PRELIMINARY DRAFT, NOT TO BE QUOTED WITHOUT AUTHORS' PERMISSION

PRODUCT MARKET POLICIES, ALLOCATIVE EFFICIENCY AND PRODUCTIVITY: A CROSS-COUNTRY ANALYSIS

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Introduction

The past two decades have witnessed major changes in the growth performance of OECD countries. Some of them – including the United States, Australia and a number of smaller European economies -- have managed to reverse the long-standing slowdown in productivity growth.[2] Other countries, including most continental European ones (as well as Japan), have been lagging behind, with stagnating or decelerating productivity growth. As a result, the income gap of the EU as a whole worsened relative to the US even discounting the effects of German unification. This reversal in the historical process of economic convergence among OECD countries is puzzling because it coincided with a period of policy convergence in many areas, such as macroeconomic stabilisation, trade and product market liberalisation and greater financial integration. The dichotomy between growth performances and policy convergence over the past decade has been related to the different ability of OECD countries to harness the potential of a new general-purpose technology – the information and communication technology (ICT).[3] It was originally thought that cross-country growth divergence was only temporary -- associated to the technology shock in ICT-producing industries (e.g. Oliner and Sichel, 2000; Gordon, 2000) – but productivity and output growth differentials have persisted well into the new millennium, further widening the gap in living standards between the United States and many EU countries. The sources of these divergent growth paths

1. Economics Department. The views expressed in this paper are those of the authors and should not be taken to represent those of the OECD member countries.

2. Among smaller European economies, there were starkly contrasting developments: productivity continued to grow fast in Ireland, some Nordic countries, Portugal and Greece, while its growth remained disappointing in the Netherlands, Spain and, especially, Switzerland.

3. Some early studies have emphasised the significant acceleration in multifactor productivity in computer and semiconductor production and its effects on IT investment in other sectors of the economy (Oliner and Sichel, 2000; Jorgenson, Ho and Stiroh, 2000; Gordon, 2000; and the survey by Anderson and Kliesen, 2006). More recently, other studies have emphasised the strong acceleration of MFP in service sectors, resulting from both organisational changes related to IT and a better allocation of resources in service industries (Basu and Fernald, 2006; Triplett and Bosworth, 2004; Bosworth and Triplett, 2007a; Bosworth and Triplett, 2007b).

have also evolved, with a greater role played by productivity acceleration in ICT-using industries (e.g. Triplett and Bosworth, 2004; Basu and Fernald, 2006).[4]

A number of theoretical and empirical studies have tried to explain the growth disparities of the past decade pointing to persistent differences in the business environment and the related incentives to innovate and adopt new technologies, as well as to the relative delay in implementing market-oriented reforms in key sectors.[5] Empirical research in this field has rapidly moved from aggregate analyses to sectoral and, more recently, firm-level studies: cross-country gaps in aggregate growth performances were shown to depend to a large extent on the performance of key ICT-"intensive" sectors (*e.g.* Triplett and Bosworth, 2004; van Ark *et al.* 2003, 2007) and on the ability, within these sectors, to nurture technology adoption and innovation through the entry of new firms and the retooling of existing businesses (Bartelsman *et al.,* 2004*;* Brynjolfsson and Hitt, 2000). Indeed, the past decade has often been seen as a sort of "natural experiment", where OECD countries with different policies and institutions were exposed to the rapid diffusion of a new general-purpose technology that required a business environment encouraging experimentation and fast reallocation of resources across sectors and firms to accommodate and make the best use of technological developments.[6,7]

The list of policy and institutional factors that could potentially promote experimentation and an efficient allocation of resources across sectors and firms is long. A substantial literature has examined the impact of credit constraints on firm dynamics and technology adoption (e.g. Rajan and Zingales, 1998; Beck *et al.,* 2004*;* Klapper *et al.* 2006; Aghion *et al*., 2007). A more limited number of studies have looked at the role of labour market regulations in influencing labour reallocation and the adaptability of firms to technological shocks (Haltiwanger *et al*., 2006; Micco and Pagés, 2006). More recently, the empirical literature has increasingly been focusing on regulations in the product market, especially those that affect competitive pressures. Interest in competition as one of the main drivers of efficiency improvements, was revived by so-called neo-Schumpeterian theories of growth, which focused on the effects of new entry and rivalry among incumbents on technology adoption, innovation and productivity growth. Some studies have focused on policy-induced entry barriers (e.g. Scarpetta *et al*., 2002; Scarpetta and Tressel, 2002; Nicoletti and Scarpetta, 2003; Arnold *et al.* 2007, Desai *et al.* 2003*;* Fishman and Sarria Allende, 2004; Griffith *et al*., 2004; Conway *et al*., 2006), while others have used foreign entry to proxy for competitive pressure on domestic incumbents (e.g. Aghion *et al.*, 2004; Griffith *et al.*, 2006). This empirical research has also been

4. See Annex 2 for the classification of ICT-producing, ICT-using and non-ICT using industries adopted in this paper.

5. Studies on the links between competition and growth are surveyed by Aghion and Griffith (2005); Acemoglu *et al.* (2005) provided theoretical foundations.. For cross-country empirical analyses see e.g. Scarpetta and Tressel, (2002); Nicoletti and Scarpetta (2003); Conway et al. (2006); Griffith, *et al.* (2006).

6. Resource reallocation is driven by incumbent firms adapting to market and technological changes, but also by firm dynamics – the entry of new firms, their expansion in the initial years of life and the exit of obsolete units. Interestingly, while the magnitude of firm demographics is fairly similar across U.S. and EU countries with different institutional and policy settings, the characteristics of entrants and exiters, their growth performance and overall contributions to technological adoption and ultimately to productivity growth vary considerably (Foster *et al.* 2006; Bartelsman *et al.* 2004; Griffith *et al.* 2006).

7. Firm-level analyses have for long been largely concentrated in the US, but in recent years a number of studies have focused on EU countries and some have even ventured in cross-country comparisons. The latter suggest that all market economies are characterized by a continuous process of reallocation of resources and that this process play a major role for aggregate productivity and output growth (e.g. Olley and Pakes, 1996; Foster *et al.* 2002; Griliches and Regev, 1995; Bartelsman *et al.* 2004).

motivated by the large cross-country variability in policy choices in this area and the sheer magnitude of reforms explicitly aimed at promoting competition and productivity growth in OECD countries.[8]

In this paper we take a fresh look at the relationship between competition policies and productivity growth focusing on the divide between relatively "deregulated" English-speaking countries and relatively "restrictive" continental European countries. Relying on both recent empirical results and new evidence at both the industry and firm levels, we argue that the relationship between the pace and depth of product market reforms – and in particular reforms in those aspects of regulations more influential for firm dynamics and resource reallocation – and the timing of the ICT shock are important for understanding the growth divergence between these two groups of countries. In many of them, notably in continental Europe, product market reforms in key ICT-using sectors have indeed been slow and hesitant. Our working hypothesis is that delaying these reforms not only reduced the scope of the creative destruction process (the entry and exit of firms and reallocation among incumbents), but also, by reducing market contestability, weakened the incumbents' incentives for incorporating ICT into new vintages of the capital stock and reaping the efficiency gains originating from the changes in the organisation of production that they allow. Drawing from harmonised industry-level and firm-level data, we provide evidence of significant differences in allocative efficiency across countries, which are largely driven by the weaker ability of heavily regulated countries to quickly channel resources towards the most dynamic firms. 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 most of the EU until recently. In turn, slower productivity improvements in ICT-using service sectors limited the scope for price containment and quality improvements for the products and services of these sectors with negative effects on the performance of other sectors that used them intensively.

The rest of the paper is organised as follows. In Section 2, we review the theoretical linkages between anti-competitive product market regulations, investment, resource reallocation and ultimately productivity growth. We also briefly discuss how differences across countries in these regulations have evolved over time relying on OECD indicators. We then move in Section 3 to the evidence on the regulation-productivity linkage at the aggregate, sectoral and firm levels. After a brief reminder of cross-country growth patterns, we show how differences in regulation have interacted with the ICT supply shock to shape divergence in growth performances over the past two decades, focusing on ICT investment and the performance of ICT-intensive sectors. We then examine more in detail how differential growth performances have been affected by the ability of OECD economies to reallocate resources to fast growing sectors and firms. For this, we present new econometric evidence on how product market regulations affect productivity performance of different firms in a sample of EU countries. In Section 4 we conclude.

II. The effects of product market regulation on productivity

II.1 How does regulation affect productivity?

Product market regulations, like other regulations, generally address public interest concerns about market failures, including monopoly conditions, externalities and asymmetric information. In this context, product market regulation can promote competition in certain industries by ensuring that market power in natural monopoly segments is not used abusively and by providing the correct incentives to market participants. However, regulatory frameworks may be flawed by several (possibly concurring) factors. Some regulations may drift away from their original public interest aims, resulting in the protection of special interest groups. Second, regulations (and their implementation) sometimes involve costs that

8. In an early attempt to relate reforms to growth, Koedijk and Kremers (1996) noted that policy changes in European product markets have sometimes been deeper than reforms in labour markets.

exceed their expected benefits, leading to so-called "government failure". Third, technical progress, the evolution of demand and progress in regulatory techniques can make the design of regulations obsolete.

Inappropriate regulations can affect the productivity performance of an economy in many ways. They can influence the productivity of existing firms by altering the incentives to invest, adopt the leading technologies available in the market and innovate. They can raise entry costs, curbing competitive pressure and hindering the reallocation of resources across sectors producing different goods and services and, within each sector, across firms with different productivities. To the extent that a lack of competitive pressure results in higher prices, this can generate trickle-down effects into downstream sectors by raising their costs of intermediate inputs, particularly in services industries where import competition is limited. Regulation can also have differential effects on different industries and firms depending on specific technological and market factors as well as on their position relative to frontier production techniques.

Given the multiple channels and the potentially conflicting effects, it is hard to provide a single and exhaustive taxonomy of the regulation-productivity linkages.[9] This section briefly reviews some of the ways in which regulations that inappropriately raise barriers to entry and firms' costs can influence productivity under two main headings: the effects on incumbent firms and the effects through firm dynamics and the associated resource reallocation.[10] Needless to say, we cannot give justice to the vast theoretical literature linking product market competition and productivity and just refer to the studies most closely related to our subsequent empirical analysis.

Regulation and the productivity of incumbents

There are three main ways in which policies that ease regulatory burdens and restrictions to competition (where competition is viable) can affect the productivity performance of incumbent firms: they can contribute to eliminate the slack in the use of resources, enhance capital intensity and increase innovative efforts. In the following we will subsume into these efforts both the adoption of frontier technologies and more fundamental innovation activities.

Regulation and slack

Product market policies that promote entrepreneurship and competition contribute to productivity improvements by raising the efficiency with which inputs are used (see Winston, 1993, for a review).[11] These policies help to eliminate organizational slack, particularly managerial slack or reduced work effort in situations of asymmetric information or moral hazard. For example, competition creates greater opportunities for comparing performance, making it easier for the owners or the market to monitor managers. Competition is also likely to raise the risk of losing market shares at any given level of managerial effort, inducing managers to work harder so as to avoid this outcome. Moreover, cost-reducing productivity improvements also generate a higher bang-for-the-buck in competitive environments in which the price elasticity of demand is higher.[12] To the extent that workers share product market rents with managers, more competition can also induce more worker effort (Haskel and Sanchis, 2000). Finally,

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9. For two recent attempts, see Griffith and Harrison (2004) and Crafts (2006).

10. In other words, we concentrate on ways in which ill-designed regulations can harm productivity. We do not discuss the potential benefits of appropriate regulations for productivity.

