Product Market Regulation and Productivity Convergence: OECD Evidence and Implications for Canada

Paul Conway and Giuseppe Nicoletti[1]
OECD

ABSTRACT

In this article we investigate the effect of product market regulation on the international diffusion of productivity shocks. The results indicate that regulations that restrict competition slow the process of adjustment through which best practice production techniques diffuse across borders and new technologies are incorporated into the production process. This effect is reflected in cross-country differences in ICT investment and speeds of catch up of sectoral productivity, which are significantly influenced by differences in product market regulation. Thus, persisting cross-country differences in product market regulation can partially explain the recent observed divergence of labour productivity in OECD countries, given the emergence of new general purpose technologies over the 1990s. In the case of Canada, the results suggest that remaining regulatory barriers to competition in a few key non-manufacturing sectors may have prevented the economy from benefiting to the full extent from high productivity growth rates in the United States and other productivity leaders.

ONE OF THE ECONOMIC PARADOXES of the past decade was that GDP per capita diverged across OECD countries even as policies converged in many areas, such as macroeconomic stabilization and product market regulation. The paradox was particularly striking in productivity performance across countries, the major driver of divergence in GDP per capita. Spectacular productivity growth acceleration in some countries, *in primis* the United States, was matched by continued stagnation or even deceleration in many continental EU countries. Yet, product market policies, which are thought to affect productivity growth, became increasingly market-oriented everywhere, with privatization and liberalization spreading throughout the OECD area. How can this be reconciled with the idea that institutional change and product market reforms should lead to improved productivity performance?

This article argues that it is not only institutions and policies *per se* that mattered for explaining the productivity episodes from the late-1990s, but also the relationship between the

1 Economist and Head of Division in the OECD Economics Department respectively. The authors would like to thank Jorgen Elmeskov, Mike Feiner, Joaquim Oliveira Martins, Dirk Pilat, Annabelle Mourougane and Andrew Sharpe for useful comments and discussion. The statistical assistance of Isabelle Wanner and secretarial help from Irene Sinha are also gratefully acknowledged. The views expressed in the article are the authors' own and do not necessarily reflect those of the OECD or its Member countries. Email: paul.conway@oecd.org and giuseppe.nicoletti@oecd.org.

timing of policy reforms and the timing of technological change. In many OECD countries, notably in continental Europe where productivity performance was most disappointing, product market reforms were slow and hesitant during most of the 1990s, a period during which the diffusion of information and communication technologies (ICT) was particularly intense. We think that delaying reforms made firms in these countries unable to fully capture the benefits of ICT, both in terms of incorporating them into new vintages of the capital stock and reaping the efficiency gains originating from the changes in the organization of production that they allow. The negative repercussions on productivity of the mismatch between the timing of reforms and the timing of technological change were amplified by the fact that ICT is a general purpose technology that can be usefully employed in most sectors of the economy. We show that the damage of delaying reforms was particularly serious in ICT-using services that have driven productivity growth acceleration in the United States, but remained tightly regulated and slow-growing in the EU and some other OECD countries until relatively recently. In Canada, a lack of reform in some key non-manufacturing sectors — such as electricity, retail distribution, and the professional services — together with persisting barriers to inter-provincial trade may partly explain subdued productivity growth.

The empirical approach summarized in this article gives product market regulation an important role in determining how quickly productivity shocks diffuse across borders. Because relatively liberal countries benefit from improvements in the world productivity frontier more quickly than countries with more restrictive policy regimes, the cross-country dispersion of productivity levels increases in the wake of a positive global productivity shock. Thus, in times of rapid improvements in the productivity frontier the effect of product market regulation on the speed of catch-up is amplified. This increases the dispersion of productivity levels across countries in which the stringency of product market regulation differs. Digging a bit further, we show that one channel through which anti-competitive product market regulation has slowed down catch-up to best practice in regulated countries is by curbing investment in ICT, with relatively liberal countries more successful at incorporating ICT into the production process in comparison to relatively restrictive countries.[2]

Product market reform, however, is not the only factor accounting for differential productivity developments across countries. Other factors not explored in depth in this article include the degree of market integration in federal countries (or economic unions), location and geographic advantages, and differences in human capital. Moreover, recent research also suggests that labour market regulation can have important implications for the abilities of economies to adjust to technological shocks (OECD, 2007).

The rest of the article is structured as follows. In section two we look at parallel developments in labour productivity and product market regulation in the OECD area over the past two decades. Section three summarizes our empirical work on the link between product market regulation, ICT investment and productivity growth, providing some illustrative simulations of the effects of product market reforms. Finally, in section four, we discuss some implications of our analysis for assessing productivity developments in the Canadian economy.

2 In the original paper on which this work is based (Conway *et al.*, 2006), we found evidence that anti-competitive regulation in product markets curbs the establishment of foreign affiliates of multinationals, which is also likely to inhibit the international diffusion of new technologies.

Product Market Regulation and Labour Productivity in the OECD: Convergence *and* Divergence?[3]

As illustrated in detail in OECD (2003a), productivity performances have varied markedly across countries over the past two decades. Two related trends emerged at the international level. A group of countries, led by the United States, succeeded in reversing the productivity slowdown experienced since the mid-1970s: their productivity accelerated sharply from the mid-1990s and continues to grow faster than in the past. Other countries, especially continental European ones, continued to experience stagnating or decelerating productivity growth rates. As a consequence, the process of catch-up, which has been an important driver of productivity dynamics since the 1950s, has been stalling for several years and only a few high-growth countries have continued to converge towards the productivity levels of the United States (Chart 1). Canada is the only country with long-time series data in which labour productivity per hour has, on average, fallen behind that of the United States in both the 1980-1994 and 1995-2005 periods (in both levels and growth rates).

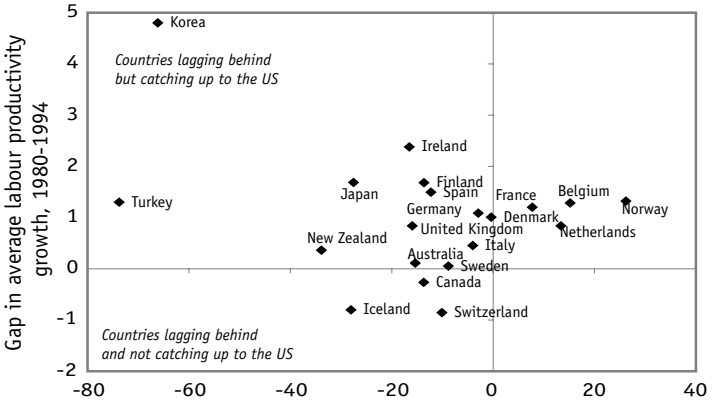
These disparities in productivity growth to a large extent reflect differing degrees of resilience across countries to recent technology shocks (OECD, 2003b). In the United States a large proportion of the increase in labour productivity in the second half of the 1990s originated in sectors that either produce or intensively use ICT (Chart 2). A few other countries — for example, Ireland, Australia, Finland, Mexico, Portugal, and the United Kingdom — also experienced accelerating productivity growth in these sectors in the second half of the 1990s. In a number of

Chart 1

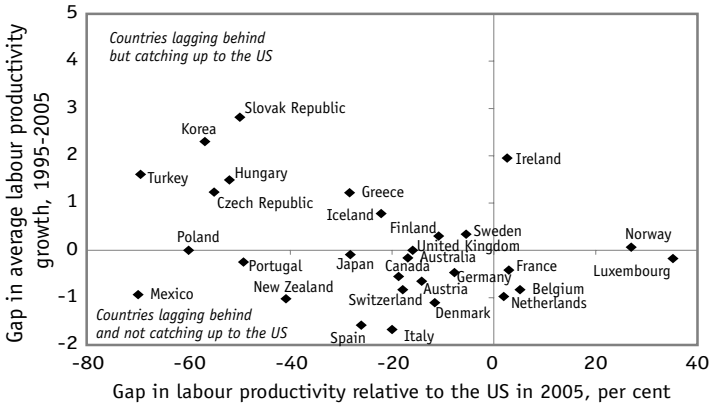
Labour Productivity Levels and Growth Rates[1]

Gap vis-à-vis the United States

Panel A: 1980-1994



Panel B: 1995-2005

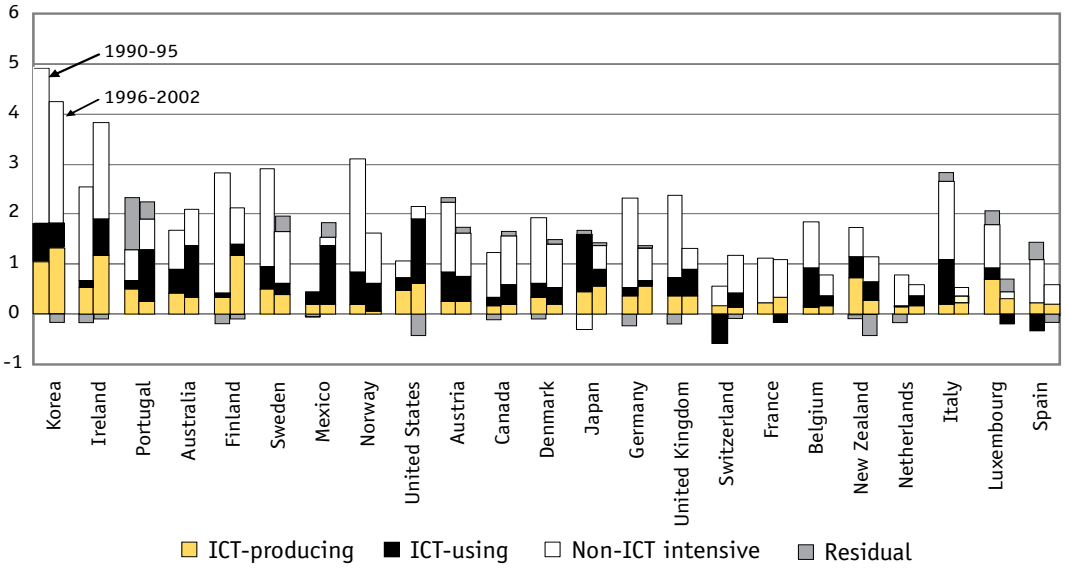


1 Labour productivity is measured as GDP per hour worked. The level of GDP is calculated on the basis of 2000 PPPs. Data are not available for several countries in the earlier period.

