main accounts concerned are the NIPAs and the International Transaction Accounts (ITAs) published by the BEA, and the flow-of-funds accounts (FFAs) published by the FRB. These accounts have each been gradually developed for specific purposes and, although they should be consistent conceptually, they are not in practice. The authors show that a number of changes to current practices could help improve the consistency: the use of harmonised definition for the "sectors", the use of common data sources, and a harmonised treatment of transactions. The authors propose a way to integrate financial and income accounts for 1985-2002, which is almost perfectly in line with the SNA standards.

In the 12th and final chapter, Randy A. Becker, John Haltiwanger, Ron S. Jarmin, Shawn D. Klimek and Daniel J. Wilson (*Micro and Macro Data Integration: The Case of Capital*) confront the discrepancy between aggregate measures of capital stocks and flows and the business-level measurement of capital. These two approaches seem difficult to reconcile given the wide differences in methodologies. More importantly, the limited degree of detail available from asset surveys and changes in the sample of firms overtime, especially in the case of younger businesses, create serious obstacles. Nonetheless, the availability of capital expenditure estimates at the firm level through the Annual Capital Expenditures Survey (ACES) could allow for a significant improvement in the measurement of capital. The authors propose a hybrid approach between the top-down and bottom up approach for the measurement of capital stocks and flows by asset and by industry. They justify their effort by noting that developments at the macro level result from very heterogeneous behaviours at the micro level. This reconciliation also sheds light on issues such as capital destruction over time at the micro level, which is assumed to be constant at the macro level. The authors also investigate the treatment of firm exits and whether the value associated with these firms is transferred or scrapped. They favour a hybrid approach, using both macro and micro sources of information and including the use of survey data.

An Assessment

Measurement is the cornerstone of the national accounts. Some transactions are directly measured, sometimes with a wealth of data, sometimes with a dearth of data. Inconsistencies emerge when different sources of information give different results due to a lack of integration and when different concepts – such as current price GDP and GDI – should correspond but do not in practice. This is the problem with having two watches. Some contributions have focused their efforts on sorting out the sources of these differences and, in many cases, proposing ways to reduce them. An interesting example is found in Chapter 2, where Karen Wilson mentions the statistical discrepancy between net lending/borrowing and financial requirements in Canada, Australia and the U.-K., and judges it to be more an information about the quality of the data than a matter for concern. It is indeed a good question to raise: at what price and to what extent should the gaps between the different sources of data be reduced? In some contributions a weighting scheme is introduced that clearly favours the sources that are identified as more reliable, but still tries to extract information from less reliable sources.

Yet, it has long been recognized that it was not possible to restrict the National Accounts only to transactions directly measured. Imputations have a long history and are common practice. The issue is not particularly problematic as long as it is possible to obtain direct measures which provide a close approximation of what one wants to quantify. Nevertheless, this is the problem with having only one watch. On the other hand, expanding the system of accounts looks very much like trying to tell what time it is without a watch. In that context, the use of imputations is widespread, but is it justified? We do not think that there is a unique answer to this question, since in our view it depends very much on the purpose of this evaluation. This is very well illustrated by the attempt to quantify non-market activities and to measure productivity. It has been known for a long time, for instance, that a portion of actual consumption is made of goods and services that consumers produce themselves. The development of the internet and of consumer-produced goods and services, however, adds a modern twist to this old issue. It is hence interesting to estimate the value of this output, as well as the inputs used to produce it. But, since this is a non-market activity, by nature there is no transaction involved. Thus, it would be very doubtful to include non-market components in the aggregate driving money demand, for example, since no money is required if there is no transaction. It is hence key for the user to identify the various components and to treat them appropriately given different purposes.

Turning to productivity, a researcher may question how close an economy is from perfect competition. In a Cobb-Douglas framework, she could try to measure the gap between real wages and labour productivity. But, since labour productivity is not observable, if the available information on labour productivity has been built using real wages in a Cobb-Douglas framework under the hypothesis of perfect competition, her results will reflect the method used to construct the data, without guarantee that this actually reflects the state of the economy at hand. In other words, the use of theoretical foundations to build a measure of an economic phenomenon not directly observable can be acceptable to estimatevaluate the order of magnitude of that phenomenon. This practice, however, can become problematic when researchers attempt to establish strict relationships between variables, rather than only estimate the magnitude or test the consistency across numbers.

These examples, although simplistic, show that in practice transparency about the methods and the estimations used in the National Accounts is the key element for practitioners. In this context, references like the volume under review are more than welcome. Users must be provided with a degree of details such that they can best use the data on purpose.

The structure of the national accounts is the way to deal with part of the problem. As Nordhaus recalls p. 144 "[...] *I must emphasize that, while non market and environmental accounts form an important addition to our understanding of economic activity, they are not ready for center stage. It would not be advisable to incorporate further major non market activities into the core National Income and Product Accounts at this time.* [..] *it would be sensible to set as a goal of the U.S. statistical system to develop satellite non-market accounts* [..]". Yet, satellite accounts are a way to provide some additional information in a framework consistent with the core system of accounts, together with the degree of freedoms required in fields where measures are less precise. Along these lines, for the sake of the users, it is indeed wise to stress how far from direct measurement some elements of the system of national accounts are.

For statisticians and economists around the world, this volume represents a valuable resource to learn about the future directions and solutions proposed by their U.S. colleagues for the development of the SNA.