11. A related channel is the elimination of the deadweight loss associated with regulatory burdens (see Crafts, 2006).

12. These channels are highlighted by Hart (1983), Lazear and Rosen (1981), Nalebuff and Stiglitz (1983); Aghion and Howitt (1998) and Nickell, Nicolitas and Dryden (1997).

business-friendly regulations may make it easier to implement efficiency improvements by reshuffling resources within and across establishments.[13]

It should be stressed that theoretical predictions of the effects of greater competition on managers' incentives are often subtle and ambiguous (Vickers, 1995; Schmidt, 1997). Models using explicit incentives under information asymmetry do not lead to clear-cut implications (see *e.g.*, Holmström, 1982), while inter-temporal models using implicit (*i.e.*, market-based) rewards suggest a positive link between competition and managerial effort only if productivity shocks are more correlated across competitors than managerial abilities (Meyer and Vickers, 1997). But, competition could also lead to more slack if managers are highly responsive to monetary incentives, as the scope for performance-related pay is reduced (Scharfstein, 1988; Martin, 1993).

Regulation, investment and technology adoption

In a recent study, Alesina *et al.* (2005) suggest that less red tape and lighter regulatory burdens lower the costs of adjusting the capital stock, thereby boosting the willingness of firms to react to changes in fundamentals by expanding their productive capacity. In their model -- an extension of the monopolistic competition model by Blanchard and Giavazzi (2003) to two factors of production -- a reduction in barriers to entry increases the number of firms, leading to a decrease in the mark-up of prices over marginal costs and, therefore, of the shadow cost associated with capital and output expansion by incumbent firms. In the long run, this is likely to expand activity levels and stimulate capital formation. Their empirical results show that restrictive regulations contribute to explain the diverging patterns of investment rates in services on the two sides of the Atlantic over the past two decades.

However, the effects of regulation on productivity through capital deepening are not straightforward for a number of reasons. First and foremost, while labour productivity rises with higher capital-labour ratios, the relationship between capital deepening and multifactor productivity is ambiguous: to the extent that an increase in the capital-labour ratio is induced by policies or institutions that distort relative factor prices, multifactor productivity may suffer. For instance, Poschke (2007) argues that more costly regulations in Europe have tilted firms' technology choices towards higher capital intensity than in the United States, which reduced multifactor productivity by acting as an entry barrier that protects low-productivity incumbents.[14] Second, recent theoretical and empirical research (*e.g.* Blanchard and Giavazzi, 2003; Griffith *et al.*, 2007; Fiori *et al.*, 2007) has shown that product market regulation also tends to lower employment. Hence, the net effect of these regulations on capital deepening is not clear a priori. Third, different types of regulations are likely to have different effects on capital formation. For instance, certain regulations, such as ceilings on the rate of return on capital, encourage firms to over accumulate capital in order to increase their overall remuneration – the so-called Averch-Johnson (1962) effect. Moreover, ill-designed de-regulation can fail to provide the right incentives to expand capacity.[15]

13. For instance, Lagos (2006) provides a model that relates multifactor productivity to labour market regulations faced by entrepreneurs. The effects on growth trajectories of reforms that improve the efficiency in the use of inputs have been recently stressed by Bergoeing *et al.* (2002), among others.

14. Using a standard heterogeneous-firm model, Poschke (2007) shows that small differences in administrative entry costs can explain a significant proportion of US-EU differences in capital-output ratios and multifactor productivity. In his model, higher entry costs induce both a higher equilibrium capital intensity and a lower investment rate, due to less firm entry. Thus, his findings are consistent with the inverse relationship between regulation and investment rates found by Alesina *et al.* (2005).

15. In particular, certain sectors such as network industries have been subject to a re-design of price regulation (e.g., from rate of return to price caps or access pricing regimes), changes in industry structure (e.g., vertical separation of networks from service provision) and ownership structure (e.g. privatization), with uncertain effects on capital

The effects of lighter product market regulation on productivity through technology adoption are more clear-cut. The opening up of markets and increased competitive pressures provide both opportunities and incentives for firms to upgrade their capital stock and adopt new technologies to reach frontier production techniques, though this may depend on their distance to frontier (see below). The role of regulatory barriers and monopoly rights in curbing or preventing technology adoption has been illustrated in a series of studies by Parente and Prescott (*e.g.*,1994; 1999) who pointed out, using calibrated neo-classical growth models with technology adoption, that differences in such barriers could help explain persisting cross-country differences in GDP per capita levels. Another class of models has focused on the role of new technologically advanced entrants. Firms may come with new technology, often embodied in new capital stock, and this gives incumbents the opportunity to upgrade their capital through imitation. Aside from pure imitation, incumbents may also benefit from various kinds of externalities originating from affiliates of foreign multinationals -- such as exposure to foreign high-technology intermediate inputs (Rodríguez-Clare, 1996) and learning spillovers for the host-country labor force (Fosfuri *et al.*, 2001).[16] While the empirical evidence is mixed, recent cross-country and micro-economic studies suggest that these effects are significant, especially in the developed countries and were absorptive capacity is high, indicating that an increase in the presence of foreign affiliates is likely to be associated with higher levels of multifactor productivity.[17]

Recent neo-Schumpeterian models of endogenous growth (Acemoglu *et al*., 2003) embody the feature that, with technology flowing unfettered across countries, productivity growth in follower countries or industries is a positive function of the gap between the productivity level of the country or industry and the world technological frontier, i.e. countries and industries lagging behind the technological frontier can promote productivity also be adopting leading technologies available on the market (the technological catch-up phenomenon). Thus, productivity growth depends on both the ability to catch up and the ability to innovate, with the importance of the latter increasing as the country or industry gets closer to the world frontier (Aghion and Howitt, 1998 Ch. 8).[18] It should be stressed, however, that neo-Schumpeterian research finds the aggregate impact of (domestic or foreign) competition on productivity to be non-linear and to depend on the characteristics of incumbent firms (*e.g.* on the degree of firm heterogeneity). We discuss these issues below in the context of the effects of competition on innovation.

Innovation

The channels through which regulations that promote or hinder competition can influence innovative activities of incumbent firms are multiform. Research focusing on the effects of competition on innovation has a long history but theoretical and empirical studies have been growing rapidly over the past decade, as surveyed recently by Aghion and Griffith (2005). Here, we will just remind some landmark results that will be useful in understanding our later empirical analysis, focusing on models that allow for an effect of competition on aggregate productivity growth through its effect on innovation. Two main

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formation. Regulatory risk due to a frequently changing regulatory framework can also have implications for investment behaviour.

16. The role of "knowledge capital" in multinational enterprises, which provides the basis for spillovers to host-country firms, has recently been summarised by Markusen (2002).

17. This literature has been recently surveyed by Keller (2004) and Görg and Greenaway (2004). For studies finding positive spillovers, see for instance Haskel *et al.* (2002), Griffith *et al.* (2006), Javorcik (2004) and Arnold *et al.* (2007). Recently, the attention has been focused on the precise channels through which these spillovers occur (see, for instance, Crespi *et al.*, 2007).

18. Griffith *et al*. (2004) show that, by investing in R&D, follower countries reap a double dividend: they improve both their ability to innovate and their ability to incorporate frontier technologies in to the production process.

effects are at work: the so-called "appropriability" effect that stresses the need for innovating firms (new entrants or incumbents) to expect a sufficient level of post-innovation rents; and the "escape competition" effect that stresses the need for incumbents to innovate in order to preserve their pre-innovation rents, when faced with the possibility that their rivals (new entrants or incumbents) may innovate.

Early analyses focused mainly on the appropriability effect and post-innovation rents (in the Schumpeterian spirit). In this framework, the main source of aggregate innovation originates from new entrants and the "creative destruction" process through which inefficient incumbents are replaced by new innovating firms. Because tighter competition reduces the expected post-innovation rents, a generally negative effect of increased competition on innovation efforts (and therefore productivity) of incumbents is expected, except under very special conditions (*e.g.* perfect protection of intellectual property rights).[19]

More recent "neo-Schumpeterian" analyses have questioned this view in several ways. First, they stressed that, as competitive pressures increase, what is relevant for incumbents' innovation incentives is their effect on the *difference* between pre and post-innovation rents or, equivalently, whether the escape competition effect dominates the appropriability effect (Aghion *et al*., 2005).[20] If the escape competition effect is sufficiently strong, incumbents will engage in innovation when faced with tougher competition.[21] These models therefore potentially allow innovation by both new entrants and incumbents. However, as competition becomes tough enough to substantially reduce post-innovation rents, the escape competition effect may not dominate anymore and incumbents may cease to innovate in response to increased competition. Thus, the relationship between aggregate innovation (and productivity) and competitive pressures is likely to be hump-shaped, with too little or too much competition being harmful for innovative efforts (for given protection of intellectual property rights). Moreover, when entry of firms operating at the world technological frontier is explicitly accounted for, neo-Schumpeterian models imply that the positive escape competition effect on incumbents' innovative activities will be stronger for firms whose cost structure is close to that of their innovating rivals than for firms that have a large technological gap to fill (Aghion *et al*., 2004; Aghion *et al*., 2006). The reason is that a "discouragement" effect is at work: the innovation effort needed of firms that are "neck-and-neck" to maintain the lead over their rivals is smaller than the effort required from firms that are further back on the technology scale.[22] Indeed, for firms that are far enough from the world frontier, the discouragement effect due to an increase in entry (which can reflect competition in a market) can be strong enough to deter any innovation activity. This highlights the importance of firm heterogeneity and reallocation of resources from low to high-productivity firms for assessing the impact of product market policies on aggregate productivity outcomes.

Regulation, reallocation and firm dynamics

The Schumpeterian view of the importance of creative destruction for promoting a better allocation of resources and productivity growth has gained further strength over the past decade as

19. Negative effects of competition on innovation by incumbents are a feature that is common to a wide variety of models of endogenous technical change in which entry of new firms is the only source of innovation (Romer, 1990; Aghion and Howitt, 1992; Grossman and Helpman, 1991).

20. This insight of neo-Schumpeterian theories is related to earlier analyses of the interplay between the "rent dissipation" effect and Arrow's (1962) "rent replacement" effect (Gilbert and Newbery, 1982; Fudenberg and Tirole, 1986).

21. A related effect of competition on incumbents' innovation incentives (the "restructuring" effect) had been previously unveiled by Aghion and Schankerman (2003) in a model with heterogeneous firms, in which competition would encourage high-cost firms to innovate in order to avoid losing market shares to low-cost rivals.

22. An early model with gradual innovation, in which neck-and-neck firms coexist with more laggard firms was proposed by Aghion *et al*. (1995).

evidence of wide heterogeneity in firms' characteristics and performance in most market economies has grown.[23] This widespread heterogeneity highlights the limits of models based on the "*representative agent"* hypothesis or based on identical monopolistic competition firms, and suggests that the assessment of aggregate productivity may require knowledge of the cross-sectoral distribution of activity and changes at the firm level. The observed heterogeneity of firms is often associated with the idea that firms, whether new entrants or incumbents, are continuously evolving and testing new technologies (broadly defined to include the use of advanced technologies but also organizational structures) in order to gain market shares or simply survive.[24] Experimentation is directly related to firm dynamics. New firms replacing obsolete units represent a way in which the market evolves. Moreover, firm turnover may also be an important vehicle for the adoption of new technologies and indeed this may be particularly relevant in the case of ICT.[25] The latter often require significant changes in the organization of production and skill composition, and newcomers may have a comparative advantage in adopting them relative to existing firms in as much as they do not have to incur in these adjustment costs. However, entering a new market always involves significant uncertainties, especially if this is associated with the adoption of a new, potentially more productive but also more uncertain, technology. The wider technological options available to entrant firms but also the greater uncertainty concerning their business plan justify the observed greater variance in the performance of young businesses compared with older incumbents.