Source: OECD Productivity Database.

3 This section provides only a very brief summary of trends in product market regulation and productivity in OECD countries. The OECD routinely produces quantitative indicators that allow countries to be compared in a number of different areas of regulation. The indicators measure the extent to which general-purpose and sectoral regulations restrict competition and/or private governance in areas where these are viable and promote competitive mechanisms in areas where market failures require public intervention. The indicators are based on a large amount of qualitative data provided (and vetted) by OECD countries. For more on the construction of the indicators used to measure anti-competitive regulation and patterns of regulatory reform in OECD countries see Conway *et al*. (2005) and Conway and Nicoletti (2006). All of the indicators used in this paper are available on the OECD's Product Market Regulation Homepage at http://www.oecd.org/eco/pmr. Trends in productivity in OECD countries are discussed in detail in a number of other sources including O'Mahony and Van Ark (2003) and Gordon (2004).

Chart 2
Contributions to Aggregate Labour Productivity Growth[1]



1 Annual average contributions to the growth of total value added per person employed, in percentage points. The residual reflects adding up differences in aggregating from sectoral to the aggregate economy level. Countries are ordered according to labour productivity growth in the most recent period.

Source: Pilat, Lee, van Ark (2002) (updated).

other countries, however, the contribution of ICT-producing or using sectors to productivity growth has typically been smaller than in the United States and even declined in several of them over the 1990s.[4] In Canada, although labour productivity growth in ICT-using sectors increased marginally after 1995, the contribution of these sectors to overall productivity growth has been relatively small and the labour productivity gap vis-a-vis the United States has been increasing in recent years.

These diverging productivity trends are somewhat surprising in the light of the increasing homogeneity of the policies followed by OECD countries in product markets. OECD indicators that measure the extent to which these policies restrict competition and market mechanisms suggest that in all major areas (barriers to entry, public ownership, vertical integration, and price controls) approaches have converged across countries over the past two decades (Chart 3). Product market regulation has become more conducive to market mechanisms in the OECD area in recent years as governments have liberalized potentially competitive markets, re-regulated natural monopoly markets establishing pro-competitive regulation where possible, and privatized previously state-owned assets. A major motivation for these policies is indeed to improve productivity performance and a link between market pressures and productivity has been highlighted in many recent contributions to the theory and empirics of growth.[5]

4 The role of ICT production and use is discussed in detail in Pilat and Wölfl (2004). Differences in the contribution of ICT-using sectors to productivity growth have been found to be important sources of productivity divergence between the United States and Europe. See, for example, van Ark *et al.*, (2002) and Gust and Marquez (2004).

5 See, for instance, Aghion and Griffith (2005), Acemoglu *et al.* (2006), Nickell *et al.* (1997) and Nicoletti and Scarpetta (2003). Crafts (2006) provides a good summary of this literature.

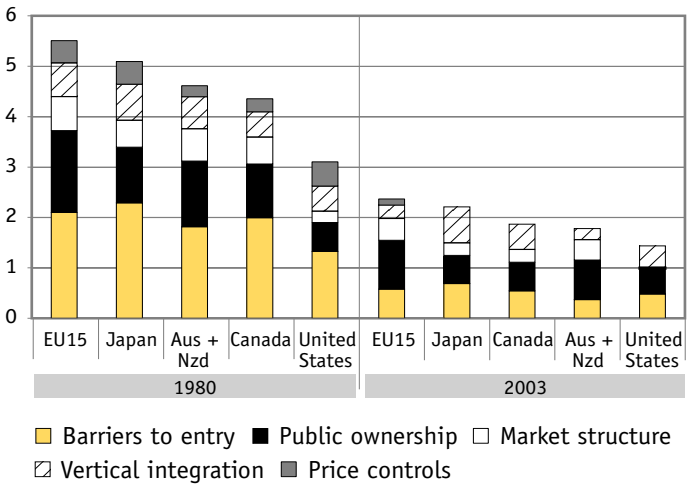
A closer look at policy developments shows, however, that the timing of product market reforms has differed dramatically across countries. The United States was the first country to begin reforming product market regulation in the early 1980s. A number of other countries — notably the United Kingdom, Canada, New Zealand, the Nordic European countries and Japan — commenced reform a little later, from the mid 1980s. But in most EU countries the bulk of product market reform occurred during the second half of the 1990s, and a number of them still had a relatively restrictive product market environment at the turn of the century. As a result of these different starting points and reform patterns, regulations remained more restrictive in the EU than in the average of other OECD countries until very recently. Moreover, the dispersion in regulatory approaches increased widely in the EU area over the 1990s, while regulation in other OECD countries kept becoming more homogeneous all along (Chart 4). From 2000 onwards, the dispersion in policy approaches also fell within the EU, in part because regulation in the Euro area and former transition countries started to quickly move towards that of the more liberal countries.[6] In other words, some OECD governments were unable to implement reforms early enough to create a favourable business environment for absorbing the ICT shock that began unfolding over the 1990s.

Delaying product market reform potentially damaged the ability of OECD countries to reap the full benefits of the ICT revolution because the negative impact of anti-competitive regulation in non-manufacturing sectors are typically largest in sectors in which ICT is

Chart 3

Product Market Regulation by Major Area in Selected OECD Countries, 1980 and 2003

(OECD indicator, scale 0-6 from least to most restrictive)

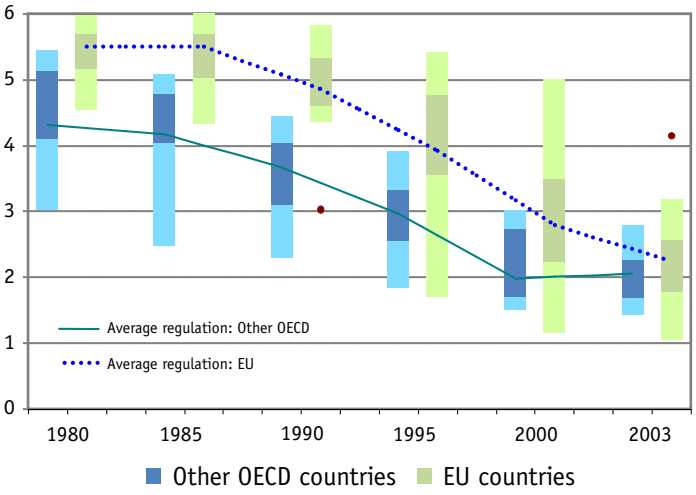


Source: Conway and Nicoletti (2006).

Chart 4

The Evolution and Dispersion in Product Market Regulation in the EU and other OECD countries, 1980-2003[1]

(OECD indicator, scale 0-6 from least to most restrictive)

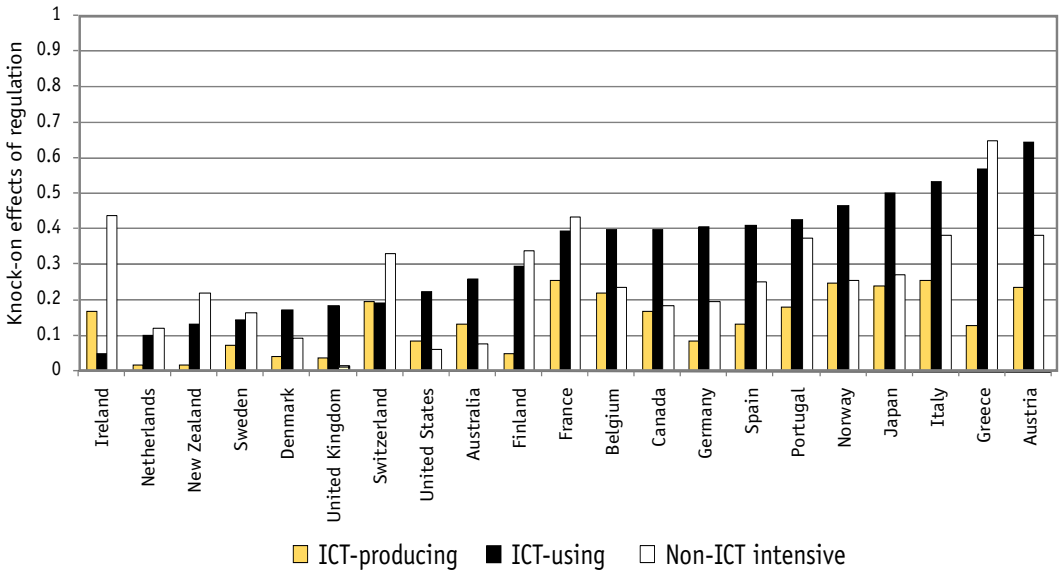


1 Box chart of the cross-country dispersion of the aggregate indicators of regulation in transport, energy, and communications sectors across countries. The bars show the range of the indicator values across country groupings in each year. The dots represent outliers. The lines show the means.

Source: Conway and Nicoletti (2006).

6 Notwithstanding this convergence, broader OECD measures of product market regulation, covering more sectors and general-purpose regulations, suggest that product market approaches still differ substantially across countries in the OECD area (Conway *et al.*, 2005). Unfortunately, these broader measures are only available for 1998 and 2003 and cannot be used to assess regulation trends over long periods.