The incentives for new firms as well as for incumbents to engage in experimentation and the associated reallocation of resources are likely to be influenced in different ways by product market regulations. It should be stressed that the links between firm heterogeneity and the degree of market experimentation on the one hand, and product market regulations, on the other, is not clear-cut. As stressed by Bartelsman *et al.* (2004), inappropriate regulations may affect the reallocation dynamics on different margins in a variety of ways. For example, high start-up costs are likely to reduce firm turnover and potentially lead to a less efficient allocation of resources, but those firms that indeed enter the market may have a higher productivity than otherwise due to a tighter selection at entry. In turn, the average productivity of incumbents and exiting businesses will be lower. Similarly, certain market distortions might weaken the selection process at entry and exit leading to less systematic differences between entering, exiting and incumbent businesses. There is also an important time dimension related to the analysis of firm dynamics and economic performances. Market conditions that promote experimentation and trial and error processes, may be associated with more risk and uncertainty in the short run, leading to a lower immediate contribution from entry and exit to productivity, but a higher long-run contribution when the trial and error process of the experimentation has worked its way out (through learning and selection effects).

A number of theoretical studies have tried to account for firm heterogeneity and modelled distortions to entry and exit as well as reallocation. For example, Bernard *et al.* (2003) and Melitz (2003) highlight the role of external barriers affecting the degree of competition in the product market, while building on models by Melitz and Ottaviano (2007) and Del Gatto *et al.* (2006), Corcos *et al.* (2007) find that lifting behind-the-border barriers may be even more important for productivity. In their models with heterogeneous firms, a lowering of trade barriers generates a reallocation of resources in favour of more

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23. The heterogeneity in firm's behaviour, even within narrowly-defined industries or markets has been well documented (see e.g. Caves, 1998; Bartelsman and Doms, 2000; Bartelsman *et al*., 2004).

24. Different theoretical models and a growing empirical evidence support the idea that firms – both incumbents and new firms – are engaged in a continuous process of "experimentation" in which they choose whether to enter or stay in the market, and whether or not to expand and adopt new technologies that may have higher potentials but also run greater risks (see e.g. Sutton, 1997, Pakes and Ericson, 1998, and Geroski, 1995, for surveys)

25. Bartelsman *et al*. (2004) as well as Bartelsman (2005) indeed found that the entry of new firms plays a stronger role in boosting aggregate productivity in high-tech industries as compared with medium and low-tech industries.

productive firms. In particular, the exit of low productivity firms and the expansion in the domestic and foreign markets of more productive firms lead to an increase in aggregate productivity growth. Bergoeing *et al.* (2004) also allow for idiosyncratic differences in firm productivity and focus on the effect of a productivity shock on aggregate productivity when there are government-induced frictions in the reallocation of resources, which they assume to take the form of a subsidy to incumbents. Their simulations suggest that such subsidies lengthen the period in which output is below potential. A few additional studies have further developed models with adjustment frictions that prevent resources from immediately being allocated to the most productive firms (see e.g. Restuccia and Rogerson, 2007; Hsieh and Klenow 2006; Bartelsman *et al*., 2007). Static and dynamic frictions partly depend on market characteristics and technological factors but are also clearly related to inappropriate product market regulations. In particular, frictions may represent the costs of adjustment – either in the form of entry and exit costs, or adjustment costs in reallocating factors of production such as capital and labour.[26] In these models as well, both policy-induced entry costs and regulations that raise the adjustment costs to technological shocks reduce aggregate productivity.

Summing up

A number of theoretical models suggest that by easing the entry of new firms, increasing rivalry among incumbents and reducing frictions in the reallocation of resources, product market reforms are likely to promote aggregate investment, technology adoption, innovation and, ultimately productivity growth. However, offsetting factors and uncertainties inherent in the channels described above – *e.g.* the ambiguous effect on managerial incentives and the different response of firms with different characteristics -- indicate that the strength, if not the direction, of the link between product market competition and productivity performance remains an empirical issue. Recent research has focused on the sources of within-firm productivity improvements and on the role played by resource reallocation across heterogeneous firms for aggregate productivity developments. This research has helped reconcile theory with a number of stylized facts [27]– *e.g.* the fact that competitive pressures often provide both incumbents and new entrants incentives to innovate and the crucial role played by fast-growing firms -- and has significantly enriched the analysis of the link between product market policies and productivity. For instance, neo-Schumpeterian views threw light on the complementary roles of antitrust and patenting policies and the distinct roles played by international openness and domestic liberalization. Moreover, Neo-Schumpeterian views and recent research on firm heterogeneity stressed the role that appropriate regulations can play in facilitating the reallocation of resources from low to high productivity incumbents in a competitive environment. In the sequel, we will draw on both these strands of literature to analyze the effects of changes in product market regulations on productivity from a cross-country point of view. To this end, in the next sub-section, we first discuss ways to compare regulatory settings in different countries and then look at regulatory reforms that countries have undertaken over the past two decades.

26. The latter might involve a range of costs including the search and matching frictions that have been the focus of much of the recent literature on studying the dynamics of the labor market (see e.g. Davis *et al*., 1996; Restuccia and Rogerson, 2007; Hsieh and Klenow, 2006).

27. For instance, while attempts to test earlier theories of innovation against the data were not very successful (see Cohen and Levin, 1989, for a survey of these empirical studies), the predictions of neo-Schumpeterian models are generally supported by both industry-level and firm-level empirical analyses.

II.2 Has product market regulation changed?

Measuring regulation

Different approaches have been used in the literature to characterise the degree of competition in the product market and the role of policy and regulatory settings. Traditional indicators of product market conditions, such as mark-ups or industry concentration indices, cannot be treated as exogenous determinants of economic outcomes.[28] Entry of new (possibly foreign) firms is also obviously not exogenous to productivity outcomes. Indeed, addressing the endogeneity of competition measures has been one of the main challenges in trying to identify the impact of competition on innovation or productivity. Moreover, recent research shows that many of the market indicators of productivity are not univocally related to product market competition.[29] Finally, they fail to provide a direct link to policy or regulation.

To address these concerns, the empirical analyses reported in the next section are based on some of the potential policy determinants of competition, rather than on direct measures of it. A similar approach has been recently taken by Griffith *et al*. (2004) and Aghion *et al*. (2006). While these authors focus on EU data on anti-monopoly cases and the implementation of the Single Market Programme, we use indicators of product market regulations drawn from the OECD international product market regulation database.[30] We focus on regulation in non-manufacturing industries and on the "knock-on" effects of inappropriate regulations in these industries on all sectors of the economy. The main reason for focusing on these indicators in the empirical analysis of productivity is that they capture regulations affecting key ICT-using sectors. The non-manufacturing sector is undoubtedly the most regulated and sheltered part of the economy, while few explicit barriers to competition remain in markets for manufactured goods of OECD economies. Moreover, even low-regulated industries suffer from regulation-induced inefficiencies in non-manufacturing because all industries are heavy intermediate consumers of non-manufacturing products. The indicators measure to what extent competition and firm choices are restricted where there are no *a priori* reasons for government interference, or where regulatory goals could plausibly be achieved by less coercive means. The indicators are constructed to measure regulation in a particular area, certain industries, or the overall economy. A detailed description of the indicators of non-manufacturing regulation and the knock-on indicators of "regulation impact" is provided in Conway and Nicoletti (2006). Annex 1 explains their main features.

In synthesis, the indicators of non-manufacturing regulation cover energy (gas and electricity), transport (rail, road and air) and communication (post, fixed and cellular telecommunications), retail distribution and professional services, with country and time coverage varying across industries.[31] They

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28. Amongst the very few cross-country studies that explore the role of competition for productivity, Cheung and Garcia Pascual (2001) use mark-ups and concentration indexes. At the single-country level, Nickell (1996), Nickell *et al.* (1997), Blundell *et al.* (1999) and Disney *et al.* (2000) use a variety of market indicators to capture competitive pressures. The potential problem of endogeneity of market shares and mark-ups is even more serious at firm-level as firms that have high productivity may gain market shares and enjoy innovation rents. Additional problems specific to market shares and concentration indices are that they depend on precise definitions of geographic and product markets (*i.e.* the relevant market where competition unfolds) and tend to neglect potential as well as international competition.

29. Boone (2000) suggests that there may be a hump-shaped relationship between competition and mark-ups. Some authors have addressed this issue by using related indicators of relative profits and profit persistence (Creusen *et al*., 2006; Greenhalgh and Rogers, 2006).

30. The data are publicly available at www.oecd.org/eco/pmr. The most recent observations are currently for 2003, but an update to 2007 will be available at the end of 2008.

31. In addition to the above industries, the indicator of regulation in banking constructed by de Serres *et al*. (2006) is also used to derive the "knock on" indicators of regulation impact. Indicators for energy, transport and communication cover 21 OECD countries over the 1975-2003 period; the indicators for retail distribution and professional services

focus on three main areas affected by sweeping reforms in OECD countries, with the aim of promoting entrepreneurship and competition: (i) privatisation, (ii) entry and business conduct in potentially competitive domestic markets, (iii) pro-competitive regulation of natural monopoly markets (*e.g.* by regulating access to networks or unbundling them from the provision of services). Indicators for each of these areas are based on detailed information on laws, rules and market and industry settings. From these data, regulation impact indicators of the "knock on" effects of anti-competitive regulation for 39 sectors that use the outputs of these non-manufacturing industries as intermediate inputs are calculated for the 1975-2003 period. To the best of our knowledge, these indicators provide the broadest coverage of sectors and areas, and the longest time-series currently available for comparing product market regulation across OECD countries. They are complementary to indicators of economy-wide anticompetitive regulation already published by the OECD (Conway *et al.* 2005). All indicators take continuous values on a scale going from least to most restrictive of private governance and competition.

As already mentioned, the main advantages of using these indicators in empirical analysis is that they can be held to be exogenous to productivity developments and that they are directly related to underlying policies, a feature that business survey data do not have.[32] Another advantage is that, as they are composite constructs based on detailed information about policies, they address multicollinearity problems in estimation. At the same time, they make it possible to focus on the specific aspects of policies that are thought to be relevant for productivity. For instance, most of the analyses reported below focus on the barriers to entry and administrative burdens elements (and sometimes, separately, the public ownership one). Some analyses explicitly distinguish border and non-border policies that affect competition. Yet another advantage of the OECD indicators is that they vary over countries, industries and time, though full time variability is limited to a subset of non-manufacturing industries. Moreover, the regulation impact indicators of the knock-on effects of regulation in other sectors extend, with some limitations, time variability over 1975-2003 to most of the business industries.[33]

Reforms over the past two decades

In tune with a number of qualitative analyses of product market policy developments in the OECD area, the quantitative OECD indicators suggest that market-oriented reforms were extensive over the past two decades. Here we illustrate reforms in the non-manufacturing sectors of selected OECD countries and their implications for regulatory burdens on the manufacturing sector as well as for ICT and non ICT-intensive sectors. For the purposes of this paper, we focus on four groups of countries that had widely different reform and productivity patterns: the United States, the United Kingdom, other English-speaking countries (Canada, Ireland, Australia and New Zealand), Nordic EU countries (Denmark, Finland and Sweden) and large continental EU countries (France, Germany, Italy and Spain). Figure 1 shows developments in various areas of regulation in energy, transport and communication from 1985 to 2003

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cover 30 OECD countries for 1998 and 2003; the indicator for banking covers 30 OECD countries for 2003. As a result, while in the cross-section dimension the indicators cover most of the regulated sectors, the time variability of both the non-manufacturing and regulation impact indicators originates mostly in policy changes in the energy, transport and communication sectors.