Chart 5
The Knock-on Effects of Regulation on ICT-producing, ICT-using, and non-ICT intensive Sectors in OECD countries, 2003[1]



1 These data are the simple averages of the regulation impact indicators for the individual industries included in ICT-producing, ICT-using, and non-ICT intensive sectors in 2003. These indicators reflect the "knock on" effects of anti-competitive regulation in non-manufacturing sectors on firms that use the output of these sectors as intermediate inputs in the production process. There is no "official" definition of ICT-intensive sectors. The one we adopt here and throughout the article follows Inklaar *et al.* (2003) by pooling together their proposed lists of ISIC Rev 3 sectors as ICT-producing or ICT-using (see the data annex for details). Other sectors are classified as non-ICT. The data is ordered according to the indicator values for ICT-using sectors.

Source: OECD International Regulation Database.

used intensively (Chart 5).[7] These effects depend on the extent to which each sector uses intermediate inputs coming from regulated non-manufacturing sectors, and use of these intermediate inputs is particularly strong in ICT-using sectors. The OECD measures these "knock-on" effects of regulation by means of indicators of regulatory impact in each sector. These are constructed as averages of the indicators of regulation for non-manufacturing sectors weighted by the share these sectors represent in the consumption of intermediate inputs of each sector. Reflecting more restrictive regulations, these "knock-on" effects of anti-competitive regulation on ICT-using sectors are particularly high in many continental EU countries, Japan, and Canada, while they are much weaker in countries that have experienced high productivity growth in these sectors.[8]

7 Using data on regulations in non-manufacturing sectors and harmonised input-output tables, the OECD computes "regulatory impact" indicators that measure the burden that these regulations impose on all sectors of the economy that use non-manufacturing products as intermediate inputs in production. These indicators cover 39 ISIC rev. 3 sectors in 21 OECD countries over the period 1975 to 2003 and are available on-line at http://www.oecd.org/eco/pmr. See Conway and Nicoletti (2006) for details.

8 As well as intermediate inputs, the "knock-on effects" of regulation in non-manufacturing sectors will also propagate through the economy via a number of other channels such as the effect on the price of investment goods and "Baumol disease" effects that act through wages. In this context, focussing on the role of non-manufacturing sectors as suppliers of intermediate inputs provides only a lower bound to these propagation effects. It does, however, facilitate their empirical measurement, which is important in the context of the analysis that follows.

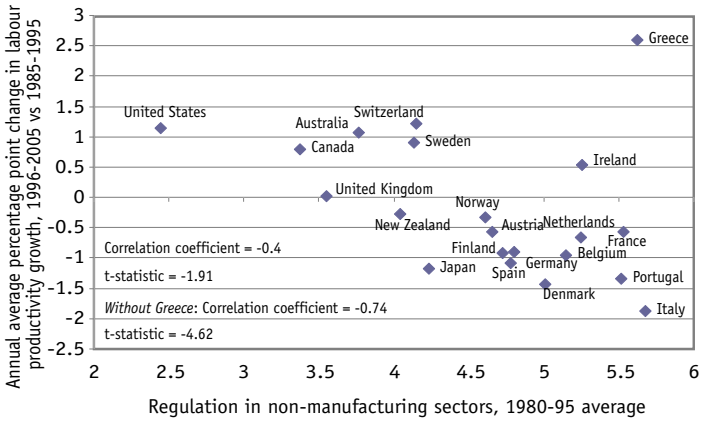
How Does Regulation Affect Productivity Growth?

As summarized by Crafts (2006), the main way in which regulations that curb competition may affect productivity growth is by reducing firms' incentives to invest, enhance efficiency and innovate. Recent empirical analyses have almost invariably found that a lack of competitive pressure is reflected in weaker investment (Alesina *et al.*, 2005), weaker efficiency gains (Nickell *et al.*, 1997; Nicoletti and Scarpetta, 2003) and, at least over a range, weaker innovation (Aghion *et al.*, 2005; Griffith *et al.*, 2006).[9]

If anticompetitive regulations hinder the adoption and efficient use of ICT, their negative effects on productivity performance are likely to have been particularly strong since the mid 1990s. The discussion in section two suggests that, although ICT is a 'general purpose' technology and readily available in worldwide markets, only a limited number of OECD countries have been reaping its significant potential benefits to the full. One possible explanation for this is that restrictive regulation increases barriers to implementing new technologies and reduces incentives to increase efficiency and innovate. As a result, the productivity enhancement expected from using ICT is slowed down considerably in countries with relatively restrictive regulation. Indeed, at first glance, countries with a relatively liberal approach to competition have tended to experience a greater acceleration in aggregate hourly labour productivity growth after 1995 (Chart 6).

We explored this conjecture more rigorously in two steps. We first looked at the effect of regulation on one indicator of technology adoption and capital quality: the evolution of the share of ICT in gross fixed capital formation. We then investigated the possibility that the speed of catch-up to best practice productivity may be curbed by anti-competitive regulation. In both cases, the analysis was performed at both the aggregate and industry levels using data for (at most) 39 sectors in (at most) 21 OECD countries over the past two decades.

Chart 6
Product Market Regulation and Hourly Labour Productivity Acceleration
(OECD indicator, scale 0-6 from least to most restrictive)



Source: OECD Productivity Database and OECD International regulation database.

Regulation and ICT adoption

Given its potential for enhancing productivity and rapid price declines over recent years — especially when adjusted for quality — ICT has spread rapidly in many OECD countries. However, consistent with the large variation in the productivity dividend from ICT investment, rates of ICT adoption have varied considerably across countries. In several English-speaking and Nordic countries the share of ICT in total investment has risen by around 10 percentage points between 1985 and 2005, while in other countries the increase has also been significant but smaller (Chart 7).[10] In 2005, the share of

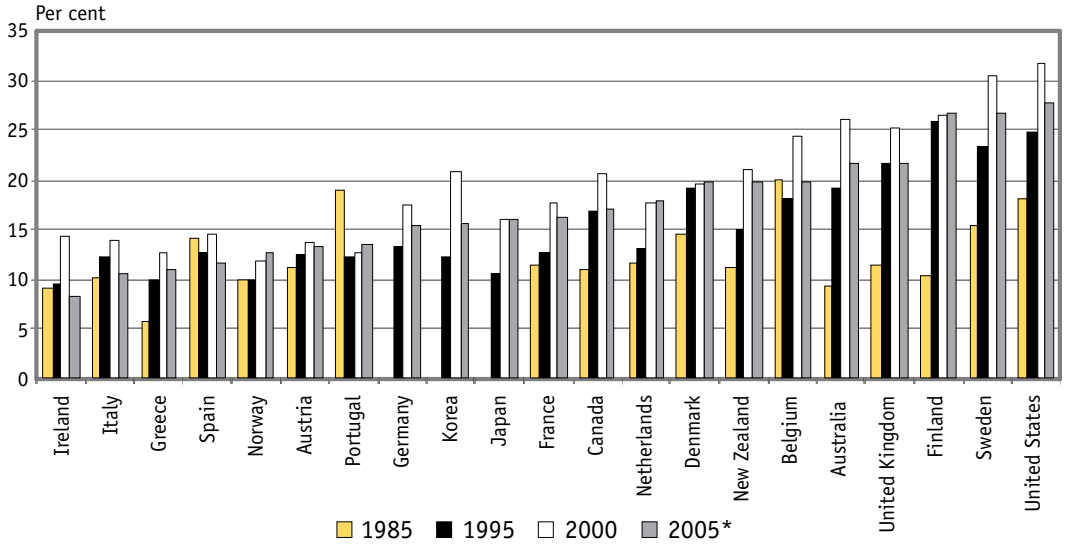
9 Based on a sample of firms in the United Kingdom, Aghion *et al.* (2005) found an inverted U-shaped relationship between competition and innovation, with too little competition or too much competition curbing innovation efforts.

10 The share of ICT investment in total investment is typically used as a key indicator of ICT diffusion. There are, however, many other indicators that measure the pervasiveness (or otherwise) of ICT technology across countries (see, for example, OECD 2002a). Most of these different indicators are closely correlated and tend to indicate a similar pattern of ICT diffusion.

Chart 7

The Diffusion of Information and Communication Technology in OECD countries

(share of ICT investment in total non-residential gross fixed capital formation)



* Or latest available year.

Source: OECD, Productivity Database.

ICT investment was particularly high in the United States, Sweden, Finland, the United Kingdom and Australia. In contrast, the ICT share in some continental European countries, Japan and, to a lesser extent, Canada was substantially lower. Several reasons can be envisaged for these differences, ranging from industry specialization and first-mover advantage to gaps in worker skills. However, given the wide availability of ICT and the relative homogeneity of industry features in the OECD area, cross-country differences in the pace of ICT uptake provide a useful 'natural experiment' with which to test whether restrictive regulations may have slowed down the adoption of this technology.

There are a number of potential reasons why this might be the case. In a competitive environment with low barriers to entry the incentive to invest in ICT so as to increase productivity and retain market share may be stronger than in a more restrictive regulatory environment where incumbents are sheltered from competitive processes. For example, investment in ICT may help firms increase productivity by allowing them to expand their product range, customize their services, and respond better to client demands. ICT may also help reduce inefficiencies in the production process by, for example, reducing inventories. In addition, as pointed out by Alesina *et al*, (2005) in the context of general purpose fixed investment, the costs of adjusting the capital stock and firm structure and reorganizing the production process, all of which are necessary if new technology is to be successfully integrated, will tend to be lower when the regulatory burden is lighter. Finally, a more competitive environment is likely to put stronger downward pressure on the cost of ICT, thereby promoting its diffusion. Casual evidence suggests that, on average over the past decade, ICT adoption has been stronger in countries where regulations were more encouraging of competition (Chart 8).