32. Of course, endogeneity cannot be completely ruled out if, for instance, policies are affected by productivity outcomes through political economy channels. On the relative advantages of policy-based and survey-based composite indicators see Nicoletti and Pryor (2005).

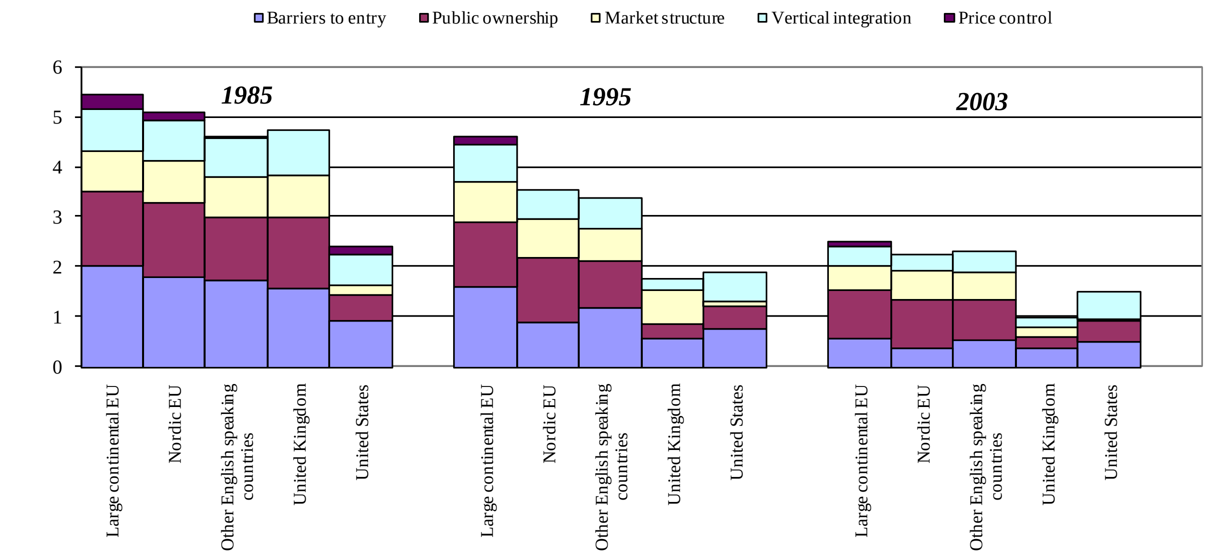
33. Griffith *et al*. (2006) formulate a number of criticisms concerning the OECD indicators, the most compelling being that their time dimension is limited to a subset of non-manufacturing sectors that they do not think are representative enough of economy-wide regulatory developments. The use of the regulation impact indicators partly addresses this concern. Besides, Conway and Nicoletti (2006) show that the OECD indicator of non-manufacturing regulation is closely correlated, both across countries and over time, with a popular indicator of economy-wide business regulation, the Economic Freedom of the World index by Gwartney and Lawson (2006). This is not surprising since most of OECD product market reforms have been implemented in the non-manufacturing industries over the past decades.

(Panel A) as well as developments in retail distribution and professional services from 1998 to 2003 (Panel B). It confirms that -- at least in energy, transport and communication -- approaches have converged across countries over the past two decades. Product market regulations have become more conducive to market mechanisms as governments have liberalised potentially competitive markets, re-regulated natural monopoly markets by establishing pro-competitive regulations where possible, and privatised state owned enterprises. The shorter data for retail and business services also suggest a move to a more business-friendly environment, though cross-country differences remain large and action has been lesser, especially in large continental EU countries.

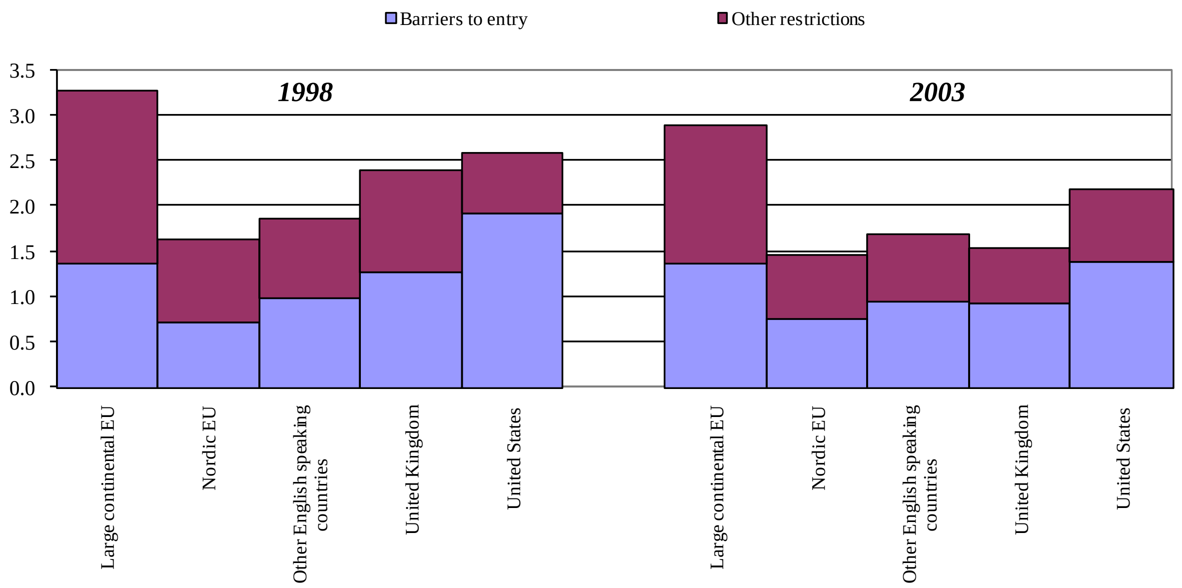
Figure 1. Product market regulation in non-manufacturing industries

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

Panel A: Network industries



Panel B: Retail trade and professional services

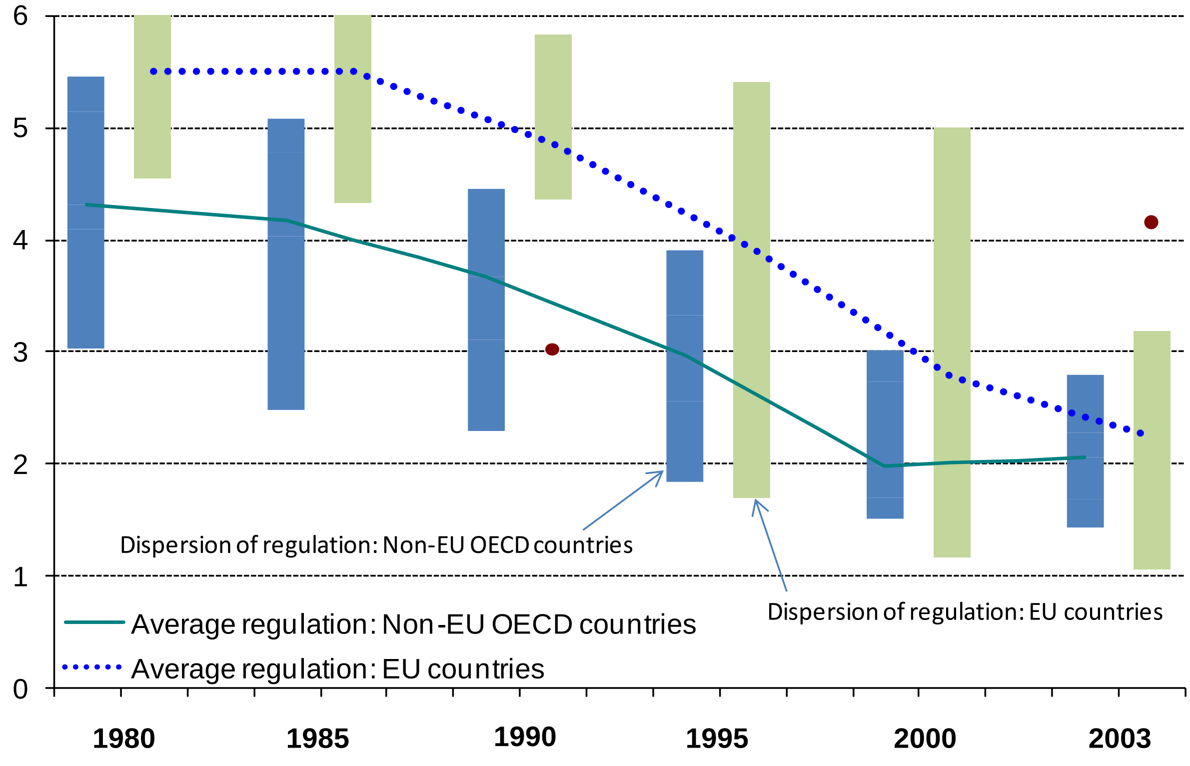


Source: Conway and Nicoletti (2006).

While the process of convergence towards more market-friendly regulations is widespread across OECD countries, the timing and depth of reforms differed dramatically across countries. The United States was the first country to undertake wide-ranging reforms in the early 1980s. A number of other countries – notably the United Kingdom, Canada, New Zealand and the Nordic countries – launched reforms a little later, from the mid-1980s. But in most of the EU countries, and most notably in the large continental ones, the bulk of product market reform occurred much later, in the mid-1990s, and a number of them still had a relatively restrictive non-manufacturing environment at the turn of the century. As a result of these different starting points and reform patterns, regulations remained on average more restrictive in the EU than in the other countries. Moreover, the dispersion in regulatory approaches increased widely in the EU area over the 1990s, while regulations in other OECD countries kept becoming more homogeneous all along (Figure 2). It was only in the most recent years that EU countries also started to significantly converge in their regulatory settings, mainly because of the efforts made by some of the laggard EU countries of the 1990s. The working hypothesis that we develop in the next sections of our paper is that, by delaying regulatory reforms in key ICT-intensive sectors, many EU countries failed to create a favourable environment for absorbing the ICT shock that unfolded over the 1990s.

Figure 2. The evolution and dispersion in product market regulation in the EU and other OECD countries
Energy, transport and communication, 1980-2003[1]

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



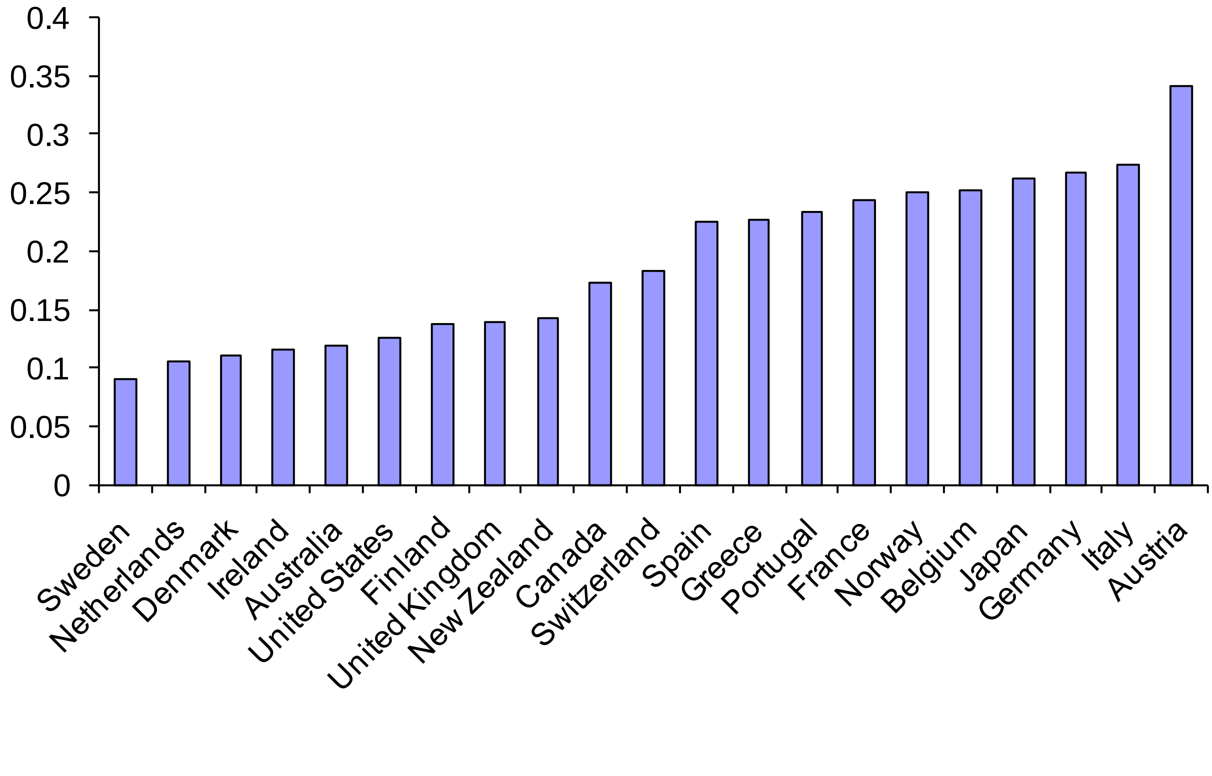
1. Box chart of the cross-country dispersion of the aggregate indicators of regulation in transport, energy, and communications sectors across countries. The boxes show the dispersion of the indicator values across country groupings in each year. The dots represent outlier countries.