We used more formal panel regressions to confirm this evidence. These regressions accounted for other (observed and unobserved) factors that

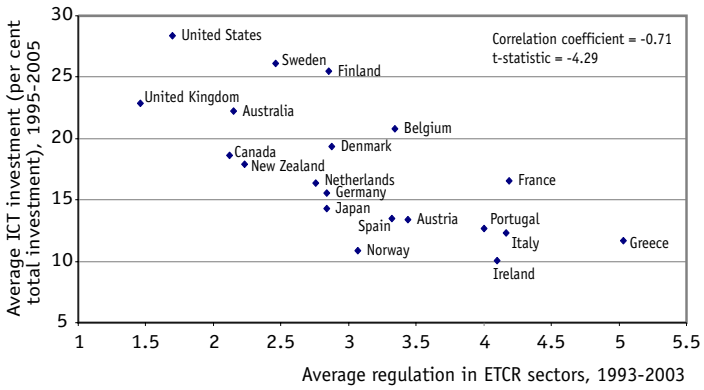
could potentially affect ICT adoption such as worker skills, industry composition, and other country and/or industry specific characteristics (Conway *et al*., 2006). The link between regulation and ICT investment was examined at the aggregate and industry levels.[11] In the former, regulation was proxied by the OECD indicator of anti-competitive regulation in seven non-manufacturing sectors and in the latter by the OECD industry-level indicators of the knock-on effects of non-manufacturing regulation in all business sectors. In both cases domestic restrictions on competition were found to have a strong negative effect on ICT investment, with some evidence that these effects are concentrated in ICT-using and non-ICT intensive sectors, which are less exposed than ICT-producing sectors to foreign competition.[12] Interestingly, the largest negative effects were found for regulations that increase barriers to entry in domestic markets, while the presence of publicly-owned firms did not seem to affect ICT investment, perhaps because, especially in network industries, publicly-controlled firms have in some cases been found to over-invest in new technologies. For example, telecommunications companies have sometimes abandoned costly plans to expand digital or cable networks in the wake of privatization.

In sum, the results suggest that firms operating in a relatively liberal regulatory environment are more inclined to incorporate ICT into the production process than firms operating in an environment in which product market regulation is more restrictive. But to what extent does this effect explain observed differences in ICT investment across countries? To answer this question Chart 9 graphs the contribution of each of the explanatory variables in the aggregate regression to deviations of ICT investment from the OECD average over the full sample period. Overall, product market regulation is estimated to explain around 12 per cent of the cross-country differences in ICT investment, with other factors — such as human capital, the share of services in value added and other country characteristics — explaining the rest. Over the 1985-03 period, a relatively pro-competitive regulatory environment was found to increase the average share of ICT investment in total investment in the United States by more than four percentage points above the OECD average of 15.5 per

Chart 8

Product Market Regulation and the Diffusion of Information and Communication Technology in OECD countries[1]

(OECD indicator, scale 0-6 from least to most restrictive)



1 The indicator of regulation is the simple average of the OECD regulation indicators for seven non-manufacturing industries.

Source: OECD Productivity Database and OECD International Regulation Database.

11 Our analysis of aggregate ICT followed the work of Gust and Marquèz (2004), who, however, focused on labour market regulations and used a smaller and shorter cross-country sample. Our aggregate regressions covered 18 countries over the period 1985-2003: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, Ireland, Japan, Netherlands, Portugal, Spain, Sweden, the United Kingdom, and the United States. Our industry-level regressions covered the period 1980-2001 for five countries for which data on industry-specific ICT investment were available at the time of the analysis: France, Germany, the Netherlands, the United Kingdom and the United States.

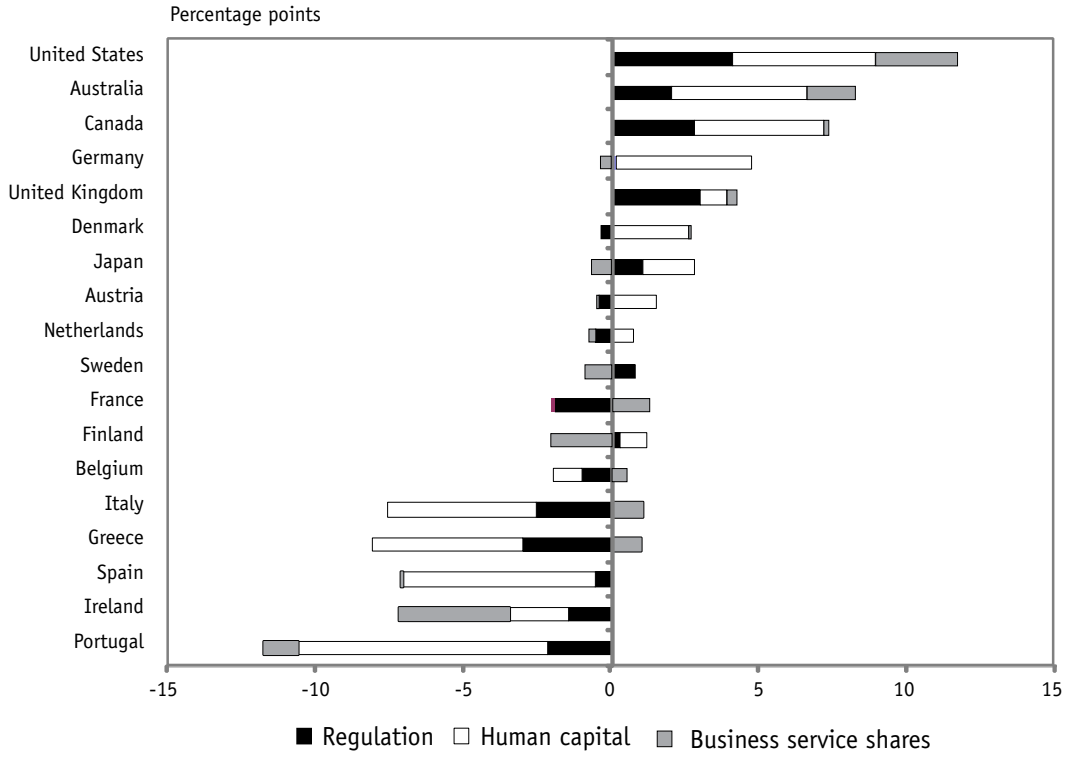
12 Also, the development of ICT-producing industries often reflects factors that are unrelated to regulation, such as first-mover advantage or specialization due to country-specific comparative advantages and/or agglomeration economies.

Chart 9

Contributions of Product Market Regulation and Other Factors in Explaining ICT Shares in Total Investment of OECD countries, 1985-2003[1]

Deviation of ICT shares from OECD average over the full sample period

OECD average share = 15.5%



1 These contributions have been calculated using the results of the aggregate ICT regression reported in column 4 of Table 2 in Conway *et al.* (2006). Countries are ordered according to the sum of the different contributions.

Source: Conway *et al.* (2006).

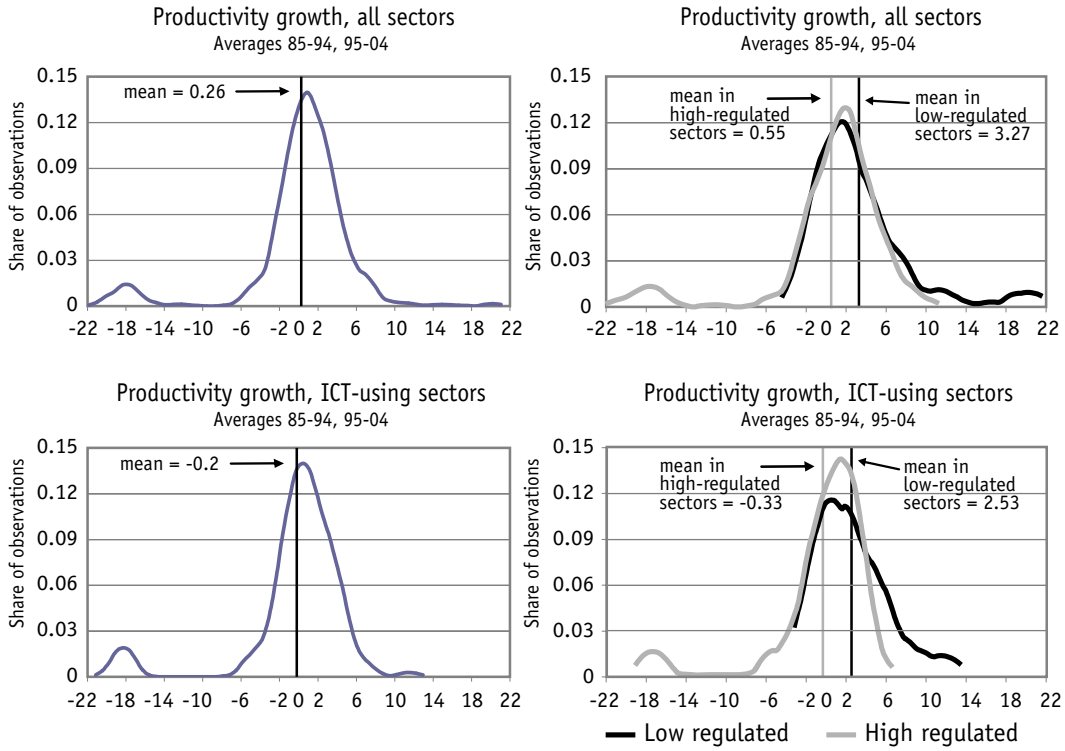
cent. In the United Kingdom, Canada, and Australia, the estimated contribution of product market policies to investment in ICT relative to the OECD average also appears to have been significant (between 2.5 and 3.5 percentage points), but less than in the United States. Conversely, in Greece, Italy, Portugal and France relatively restrictive regulations were estimated to have significantly dragged down ICT investment relative to other OECD countries (by 2.5 to 3.5 percentage points). We obtained a similar result at the industry level, with product market regulation now explaining more than 20 per cent of the variance in ICT investment across countries and industries.

The results also imply that substantial increases in ICT investment would occur in a number of countries if they were to reform product market regulation to that of the least restrictive OECD country in each sector. For instance, our estimates imply that by aligning product market regulations on international best practice, the ICT share in Canada would increase by around 2.5 percentage points relative to its 2003 level. Larger gains would be obtained by other countries (such as Greece, Italy and France) where sectoral regulations are further away from best practice.

Perhaps more interestingly, the finding that ICT adoption is curbed by the lack of competitive pressures at home supports the idea that cross-

Chart 10

Productivity Growth Distributions with High and Low Product Market Regulation in OECD countries[1]



1 Sector observations are classified into low or high regulated cases if they fall in the first or last quintile of the distribution of regulation impact indicator respectively. These indicators reflect the "knock on" effects of anti-competitive regulation in non-manufacturing sectors on firms that use the output of these sectors as intermediate inputs in the production process.

Source: OECD STAN Database and OECD International Regulation Database.

country differences in the timing of product market reform may have had a particularly strong influence on productivity patterns over the 1990s, when technological innovation was advancing rapidly. We turn to this issue in the next section.

Regulation and productivity growth

To begin exploring the effect of anti-competitive regulation on productivity growth Chart 10 shows the distribution of average labour productivity growth over the 1985-1994 and 1995-2004 periods across the countries included in our sample. The measure of labour productivity growth has been purged of idiosyncratic effects across countries, industries, and time.[13] Three distributions are shown: for *all* countries/sectors/periods, for *high-regulated* countries/sectors/periods and for *low-regulated* countries sectors/periods, with the high and low-regulated distributions overlaid. High and low-regulated cases are defined as those falling in the first and fifth quintiles, respectively, of the distribution of the OECD indicator of the knock-on effects of non-manufacturing regulations in all business sectors. The upper panel shows the three distributions for all sectors, while the lower panel concentrates on ICT-using sectors only.

13 In other words, the figure shows the distribution of the residual of a regression of productivity growth rates on country, sector and time dummies. Moreover, sectoral productivity growth rates exceeding 30 per cent or falling short of -30 per cent per year have been considered outliers (or measurement errors) and dropped from the database. Controlling for German unification does not affect the portrayed distributions.

Several features emerge. The overall distribution is normal with a "fat" tail on the left side, indicating an asymmetry towards weak productivity growth rates, a long thin tail on the right, indicating cases of exceptionally high productivity growth, and a mean productivity growth rate of 0.3 per cent per year. Interestingly, the left tail is entirely due to weak productivity growth in countries/sectors/periods that are highly regulated. At the same time, the distribution of productivity growth rates for these highly-regulated cases is truncated to the right, with none of them showing exceptionally high productivity growth rates. Conversely, the right tail is entirely due to exceptionally high productivity growth in some low regulated countries/sectors/periods, while none of these low-regulated cases fall on the weak productivity tail of the distribution, which is truncated to the left. As a result, the mean annual productivity growth rate of low-regulated countries/sectors/periods (3.3 per cent) is significantly higher than where (and when) regulation is high (0.6 per cent). As shown in the lower panel, these patterns also emerge if one focuses on ICT-using sectors only, with the left and right truncations occurring at higher and lower productivity growth rates, respectively.[14]

These productivity distributions suggest that productivity growth tends to be more rapid in countries or sectors where product market regulation is less restrictive of competition and imposes smaller burdens on firms. This is especially the case in ICT-using sectors. Moreover, a possible interpretation of these distributions could also be that regulations that encourage competition help dispose of firms with particularly weak productivity growth rates, while at the same time promoting firms that have exceptionally high ones. The opposite would seem to be occurring when regulations restrict competition.

There are two main ways in which unduly restrictive regulations may have interacted with the ICT shock to slow the speed of productivity growth in countries that delayed reforms. First, to the extent that anti-competitive regulations slow ICT adoption, productivity growth in sectors that are potentially ICT-intensive may have been lowered by a suboptimal level of investment (the "direct" productivity effect). Second, a lack of competitive pressures and excessive regulatory burdens may have curbed the incentive to use embodied ICT technologies as efficiently as in more competitive and lightly regulated countries and thereby slowed the process of productivity convergence (the "indirect" effect). With these effects at work, and in conjunction with the fact that, as shown above, regulatory burdens have tended to fall disproportionately on ICT-using sectors, the emergence of ICT over the 1990s may have amplified the influence of cross-country differences in the depth, scope and timing of product market reforms on productivity developments, despite the overall tendency of policies in this area to converge.

We built on the results from the productivity distributions and explored the direct and indirect effects of regulation on productivity growth within the framework proposed by Aghion and Howitt (2005). In our model productivity growth in a given country (or sector) depends on its ability to keep pace with growth in the country (or sector) with the highest level of labour productivity (the leader) by either innovating or taking advantage of the best technology available. Productivity growth depends on how fast the leader is growing and the speed with which the productivity gap is closing. In turn, this speed is affected by the policy environment in the follower country (or sector). In keeping with Aghion and Griffith (2005) we focused on the

14 As expected, productivity growth rates in ICT-using sectors are generally lower than in other sectors since these are typically service sectors.

role of policies promoting firm rivalry and market entry in increasing incentives to enhance efficiency and lower the costs of reorganizing production accordingly.[15]

Two main findings emerged. First, as expected, restrictive regulations have a direct negative influence on productivity growth in ICT-intensive (i.e. ICT-producing and ICT-using) sectors implying that weak competition and regulatory burdens are particularly harmful for technology-driven productivity improvements in these sectors. No such direct impact could be detected on productivity growth in non-ICT sectors. Second, restrictive regulations also indirectly slow productivity growth by curbing the speed of catch-up to the productivity leader. The effect of catch-up on productivity growth is generally found to be strong, reflecting a high degree of economic integration in the OECD area and the fact that technological innovation usually occurs in a given region or country.[16] However, we find that catching up to best practice is much harder in inappropriately regulated countries (or sectors) than in countries (or sectors) where regulations that promote competition have been put in place. Because relatively unproductive countries or sectors have the largest potential for catch up, the cost of inappropriate regulations, in terms of productivity gains foregone, is largest in countries or sectors with the widest productivity gaps. In other words, the cost of anti-competitive regulation increases the further a country (or sector) is from the world productivity frontier.

Our findings cannot determine if this indirect negative effect of restrictive regulations on productivity growth is due to inadequate diffusion, adoption or use of new technologies. But it seems likely that a mixture of these three impeding factors is at work in inappropriately regulated countries (or sectors). In this respect, well-functioning and competitive product markets would seem to be an important condition for rapid productivity growth, because they increase the incentive to incorporate new technologies and lower the cost of making other necessary changes in the organization of production to fully exploit these technologies. Product market regulation may also affect firms' ability to engage in co-invention or innovation in other areas, which often occur as part of the process of technological diffusion (Bresnahan and Greenstein, 1996). Under these conditions, it is clear, therefore, that a pre-requisite for taking full advantage of the diffusion of new technologies is to implement reforms that make product markets receptive to them and that countries that fail to do so, especially in sectors that provide intermediate inputs to crucial ICT-using sectors, are strongly disadvantaged in their quest for growth.

The productivity effects of product market reforms

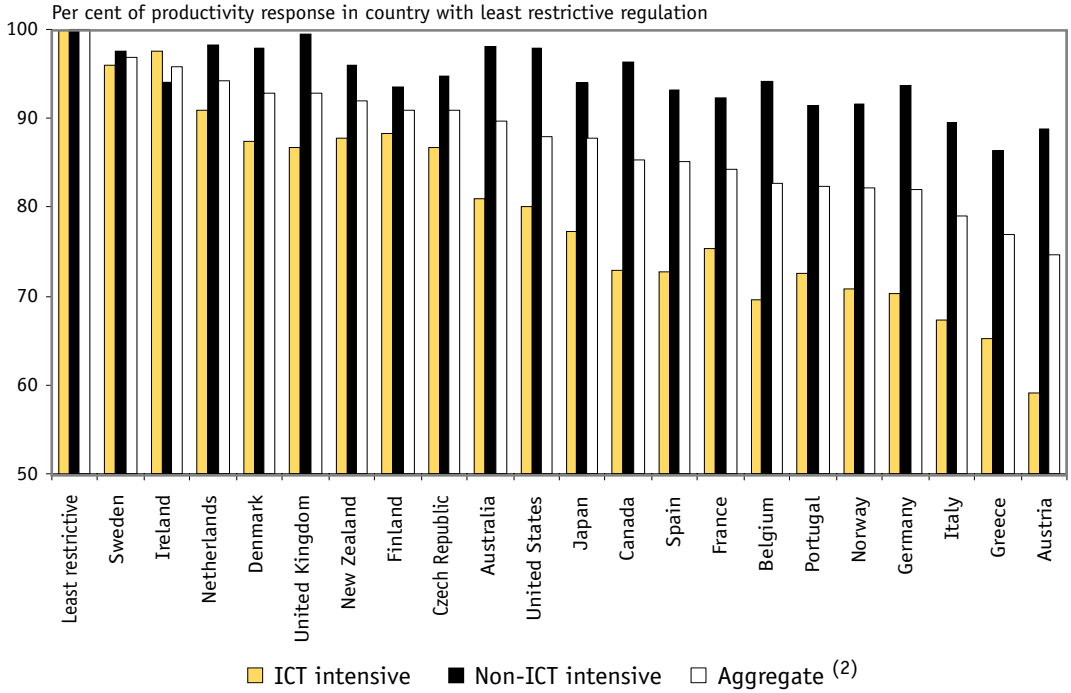
The empirical results reported above can be used to assess the potential economic significance of product market reforms on productivity growth. To provide prudential "lower

15 The regression model is a variant of that developed by Griffith *et al.* (2004) to test the effect of R&D expenditure on productivity growth. It has also been used by Nicoletti and Scarpetta (2003) to investigate the effect of product market regulation on multi-factor productivity growth. Besides the direct and indirect effects of regulation, regressions also account for a number of unobserved characteristics that are country and/or industry specific as well as for global shocks over time and industry-specific trends in productivity. The results are robust to accounting also for industry-specific workers' skills and capital deepening. Our main analysis (see Conway *et al.*, 2006) covered productivity per employee in 20 countries and sectors over the past 25 years. Regulatory burdens were approximated with the OECD industry-level indicators of the "knock on" effects of non-manufacturing regulations in all business sectors.