Source: Conway and Nicoletti (2006).

As mentioned earlier, inappropriate regulations in non-manufacturing industries have implications for regulatory burdens on other sectors through input-output interlinkages. The domestic business environment is likely to be particularly important for efficiency in utilities and service industries, where competition from abroad is weaker and a difficult balance has to be struck between regulations and market forces due to market imperfections (*e.g.*, in network industries). To the extent that enhancing competition in these industries encourages productivity growth, non-manufacturing reforms can provide a "double dividend" because they may increase both the direct contribution of non-manufacturing to overall productivity growth and contribute to overall productivity growth indirectly, via improvements in the productivity of industries that use non-manufacturing products as intermediate inputs.[34] The OECD indicators of regulation impact aim precisely at assessing these "knock-on" effects of non-manufacturing regulation on other sectors. To illustrate this, Figure 3 shows the burdens imposed in 2003 by non-manufacturing regulations on the manufacturing sector (Panel A) and on ICT and non ICT-intensive sectors (Panel B) of OECD countries. These depend on both the stringency of non-manufacturing regulations in different countries and the extent to which each sector use non-manufacturing products as intermediate products. As expected, the knock-on effects are largest in continental EU countries and lowest in Nordic and English-speaking countries. We will see later that cross-country differences are even more pronounced when the focus is set on ICT-intensive industries.

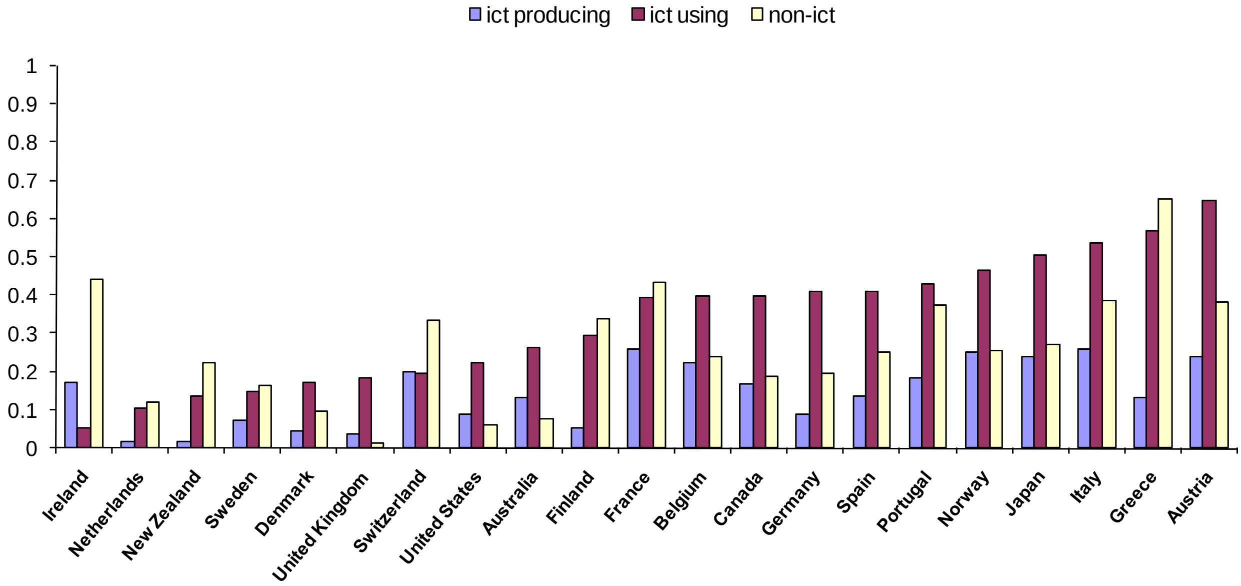
Figure 3. The burden of non-manufacturing regulation on the business sector, 2003[1]
(scale normalised to 0-1 from least to most burdensome)

Panel A. Manufacturing



34. The role of intersectoral input-output linkages in transmitting and amplifying the effects of product market reform has been recently stressed by Faini *et al*. (2004) and Conway *et al.* (2006).

Panel B. ICT and non-ICT sectors



1. These indicators reflect the 'knock-on' effects of anti-competitive regulation in non-manufacturing sectors on industries that use the output of these sectors as intermediate inputs into the production process. See Annex 1 for more details.

Source: Conway and Nicoletti (2006).

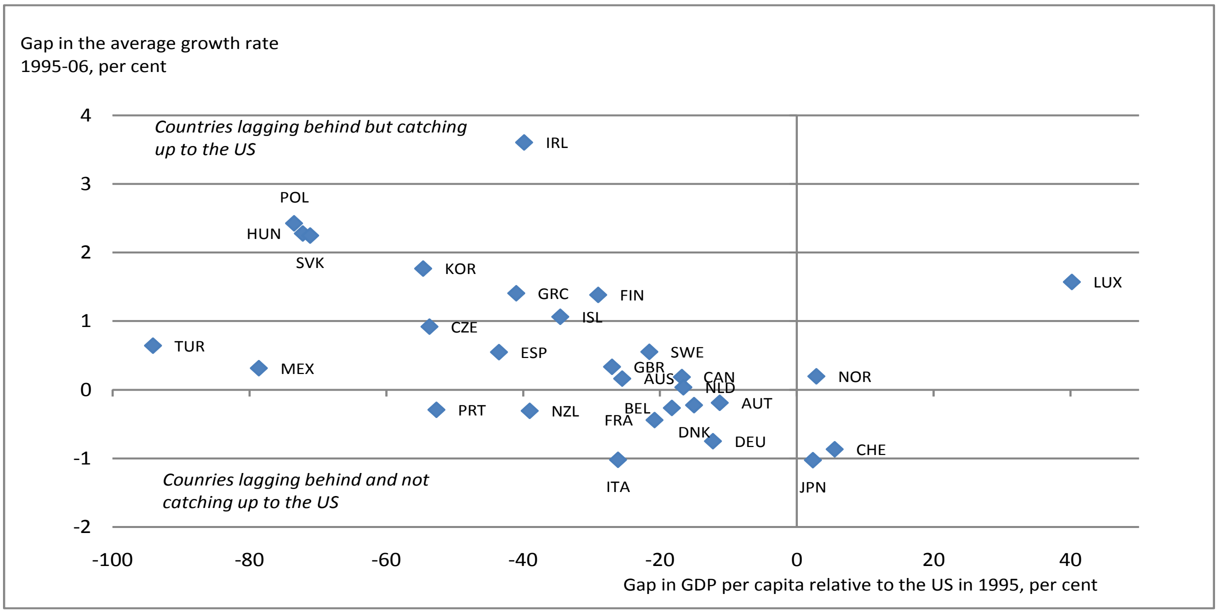
III. Evidence on product market policies and productivity

III.1 Aggregate productivity outcomes and GDP per capita growth

The traditional way to assess the process of convergence – or divergence – in GDP per capita is to plot the country GDP per capita growth rate over a given period of time against the initial GDP per capita levels: countries with lower GDP per capita levels have greater potential to grow by catching up to the levels of their wealthier counterparts.[35] This process of economic convergence, which characterized most of the post-WWII period, has come to a halt in the mid-1990s: relative to the US, a number of countries with significant gaps in living standards have experienced low average output growth over the past decade – including most large continental EU countries (South-West quadrant in Figure 1). Rapid catch-up continued in the transition economies of Central and Eastern Europe, South Korea, Greece, some of the Nordic countries and, especially so, in Ireland (North-West quadrant in Figure 1).

35. It should be stressed at the outset that cross-country differences in business cycle conditions can significantly affect international comparisons of growth patterns. The option generally used in the literature is the comparison of average growth rates over sufficiently long time periods in order to minimise cyclical influences. However, this approach is problematic for analysing recent growth patterns, given the lack of synchronisation in countries' business cycles. In an attempt to tackle this issue, we rely on cyclically-adjusted series as opposed to actual series. Cyclically adjusted figures rely on Kalman-filter estimates of the NAIRU combined with Hodrick-Prescott series for productivity and participation. Computing trends using an extended version of the Hodrick-Prescott filter (Hodrick and Prescott, 1997) yields similar results. For a more extensive discussion on the calculation of trend series and on the consistency of results using different approaches, see Scarpetta et al. (2000).

Figure 4. Convergence to US GDP per capita, 1995-2006: large continental EU countries are losing ground[1]

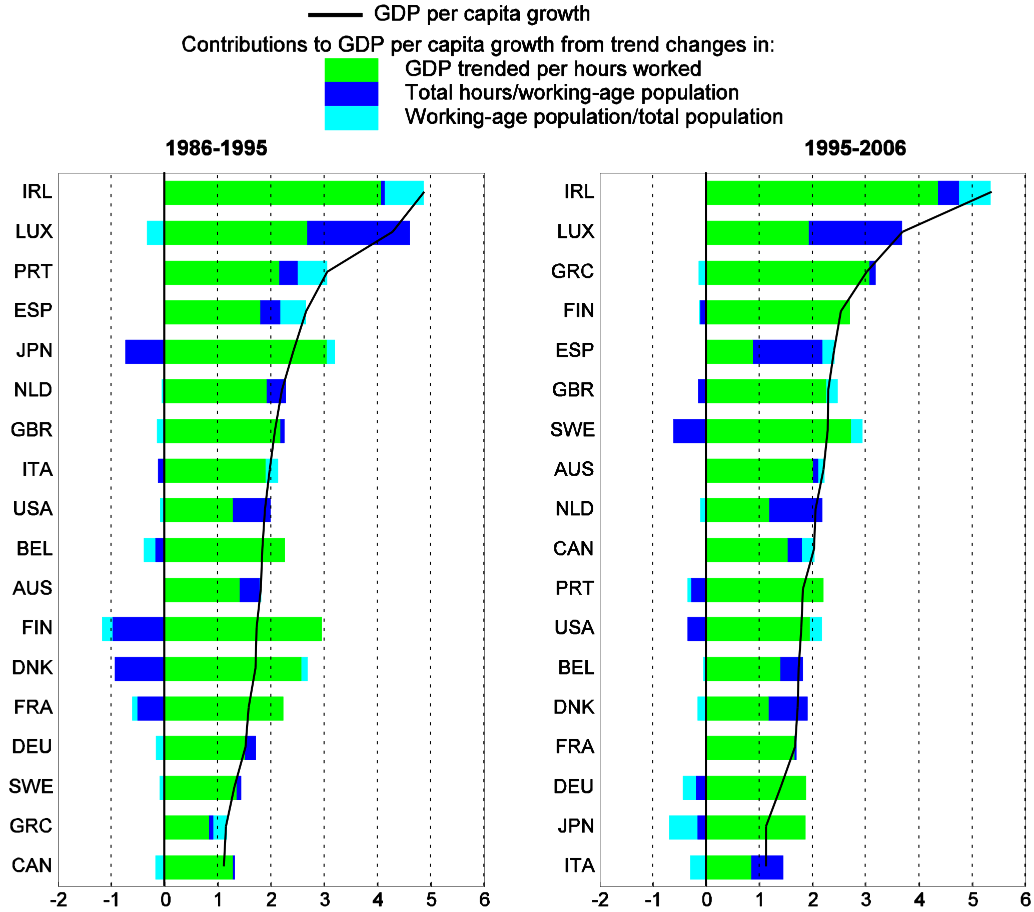


1. The average growth rate of GDP per capita is calculated on the basis of volumes data from national account sources. The level of GDP per capita is calculated on the basis of 2005 PPPs.
Source: OECD

From an accounting point of view, one way to decompose aggregate GDP per capita growth is to distinguish: *i)* a *demographic factor*, resulting from changes in the ratio of persons of working age (15–64 years) to the total population; *ii)* a *labour productivity factor*, resulting from changes in output per hour worked; *iii)* a *labour utilisation factor*, resulting from changes in the labour utilisation (total hours worked to working age population). This decomposition is presented in Figure 5 for a number of OECD countries over the 1990s and the most recent years.

Changes in GDP per capita growth have been largely driven by changes in labour productivity and utilisation. Significant increases in labour utilisation in the Netherlands and Spain contrast sharply with declines or weak growth in Sweden (from very high employment rates) as well as in some of European countries (e.g. Italy, from low levels) and Japan.

Figure 5. Decomposition of GDP per capita growth, 1990-2006



Source: OECD, Economic Outlook No 82 and Analytical database.

The growth of labour productivity per worker accounts for at least half of GDP per capita growth in most OECD countries and considerably more than that in some of them. A similar picture emerges if working hours are taken into account. Compared with the 1980s, hourly labour productivity growth picked up in a number of countries, including the United States, Finland, Australia, Canada, Ireland and Sweden. By contrast, growth decelerated in continental European countries – especially Germany, France, Italy and Spain -- and barely changed in the United Kingdom (see Figure 7 below). Formal tests, based on a variety of univariate and multivariate time-series models for hourly productivity, suggest that the US acceleration and the European (EU15) deceleration were "structural", and occurred around the mid-90s. Downward structural breaks appear to be particularly clear for the four large continental EU countries, while no such a break is generally found for the United Kingdom. [36]

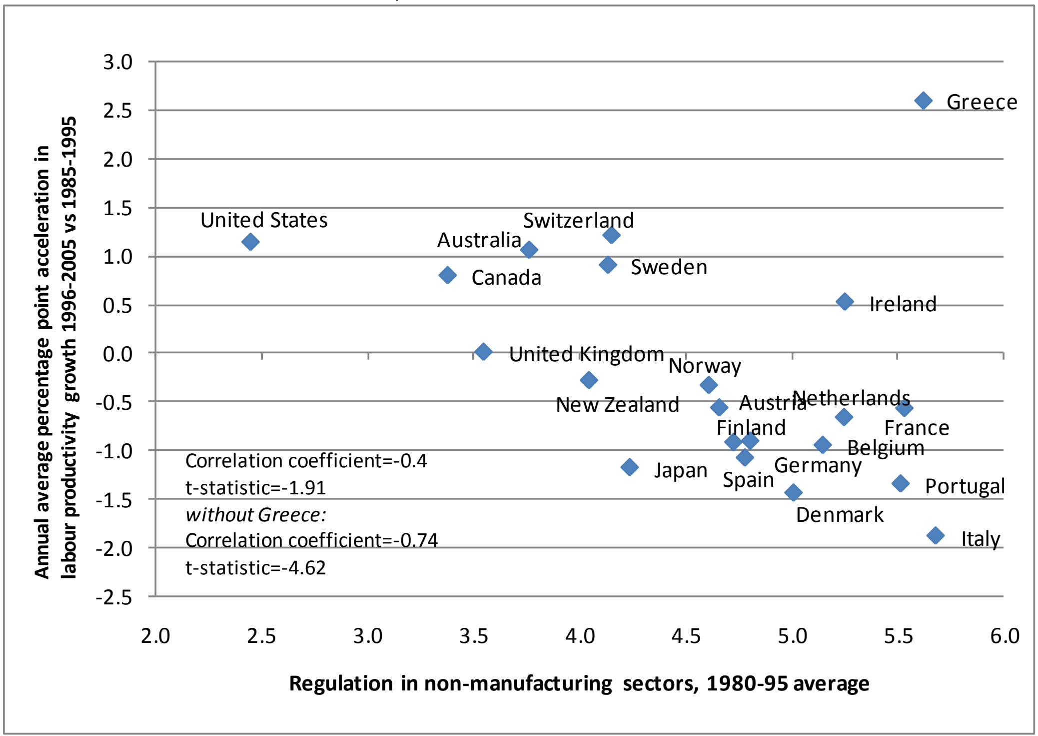
To what extent have differences in product market regulations affected the productivity performance of the OECD countries? Figure 6 plots the acceleration in hourly labour productivity growth against the stringency of product market regulations in non-manufacturing industries for which we have matching time-series data. At first glance, countries with a relatively liberal approach to competition have

36. See Kahn and Rich (2006) for the US and Jimeno *et al.* (2006) for EU countries. The lack of acceleration in the UK has been referred to as the "UK productivity puzzle" by Basu *et al.* (2003).

tended to experience a greater acceleration in aggregate hourly labour productivity growth after 1995. The rest of this paper explores more in depth this suggestive cross-country evidence, looking at two main channels through which differences in product market policies may help explain aggregate productivity outcomes: their effects on incentives to adopt the most efficient technologies and their influence on the ability of OECD economies to allocate resources to their best use.

Figure 6. Product market regulation and hourly labour productivity acceleration

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



Source: OECD Productivity Database and Conway and Nicoletti (2006)

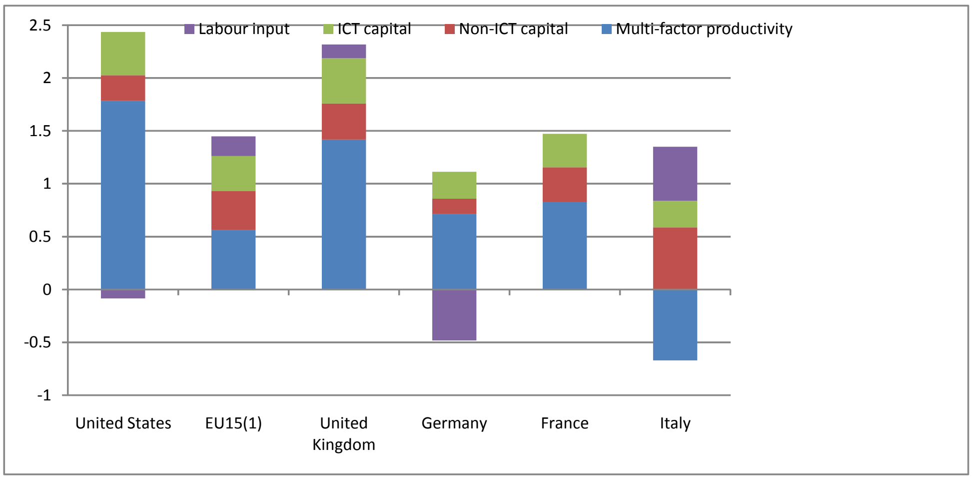
III.2 The role of information and communication technology[37]

Recent industry-level empirical analyses suggest that it is not so much product market policies per se that mattered for explaining diverging cross-country performance patterns from the late-1990s, but rather the relationship between the timing of policy reforms and the timing of technological change (Conway *et al.*, 2005; Conway and Nicoletti, 2007). As illustrated earlier, in many OECD countries, notably in continental Europe where growth 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. Moreover, key ICT-using sectors (such as retail trade and business services) remain relatively regulated. Delaying reforms may have 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 organisation of production that they allow. The negative repercussions on aggregate performance of the mismatch between the timing of reforms and the timing of technological change may have been amplified by the fact that ICT is a general-purpose technology that can be usefully employed in most sectors of the economy.

37. This section draws extensively on Conway and Nicoletti (2007).

To begin assessing the role of ICT in promoting productivity and output growth, Figure 7 decomposes output growth over the 2000-05 period in: i) capital deepening – distinguishing between ICT capital and non-ICT capital; ii) labour input; and iii) technical progress, as measured by residual output growth once the contributions of labour and capital inputs have been subtracted (so called multifactor productivity, MFP).[38] It is important to note at this stage that, aside from the direct contribution of ICT capital to output growth, several key factors related to ICT are also embodied in the aggregate measure of MFP growth: the acceleration of productivity in ICT-producing sectors themselves, the growing share of these sectors in OECD economies and the spill-over effects of new technologies on productivity in ICT-using industries – largely high-tech manufacturing and, especially, some service industries. The figure clearly suggests that ICT capital deepening and MFP growth have driven output growth in the U.S. to a larger extent than in the EU. Among the large EU countries, only the UK has experienced similar growth contributions from ICT capital and MFP. In both France and Germany, ICT capital deepening and MFP growth contributed less. In Italy, MFP actually declined.

Figure 7. ICT capital deepening and MFP growth are the two key drivers of output growth, 2000-2005



Source: Authors'calculations; OECD Productivity Database

If anticompetitive regulations hinder the adoption and efficient use of ICT, their negative effects on productivity performance are likely to have been particularly strong in large continental EU countries since the mid 1990s. Recent empirical analyses explored this conjecture in two ways. Gust and Marquez (2004) and Conway *et al.* (2006) 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. [39] Nicoletti and Scarpetta (2003), Conway *et al*. (2006), Griffith *et al.* (2006) and Inklaar *et al*. (2008) investigated the

38. Depending on the way the growth of inputs is computed, different measures of MFP growth can be obtained, with different interpretations. In the figure we present the simplest measure – the Solow residual – that includes both embodied (in physical and human capital) technological progress and disembodied technological progress resulting from innovations, organisational change and, more generally, more efficient use of all inputs.