16 Keller (2004) notes that "only a handful of rich countries account for most of the world's creation of new technology" and that in most countries "foreign sources of technology account for 90 per cent or more of domestic productivity growth". Guellec and van Pottelsberghe de la Potterie (2001) make a similar point.

Chart 11

The Effect of Regulation on the Diffusion of a Positive Supply Shock in OECD countries[1]



1 The increase in the level of aggregate and sectoral productivity 5 years after a positive supply shock to the world technological frontier of an equal magnitude in each sector. The data are expressed as a percentage of the response that would occur in a country with regulation that is least restrictive of competition.

2 Productivity is derived as the average of industry-level productivities weighted with value-added weights.

Source: Conway *et al.* (2006).

bound" estimates, these simulations do not embody the direct effect of regulation in ICT-intensive sectors on productivity growth but instead focus on the indirect effect of anti-competitive product market regulation on the speed with which countries operating behind the world productivity frontier catch up to best practice. Note that for a number of reasons these simulation results are only indicative.[17] They do, however, provide an idea of the order of magnitude of the estimated effects of product market policies on productivity catch-up.

As a starting point, we illustrate the effect of current anti-competitive regulations on the diffusion of a global positive productivity shock across OECD countries. To this end, Chart 11 graphs the increase in productivity that would occur in each country five years after a one-off

17 For example, they assume that policy changes do not change the estimated average relationships, which are assumed to be representative of the relationships in each country. Moreover, they may also measure incorrectly the effect of policies on aggregate productivity to the extent that reform also results in resources moving across sectors with different productivity levels, a factor that is not accounted for in our sectoral estimates. In OECD countries, productivity growth within industries has been found to make a relatively large contribution to overall productivity growth in comparison to shifts of employment across industries (OECD 2003a). Given that the reallocation of resources across industries has played a relatively minor role in explaining cross-country differences in aggregate productivity growth, aggregating the results that emerge from the sectoral-level model may not give an excessively biased view of aggregate patterns. In any case, the direction of the potential bias is not clear. For instance, recent research for the United States (Bosworth and Triplett, 2007) has found that reallocation of resources across sectors has typically curbed aggregate productivity growth in the past, but that this pattern has been reversed after the year 2000.

outward shift in the world productivity frontier of an equal magnitude in all sectors. To isolate the effect of product market regulation, this simulation assumes that, initially, the level of productivity in each sector is equal across all countries. Thus, the shock opens up the same sectoral productivity gap in all countries in the first year, which then closes at different speeds depending on the extent to which regulations restrict competition and hinder adjustment in different countries. The increase in productivity that would arise in response to the shock is expressed as a proportion of the increase that would occur in a country in which product market regulation in non-manufacturing sectors is the least restrictive among OECD countries. Results are reported for aggregate productivity growth as well as for productivity growth in ICT-intensive and non-ICT sectors.

In a few countries — Sweden, Ireland, the Netherlands, Denmark, the United Kingdom, and New Zealand — the influence of anti-competitive regulation on the diffusion of the productivity shock is relatively minor with aggregate productivity increasing by around 95 per cent of the response in a country with the least restrictive product market regulation. In some of the other countries — notably Austria, Greece, and Italy — restrictive regulations imply a greater lack of adaptability in the wake of a positive global supply shock, with aggregate productivity increasing by around 75 per cent of the response in a country where product market regulation is least restrictive of competition. As a result of differences in product market regulation, the dispersion of productivity levels across countries increases over time following the positive supply shock.

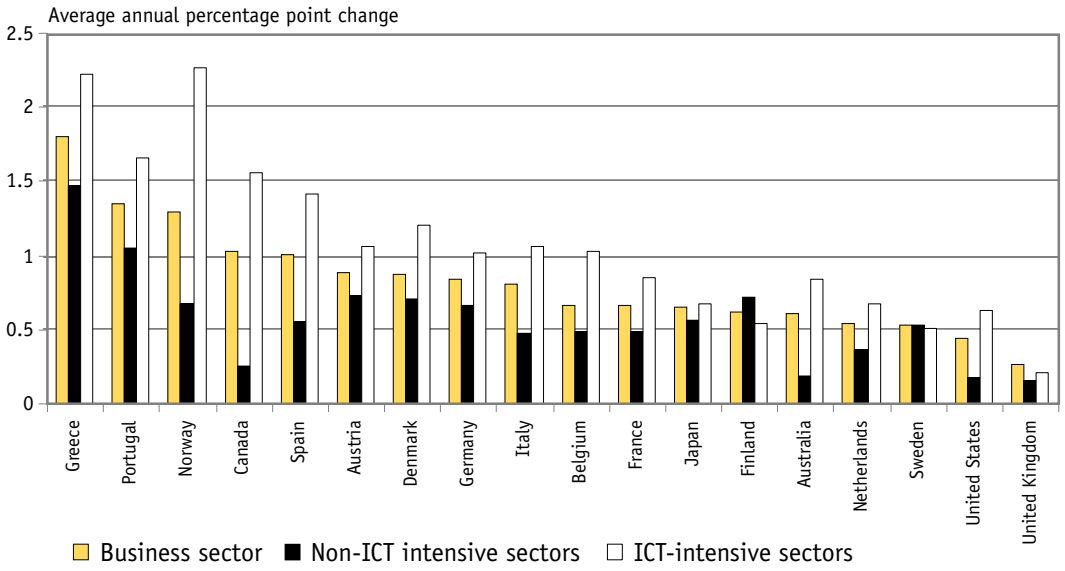
In almost all countries, the detrimental effect of anti-competitive regulation is larger in ICT-intensive sectors given that, as discussed above, the regulatory burden is estimated to be higher in these sectors in comparison to non-ICT intensive sectors. The estimated gap in productivity catch-up in ICT-intensive sectors is particularly sizeable in Austria, Greece, Italy, Germany, Norway, and Belgium, all of which remain 30 per cent to 40 per cent below potential five years after the initial shock. The productivity gain in ICT-intensive sectors also remains 25 per cent below potential in Canada and Spain. Reflecting larger cross-country heterogeneity in the regulation of ICT-intensive sectors, the dispersion of productivity levels across countries is also larger in these sectors following an improvement in the productivity frontier of an equal magnitude in all sectors.

To assess the productivity dividend from faster convergence to the world productivity leader given the reform of product market regulation we drop the assumption of identical initial productivity levels across countries and look at actual productivity developments from 1995 to 2003. In this simulation countries are assumed to have reformed product market regulation in each non-manufacturing sector in 1995 to those of the country with the lowest level of restrictions to competition in 2003. The effect of these reforms percolates through the economy lowering the "knock-on" effects of anti-competitive regulations to an extent that depends on the initial level of sectoral regulations and the intensity with which intermediate inputs from regulated sectors are used in production. For some OECD countries this reform package would be considered ambitious as it involves easing product market regulation in 1995 to levels that are less restrictive than present policy settings in any OECD member country.[18] However, in

18 This is because no single country has least restrictive regulations in all sectors in 2003. Thus, the simulation takes as a benchmark a fictitious country that has best practice sectoral regulations in the last year of our sample.

Chart 12

Increase in Productivity Growth over the Period 1995 to 2003 Given a Move to Sectoral Regulations that are Least Restrictive of Competition in 1995[1]



1 Data are the average increase in annual productivity over the period 1995 to 2003 following an easing of product market regulation in 1995 to the level of the least restrictive regulation in non-manufacturing sectors in OECD countries in 2003. The results are calculated as weighted averages of the sectoral productivity increases using value added weights. Sectoral reallocation effects are ignored.

Source: Conway *et al.* (2006).

the context of recent substantial improvements in product market regulation, this reform package would constitute a continuation of the trend to liberalize product markets, as opposed to a radical shift in policy stance.

In this scenario, the productivity dividend from reform in a given country depends on both the distance from the productivity leader in each sector and the extent of anti-competitive regulation relative to the least restrictive country in each non-manufacturing sector. Over the period 1995 to 2003 the average increase in annual productivity growth in this scenario ranges from 0.2 percentage points for the United Kingdom to 1.8 percentage points for Greece (Chart 12). In some of the other continental EU countries — Portugal, Spain, Germany, Italy, Austria, and France — and Norway and Canada the increase in annual productivity growth is more than 0.75 percentage points. In all countries except Finland and Sweden the gains from product market liberalization are greatest in ICT-intensive sectors, once again reflecting the greater exposure to anti-competitive regulation in these sectors.