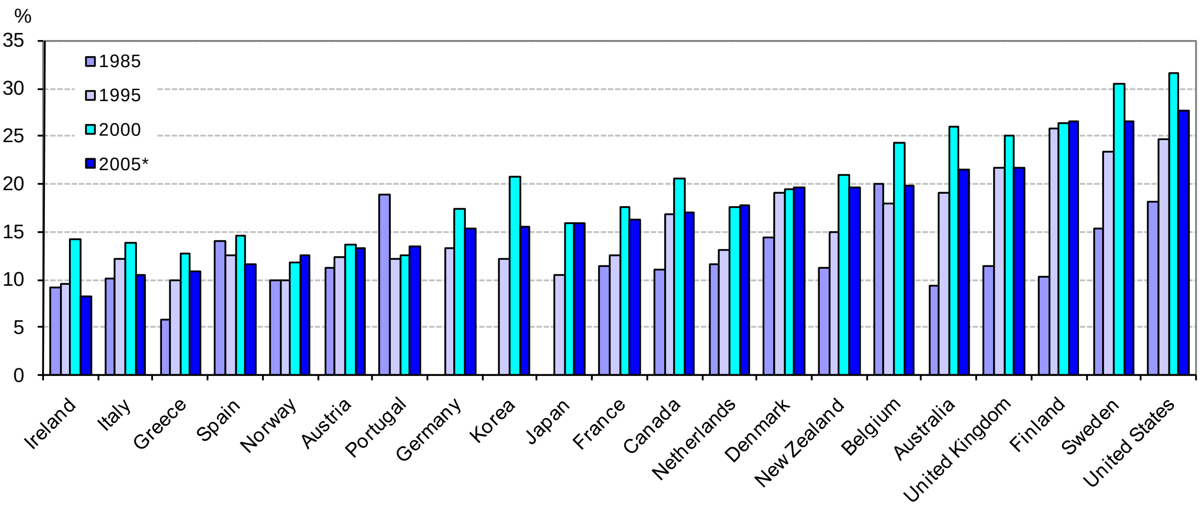
39. The share of ICT investment in total investment is typically used as a key indicator of ICT diffusion. There are, however, many other indicators that measure the pervasiveness (or otherwise) of ICT technology across countries (see, for example, OECD 2002). Most of these different indicators are closely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

possibility that the speed of catch up to best practice productivity may be curbed by anti-competitive regulation.

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 (Figure 8). In 2005, the share of 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 specialisation and first-mover advantage to gaps in workers' 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.

Figure 8. The diffusion of information communication technology
(share of ICT investment in total non-residential gross fixed capital formation)

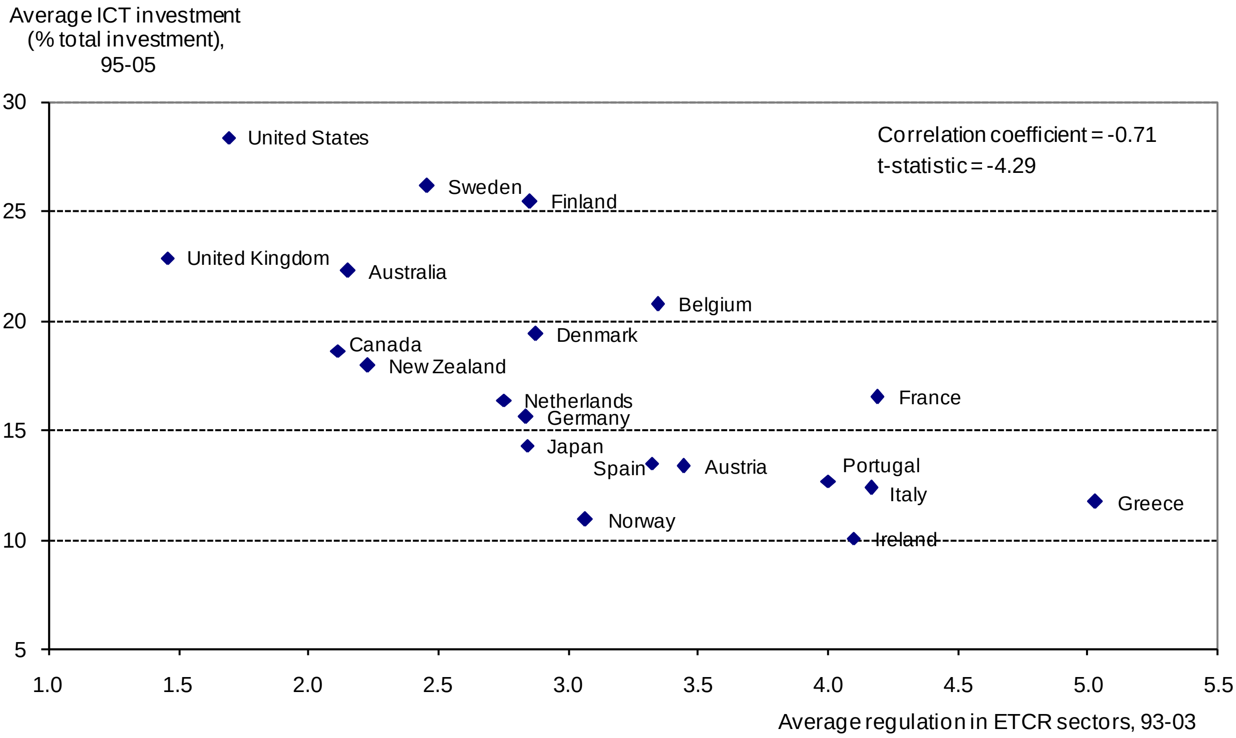


* Or latest available year
Source: OECD, Productivity Database

There are a number of potential reasons why this might be the case. As already mentioned, 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, at least for firms that are not too far from the technological frontier, 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, customise 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 reorganising 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 less burdensome and friendlier to competition (Figure 9).

Figure 9. Product market regulation and the diffusion of information communication technology[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 (see Annex 1 for details).

Source: Conway and Nicoletti (2007).

Formal panel regressions by Conway *et al*. (2006) and Gust and Marquez (2004) confirmed this bivariate evidence. Both these studies accounted for other (observed and unobserved) factors that could potentially affect ICT adoption such as workers' skills, industry composition and other country and/or industry specific characteristics. While Gust and Marquez (2004) looked mainly at the effects of labour market regulation on the aggregate ICT share, Conway *et al*. (2006) explicitly focused on the link between product market regulation and ICT investment at both the aggregate and industry levels.[40] At the aggregate level, regulation was proxied by the OECD indicator of anti-competitive regulation in seven non-manufacturing sectors, while at the industry level regulation was proxied by the OECD industry-level indicators of the knock-on effects of non-manufacturing regulation in all business sectors (see above). In both cases domestic restrictions on competition were found to have a strong negative effect on ICT

40. Conway *et al*.'s analysis of aggregate ICT 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. 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. Previous aggregate panel regressions by Gust and Marquèz (2004) used a smaller and shorter cross-country sample. Aside from labour market regulations, they also looked at the effect of a cruder measure of product market regulation.

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.[41] Interestingly, the largest negative effects were found for regulations that increase barriers to entry in domestic markets, while the presence of public-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 privatisation.

In sum, the results suggest that industries operating in a relatively liberal regulatory environment are more inclined to incorporate ICT into the production process than industries operating in an environment in which product market regulation is more restrictive. But to what extent does this effect explain observed differences in aggregate ICT investment across countries? 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%. 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).[42]

The finding that ICT adoption was curbed by the lack of competitive pressures at home supports the idea that cross-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. 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). This finding is particularly important in the light of recent results by Inklaar *et al*. (2008) that find few spill-over effects of ICT investment on "pure" MFP growth, thereby confining the effects of ICT on productivity to those of capital deepening. 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). The consequence is that the contribution of key ICT-intensive sectors to productivity growth has differed a lot across countries. 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 (Figure 10). A few other countries – for example, Ireland, Finland, Belgium, the Netherlands, and the United Kingdom – also experienced accelerating productivity growth in these sectors in the second half of the 1990s. In a number of other countries, however, the contribution of ICT-

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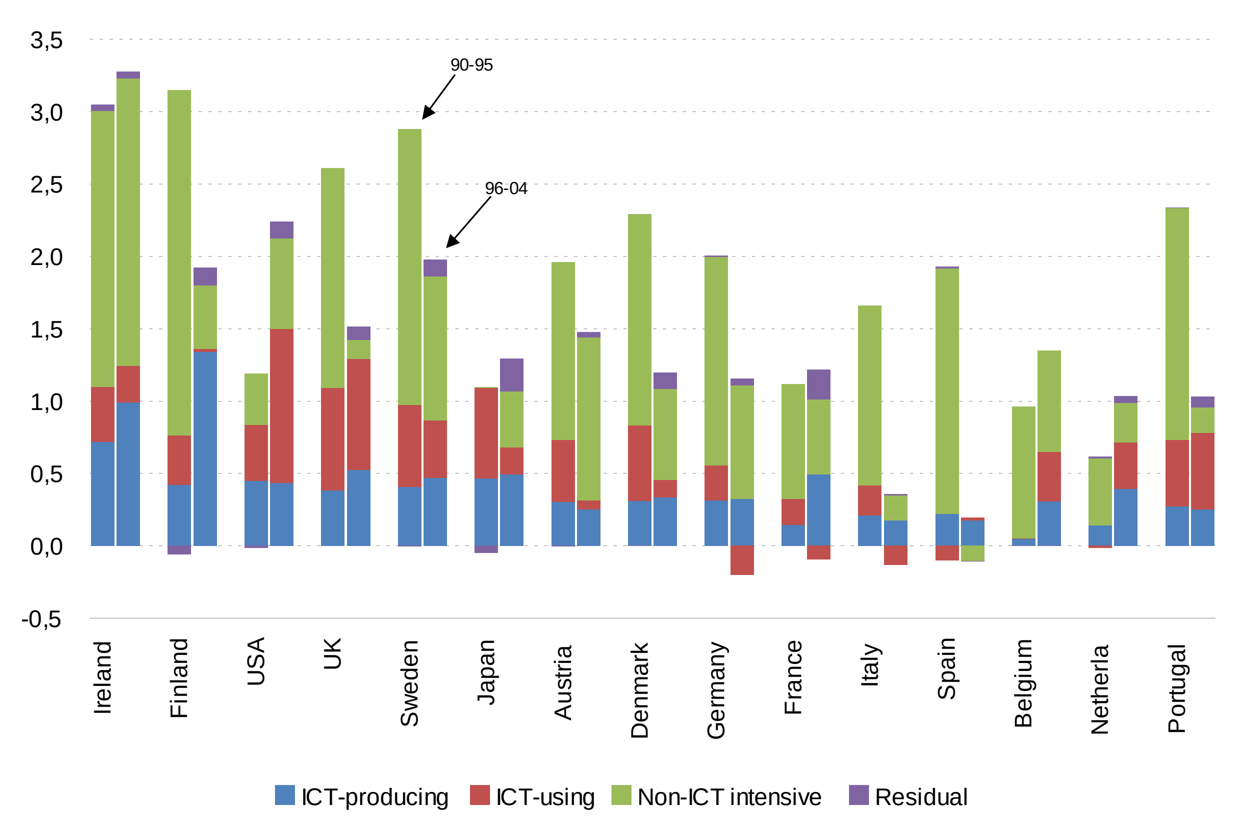
41. Also, the development of ICT-producing industries often reflects factors that are unrelated to regulation, such as first-mover advantage or specialisation due to country-specific comparative advantages and/or agglomeration economies.

42. Overall, product market regulation were estimated to explain around 12% 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. Similar results were obtained at the industry level, with product market regulation now explaining more than 20% of the variance in ICT investment across countries and industries.

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 1996-2004 period.[43]

Figure 10. Contributions to aggregate labour productivity growth, 1990-2004[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: Authors' computations from EU-KLEMS (March 2007) data

With the direct and indirect effects of regulation on productivity at work, and in conjunction with the fact that, as shown in Figure 3 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. This conjecture has been tackled in different ways by a number of recent cross-country empirical studies that focused explicitly on the policy determinants of productivity at the industry level.

Regulation, ICT and productivity growth

43. 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).

The direct and indirect effects of regulation on productivity growth have been explored by Nicoletti and Scarpetta (2003), Conway *et al*. (2006), Griffith *et al*. (2006) and Inklaar *et al.* (2008) within the framework proposed by Aghion and Howitt (2005). In their 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 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). Following Aghion and Griffith (2005) empirical studies focused on the role of policies promoting firm rivalry and market entry in increasing incentives to enhance efficiency and lower the costs of reorganising production accordingly.