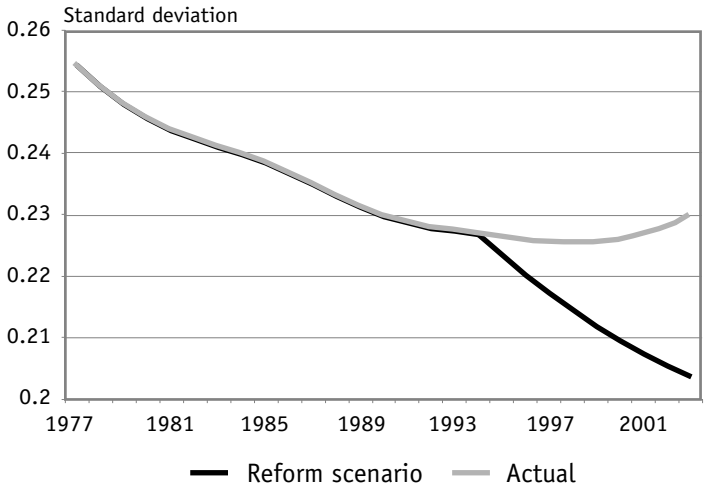
In countries behind the technological frontier the increases in productivity growth from product market reform are relatively large and persistent, implying large total benefits from reform. Because the productivity dividend is higher in these countries, the simulations suggest that convergence in productivity levels would have continued after 1995 if countries had aligned regulation in non-manufacturing sectors on that of the least restrictive OECD countries (Chart 13). This provides indirect evidence that differences in regulation over the 1990s may have at least partly driven cross-country productivity divergence in the past decade.

Implications for Productivity Growth in Canada

The performance of the Canadian economy has been strong across a number of areas over recent years, but average labour productivity growth has recently been relatively poor (Sharpe, 2007). After a period of relatively subdued labour productivity growth since the mid-1980s, productivity growth surged in the late 1990s and outperformed the United States for a couple of years. This proved to be largely cyclical, however, and since 2000 productivity growth has on average been a full percentage point lower than in the United States. As a result, the productivity gap vis-a-vis the United States has been increasing (Chart 1) and is a predominant cause of the lower average incomes in Canada (Cotis, 2006).[19]

There are a number of potential explanations for Canada's relatively weak labour productivity performance including: a comparatively high proportion of small firms, specialization in traditionally low-productivity sectors, and a shortage of the skills necessary to cope with the increasing demands of a knowledge-based economy (OECD, 2006). In addition, Canada's weak labour productivity performance can, to some extent, be related to ICT use. Over the past two decades rates of investment in ICT in Canada have been towards the middle of the range across OECD countries and significantly lower than in the United States, the United Kingdom, Australia and some Nordic European countries (Chart 7). More importantly, the contribution of ICT-using sectors to aggregate labour productivity growth has been quite small in Canada relative to most other OECD countries, particularly the United States (Chart 2). In addition, the increase in the contribution of these sectors to overall productivity growth after 1995 was relatively minor, implying that Canada failed to benefit from the same wave of technology adoption that was driving productivity growth up in the United States and other high-growth OECD countries.

Chart 13
Standard Deviation of Business Sector Output per Employed Person across Countries: Actual and in a Reform Scenario[1]



1 Calculated using cyclically-adjusted series of output and employment in business sector industries for 21 OECD countries (Hodrick-Prescott filter, lambda=100, data extended to 2006 using OECD medium-term projections to mitigate the end-point problem inherent with this filter). The simulated results are derived on the basis of countries adopting in 1995 the non-manufacturing regulations of the least restrictive OECD countries in 2003.

Source: Conway *et al*. (2006).

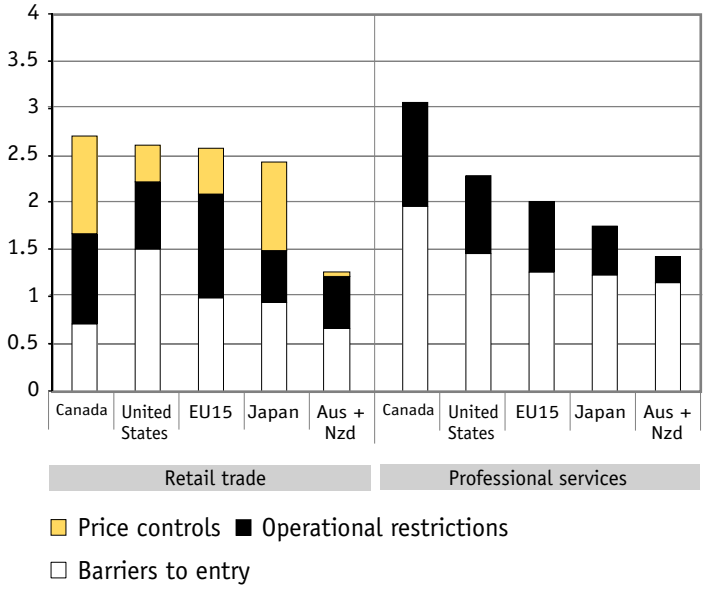
To what extent can Canada's somewhat disappointing productivity performance be related to flaws in product market policies? In this respect, Canada offers a mixed picture of its reformist intent over the past two decades. Starting in the late 1980s, Canada undertook a number of comprehensive structural reforms across a range of non-manufacturing sectors. However, in some other sectors — such as electricity, rail transport, postal services, retail distribution and, especially, professional services — liberalization has been slower and more hesitant in comparison to other countries that commenced reform

19 There is an on-going debate about the size of the productivity gap in Canada vis-à-vis the United States, partly addressing differences in measurement. By all estimates, however, the productivity gap contributes to a significant portion of the living standard gap between the two countries (Baldwin *et al*., 2005 and Institute for Competitiveness and Prosperity, 2006).

Chart 14

Regulation in Retail and Professional Services, 2003

(OECD indicator, scale 0-6 from least to most restrictive)



Source: OECD International Regulation Database.

prior to the 1990s, e.g. the United Kingdom, Australia and New Zealand.[20] In addition, restrictions on foreign direct investment remain higher than in the majority of OECD countries, particularly in telecommunications, broadcasting and air transport (Maher and Shaffer, 2005).

In the electricity sector, for example, some of the provinces are still a long way from having well-functioning electricity markets and a high degree of vertical integration persists in the industry. According to the OECD indicators of electricity regulation, Canada ranks second worst in terms of the restrictiveness of regulation among the 21 OECD countries for which this indicator has been calculated. Within the professional services, some have an exclusive right to provide a large number of services while entry barriers are in some cases high and the conduct of practitioners is restricted in a number of ways. In retail trade, price controls and a number of operational restrictions on retail outlets still persist. In both retail trade and the professions, regulations have even been made more restrictive at the turn of the century according to OECD indicators, with the introduction of additional restrictions on the coverage of retail sale licenses and additional examinations to exercise some of the professions. In both sectors regulation in Canada is estimated to be more restrictive of competition than in most other OECD countries (Chart 14).[21] More generally in the service sector, despite recent progress (as witnessed, for instance, by the TILMA agreement between British Columbia and Alberta) barriers to inter-provincial trade still persist. Although recent evidence suggests that the economic cost of these barriers may be limited (Grady and MacMillan, 2007), the implications for incentives to adopt new technologies and improve efficiency are yet to be fully explored.

Compared with the United States, regulations in Canada remain more restrictive in electricity, air transport, retail distribution and professional services. So although product market regulation is now relatively liberal in a number of sectors (particularly gas, telecoms and road transport), there are still areas in which relatively restrictive regulatory practices persist. These sectors are intensive users of ICT and largely responsible (together with banking) for the large differences in productivity growth across OECD countries (Van Ark *et al.*, 2003; Blanchard, 2004).

Notwithstanding these limitations in reform efforts, our empirical work on the effect of reg-

20 Note that in the context of the OECD indicators of product market regulation, the professional services are comprised of legal services, accounting, architecture, and engineering.

21 For instance, according to OECD regulatory data, the license and permits requirements, shop opening hours regulations, and price controls are more pervasive in Canadian retail distribution than in the most liberal countries.

ulation on ICT investment suggests that the further liberalization of network industries in Canada has had a positive impact on the share of ICT in total investment (Chart 9). Moreover, simulation exercises suggest that this share would increase from around 19 per cent in 2003 to over 21 per cent if Canada were to adopt the regulatory policies of the most liberal OECD countries in network sectors. Perhaps more importantly, further reform efforts in other areas (such as retail trade and the professions) would likely permit Canada to increase ICT investment even further, to reach that of the most ICT-intensive countries.

Our empirical results suggest, however, that the main payoff from further reform in Canada would be a more efficient use of ICT investment that would increase the contribution of ICT-using sectors to aggregate productivity growth, which has been very weak so far. The fact that some of these sectors remain burdened by inappropriate regulations may explain why Canada has found it difficult to increase the contribution of ICT investment to aggregate productivity growth since the mid-1990s. Moreover, by increasing costs and possibly lowering quality, anti-competitive regulation in some of the non-manufacturing sectors may have negative spillover effects on other parts of the economy that use the output of these sectors as intermediate inputs in the production process. Indeed, as in Japan and many continental EU countries, the knock-on effects of these restrictive regulations on ICT-using sectors are particularly high in Canada (Chart 6).

Our empirical results suggest that if Canada had implemented the regulatory policies of the most liberal OECD countries in network industries and other services in 1995, aggregate labour productivity growth would have been just under one percentage point faster per year over the period to 2003. Virtually all of these productivity gains would have occurred in ICT-intensive sectors. Looking forward, depending on future productivity growth rates in leading sectors and on whether both direct and indirect effects of regulation on productivity are considered, our model simulations suggest that labour productivity growth could be between 0.5 and 1 percentage point faster if Canada reformed the remaining areas of anti-competitive regulation in product markets to that seen in the most liberal OECD countries in each sector.

Conclusion

In this article we have summarized empirical research exploring the potential role of anticompetitive product market regulations in explaining the differing abilities of countries to integrate ICT technologies into the production process and use them efficiently. Our findings suggest a potential explanation for the apparent paradox of diverging productivity trends across countries in conjunction with a degree of regulatory convergence. Countries that delayed reforms until the late 1990s were unable to fully exploit the opportunities offered by the ICT global shock: their rate of ICT investment remained relatively low and rigidities due to excessive regulation in key ICT-using sectors propagated in the economy, making it difficult to use ICT as efficiently as in countries where the regulatory environment was more business friendly. As a result, after decades of convergence, productivity levels began diverging across OECD countries and while some countries experienced productivity growth acceleration, productivity growth in other countries stagnated or decelerated.

In the case of Canada, our work suggests that regulatory barriers to competition in a few key non-manufacturing sectors may have prevented Canada from benefiting to the full extent from high productivity growth in the United States and other productivity leaders by slowing down the speed of catch-up to best

practice. This points to a missed opportunity for past policies. On a more positive note, the same estimates would also imply that, *ceteris paribus*, implementing those reforms now could significantly increase Canadian labour productivity growth over the next decade, depending on future productivity growth in the leading economies.

Appendix: Data Sources

Labour Productivity Data

The aggregate data on business sector labour productivity are derived from national accounts and are calculated as the ratio of GDP to total employment in the business sector. GDP in the business sector in calculated by subtracting the value added of the government sector from total GDP, while employment in the business sector is the difference between total employment and employment in the government sector. GDP figures are made comparable across countries and over time by converting nominal values to 2000 purchasing power parities. OECD labour productivity data is available at http://oecd.org/statistics/productivity.

Sectoral labour productivity measures are derived from the data contained in the OECD STAN database for industrial analysis (http://oecd.org/sti/stan). Labour productivity is calculated as the ratio of sectoral value added to sectoral employment. As discussed in the text, aggregate purchasing power parities were used to make the sectoral productivity data comparable across sectors, countries and time. As for the aggregate measures, the base year chosen for the conversion of value-added is 2000.

ICT Data

The aggregate ICT dataset used in this analysis consists of OECD data on gross fixed capital formation for 18 countries over 1985-2001, with data for some countries through to 2003. The countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Portugal, Spain, Sweden, United Kingdom, and United States. The variable used in regressions, ICT share of total investment, is calculated as investment in hardware, software, and computer equipment divided by total non-residential investment.

The sectoral ICT data are obtained from the University of Groningen and are described in detail in Inklaar, O'Mahoney, and Timmer (2003). These data cover five countries France, Germany, Netherlands, United Kingdom, and United States, over 1980—2001, and are disaggregated to the two digit ISIC Rev.3 level. ICT data is available at http://oecd.org/statistics/productivity.

The classification of ICT-producing, ICT-using, and non-ICT intensive sectors

Empirical measures of ICT use by sector are available for several countries, based on capital flow matrices and capital stock estimates. Work using data for the United States implies that investment in ICT equipment is concentrated in service sectors. For example, according to some estimates 78 per cent of total business investment in ICT in the United States is undertaken in the wholesale and retail trade, finance, insurance, and real estate sectors. Manufacturing, on the other hand is found to be responsible for only 17 per cent of ICT investment. The classification of ISIC rev.3 sectors into ICT-producing (P), ICT-using (U), and non-ICT intensive (N) sectors follows Inklaar, *et al*., (2003) and is as follows:

ISIC code	Industry	ICT classification
15-16	Food Products, beverages and tobacco	N
17-19	Textiles, textiles products, leather & footwear	N
20	Wood except furniture	N
21-22	Pulp, Paper, paper products, printing & publishing	U
23-25	Chemical, rubber, plastics & fuel products	N
26	Other non-metallic mineral products	N
27-28	Basic metals and fabricated metal products	N
29	Machinery and equipment, n.e.c.	U
30-33	Electrical and optical equipment	P
34-35	Transport equipment	N
36-37	Furniture; recycling	U
40-41	Electricity, gas and water supply	N
45	Construction	N
50-52	Wholesale and retail trade; repairs	U
55	Hotels and restaurants	N
60-63	Transport and storage	N
64	Post and telecommunications	P
65-67	Financial intermediation	U
70	Real estate	N
71-74	Renting of M&EQ and other business activities	U

References

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

Aghion, P. and R. Griffith (2005) *Competition and Growth: Reconciling Theory and Evidence* (Cambridge: MIT Press).

Aghion, P. and P. Howitt (2005) "Appropriate Growth Policy: A Unifying Framework," Joseph Schumpeter Lecture, 20th Annual Congress of the European Economic Association, Amsterdam, August 25.

Aghion, P., N. Bloom, R. Blundell, R. Griffith and P. Howitt (2005) *Quarterly Journal of Economics*, May, pp. 701-728.

Alesina, A., S. Ardagna, G. Nicoletti, and F. Schiantarelli (2005) "Regulation and Investment," *Journal of the European Economic Association*, Vol. 3, No.4, pp. 791-825.

Baldwin, J., J.-P. Maynard and F. Wong (2005) "The output gap between Canada and the United States: The role of productivity," Catalogue No. 11-624-MIE, Statistics Canada (Ottawa).

Blanchard, O. (2004) "The Economic Future of Europe," *Journal of Economic Perspectives*, Vol. 18, No. 4, pp. 3-26

Bresnahan , T. and S. Greenstein (1996),"Technical Progress and Co-invention in Computing and in the uses of Computers," *Brookings Papers: Microeconomics*, The Brookings Institute.

Bosworth, B. and J. Triplett (2007) "The Early 21st Century U.S. Productivity Expansion is *Still* in Services," *International Productivity Monitor*, No. 14, Spring, pp. 3-20.

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

Conway, P. and G. Nicoletti (2006) "Product Market Regulation in the Non-Manufacturing Sectors of OECD countries: Measurement and Highlights," OECD Economics Department Working Papers. Forthcoming.

Conway, P., D. De Rosa, G. Nicoletti and F. Steiner (2006) "Regulation, competition and productivity convergence," OECD Economics Department Working Papers No. 509.

Cotis, J. (2006) "Benchmarking Canada's Economic Performance," *International Productivity Monitor*, No. 13, Fall, pp. 3-21.

Crafts, N. (2006) "Regulation and Productivity Performance," *Oxford Review of Economic Policy*, Vol 22, No 2.

Gordon, R.J. (2004) "Why Was Europe Left at the Station when America's Productivity Locomotive Departed?" *CEPR Discussion Papers*, No. 4416

Grady, P. and K. Macmillan (2007) "Inter-Provincial barriers to internal trade in goods, services and flows of capital: policy, knowledge gaps and research issues," Submitted to Industry Canada and Human Resources and Social Development Canada.

Griffith, R. and H. Simpson (2006) "Product Market Reform, Innovation and EU Productivity Growth," Institute for Fiscal Studies.

Griffith, R., S. Redding and J. Van Reenen (2004) "Mapping the Two Faces of R&D: Productivity Growth in a Panel of OECD Countries," *Review of Economics and Statistics*, November, Vol. 86, No. 4, pp. 883-895.

Guellec and van Pottelsberghe de la Potterie (2001) "R&D and Productivity Growth: Panel Data Analysis of 16 OECD Countries," *OECD Economic Studies*, No 33.

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.

Inklaar, R., M. O'Mahony and M. Timmer (2003) "ICT and Europe's Productivity Performance: Industry-Level Growth Account Comparisons with the United States," Groningen Growth and Development Centre, Research Memorandum GD-68.

Institute for Competitiveness and Prosperity (2006) "Time on the job: Intensity and Ontario's prosperity gap," Working Paper No. 9, (Toronto).

Keller, W. (2004) "International Technology Diffusion," *Journal of Economic Literature*, Volume XLII September, pp.752 – 782.

Maher, M. and J. Shaffer (2005) "Product Market Competition and Economic Performance in Canada," OECD Economics Department Working Paper No. 421.

Nicoletti, G. and S. Scarpetta (2003) "Regulation, Productivity and Growth: OECD Evidence," *Economic Policy*, Vol. 18, Issue 36, April.

Nickell, Stephen, Daphne Nicolitsas, and Neil Dryden (1997) "What makes firms perform well?" *European Economic Review*, Vol. 41(3-5), April, pp. 783-796.

OECD (2002a) "Measuring the Information Economy 2002," www.oecd.org/sti/measuring-infoeconomy.

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

OECD (2003b) *ICT and Economic Growth: Evidence from OECD countries, Industries and Firms*, (Paris: OECD).

OECD (2006) *OECD Economic Surveys: Canada*, Paris.

OECD (2007) *OECD Employment Outlook*, Paris.

O'Mahony, M. and B. van Ark (2003) *EU Productivity and Competitiveness: An Industry Perspective* Enterprise Publications, European Commission.

Pilat, D., F. Lee and B. van Ark (2002) "Production and Use of ICT: A Sectoral Perspective on Productivity Growth in the OECD Area," *OECD Economic Studies, V*ol 32, No 2.

Pilat, D. and A. Wölfl (2004) "ICT Production and ICT Use: What Role in Aggregate Productivity Growth?" in *The Economic Impact of ICT: Measurement, Evidence and Implications.* OECD, Paris.

Sharpe, A. (2007) "Three Policies to Increase Productivity Growth in Canada," in J. Leonard, C. Ragan and F. St-Hilaire (eds.), *A Canadian Priorities Agenda: Policy Choices to Improve Economic and Social Well-Being*, (Montreal: The Institute for Research on Public Policy) pp. 353-388.

Van Ark, B., R. Inklaar and R. McGuckin (2002) "Changing Gear" Productivity, ICT and Services: Europe and United States," *Groningen Growth and Development Centre*, Research Memorandum GD-60.