While the basic model used is similar, the various studies differ in data and coverage, control variables and, especially, in the measurement of product market policies: [44]

- *Data and coverage*. The analysis of Conway *et al*. (2006) focused on labour productivity per worker, and was performed at both the aggregate and industry levels using OECD ADB and STAN data for 39 manufacturing and service sectors in 21 countries over the past two decades. Nicoletti and Scarpetta (2003) had previously used similar OECD industry-level data for an earlier period, but focused on estimates of industry-level MFP (adjusted for cross-country differences in aggregate hours worked). Griffith *et al*. (2006) also rely on MFP estimates from the OECD industry-level database, but cover only nine EU countries and twelve manufacturing industries over a shorter time period. The industry-level study by Inklaar *et al*. (2008) used the new EU-KLEMS data set, from which a more sophisticated measure of MFP (adjusted for hours worked at industry-level) could be computed as the residual output growth once use of labour services (adjusted for labour composition), capital services (adjusted for asset composition) and intermediate inputs have been taken into account. However, their country coverage was limited to 10 EU countries, the United States and Japan, and the industry focus was on (a subset of) market services.

- *Control variables*. Besides the direct and indirect effects of regulation, Nicoletti and Scarpetta (2003), Conway *et al*. (2006) and, to a lesser extent, Griffith *et al*. (2006) 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.[45] Inklaar *et al*. (2006) only control for country and industry dummies.

- *Measurement of product market policies*. Conway *et al*. (2006) approximate regulatory burdens with the time-series of OECD industry-level indicators summarising the “knock on” effects of non-manufacturing regulations in individual business sectors (see above). This allows taking into account the effects of both entry barriers (especially in regulated service sectors) and the costs implied by regulation on all sectors of the economy. In a previous study, Nicoletti and Scarpetta (2003) related industry-level productivity outcomes to both the OECD time-series of the average regulatory burdens in (a subset of) non-manufacturing sectors and the OECD cross-section of industry-specific barriers to entry (in manufacturing and services sectors). Inklaar *et al*. (2008) use either the same OECD average time-series or the corresponding industry-level time-series for a

44. The regression models used by Nicoletti and Scarpetta (2003), Conway *et al*. (2006) and Inklaar *et al*. (2008) are variants of that developed by Griffith *et al.* (2004) to test the effect of R&D expenditure on productivity growth.

45. The results of Conway *et al*. (2006) are also robust to accounting for industry-specific workers’ skills and capital deepening.

subset of services sectors only.[46] Griffith *et al*. (2006) use EU anti-monopoly proceedings and dummies measuring the expected impact of the implementation of the Single Market Programme in different manufacturing sectors.

Given the above differences in data and specification, results from these studies are not easily comparable. However, a number of common conclusions emerge. To a different extent, regulations that restrict competition are found to curb productivity directly in all studies, though often only in some ICT-intensive industries. Moreover, Nicoletti and Scarpetta (2003) and Conway *et al*., (2006) find that an important channel through which restrictive regulations curb productivity growth across the board is by hindering the process of convergence to best practice productivity.

The findings by Conway *et al*. (2006) are worth mentioning in more detail in the context of this paper, because they look at both direct and indirect effects of regulation on productivity and focus explicitly on the split between ICT-intensive and other industries. They can be summarised as follows. 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 down 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.[47] However, catching up to best practice is found to be 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.

Conway *et al*.'s findings cannot determine if the indirect negative effect of restrictive regulations on productivity growth is due to inadequate diffusion, adoption or use of new technologies. But, keeping in mind the results found for the impact of regulation on the ICT share, 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 organisation 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, 1997). Under these conditions, it would seem, 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 failed to do so before the ICT shock of the early 1990s, especially in sectors that provide intermediate inputs to crucial ICT-using sectors, may have been strongly disadvantaged in their quest for growth.

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46. These authors also perform panel regressions at the level of single service industries using the relevant OECD indicators of product market regulation. They find clear effects of regulation on productivity only in telecommunications.

47. 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% or more of domestic productivity growth". Guellec and van Pottelsberghe de la Potterie (2001) make a similar point.

For example, Conway and Nicoletti (2007) use regression results to illustrate the "growth deficit" that would affect inappropriately regulated countries in the wake of a positive supply shock of a magnitude comparable to that experienced with the diffusion of ICT technologies. They estimate prudentially (*e.g.* taking into account only the indirect effect of regulations on the speed with which countries and sectors operating behind the world productivity frontier catch up to best practice) that, after 5 years from a one-off outward shift in the world productivity frontier of an equal size in all sectors, aggregate productivity in restrictive countries (such as Italy and, to a lesser extent, Germany) would increase only by a fraction of the response in a country where product market regulation is least restrictive of competition.[48] Moreover, in 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% to 40% below potential five years after the initial shock.

These experiments suggest that the dispersion of productivity levels across countries may have increased over time following the positive ICT supply shock as a result of differences in product market regulation. Moreover, the dispersion in productivity levels across countries may also have become larger in ICT-intensive sectors reflecting the larger cross-country heterogeneity of regulations in these (largely non-manufacturing) sectors. 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.

III.3 Structural change and productivity performance

The discussion in previous sections relates widening gaps in productivity performances to cross-country differences in the ability to take full advantage of new widely available technologies. In turn, we have argued that such ability has differed due to differences in regulations that shape the business environment in crucial sectors. However, each country has industries -- and, within each industry, firms -- that perform well relative to world best practice. A well-functioning economy should naturally tend to reallocate resources towards these sectors and firms. In this section we take a closer look at factors affecting the cross-industry and cross-firm dispersion of productivity performances, and the role played by regulation in shaping such dispersion and the corresponding resource reallocation process.

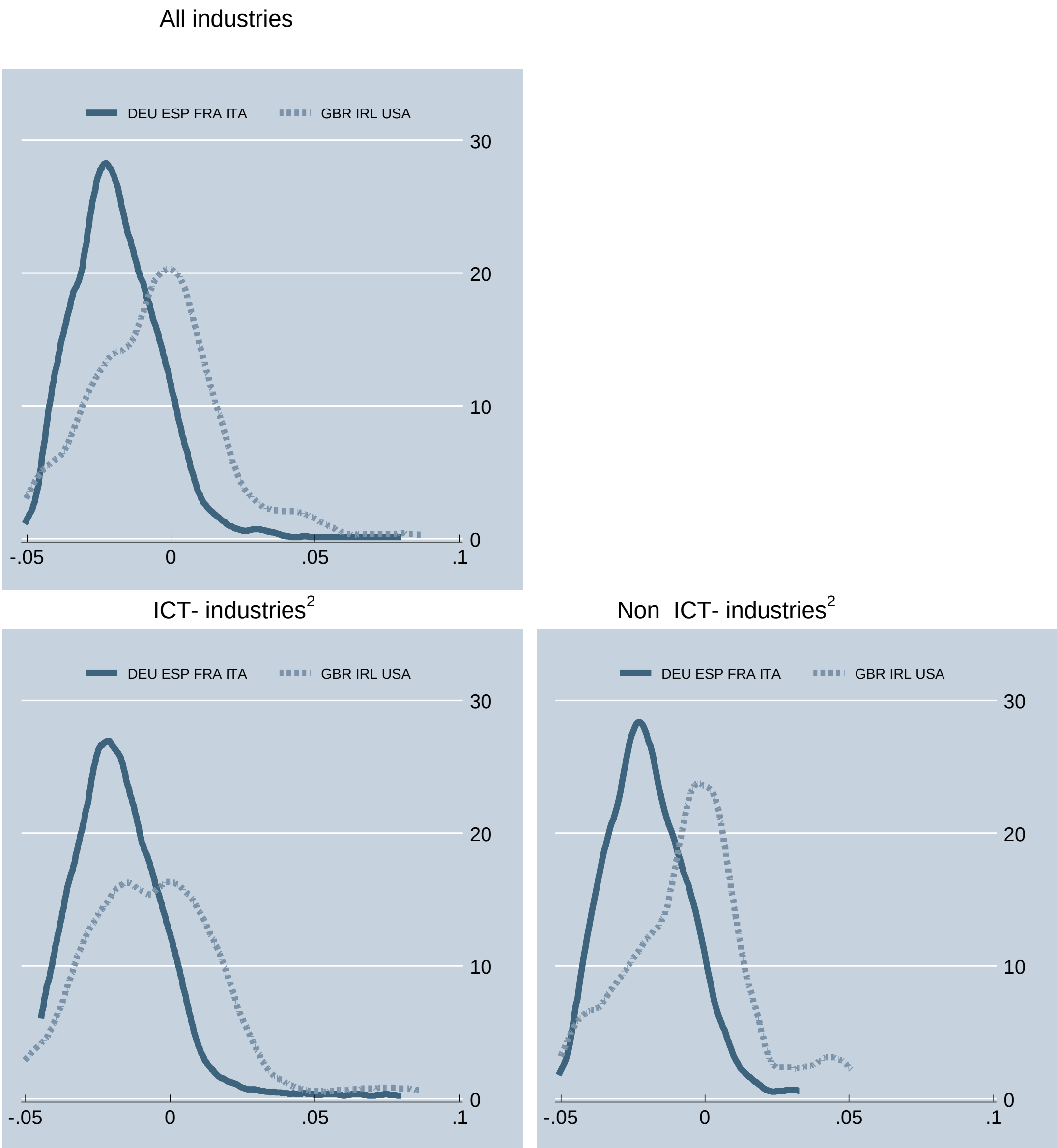
Regulation, industry heterogeneity and productivity

To begin exploring the dispersion of productivity growth rates, Figure 11 shows the cross-industry distribution of labour productivity growth rates over the 1995-2005 period in two groups of countries for which we have consistent data: three relatively "deregulated" English-speaking countries -- the United States, the United Kingdom and Ireland; and four relatively "restrictive" large continental and southern European countries -- Germany, France, Italy and Spain. For each group of countries, three distributions are shown: pooling together all 39 industries and focusing on either ICT or non ICT industries. To abstract from short-term fluctuations, a Hodrick-Prescott filter has been applied to the series using all available years. In addition, the measure of labour productivity growth has been purged of idiosyncratic effects across countries and industries to make it possible to pool the productivity data

48. To make country responses comparable and 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.

meaningfully,.[49] Therefore, values on the horizontal axis are not directly interpretable, while their dispersion (overall and in different industries) is.

Figure 11. Productivity growth distributions across countries and industries, 1995-2005[1]



1. Productivity growth purged of country, industry and period means.
2. See Annex 2 for the classification of sectors into ICT and non ICT.
Source: EU-KLEMS, March 2007

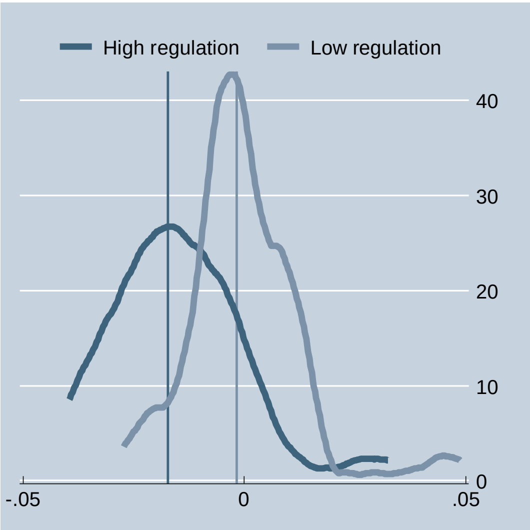
49. In other words, the figure shows the distribution of the residual of a regression of productivity growth rates on country and sector dummies after applying a Hodrey-Prescott filter and eliminating outliers(top and bottom percentile of the distribution). The resulting distributions are based on country-industry-year observations. The industry-level data are drawn from the EU-KLEMS database (March, 2007, see Inklaar, Timmer and van Ark, 2007).

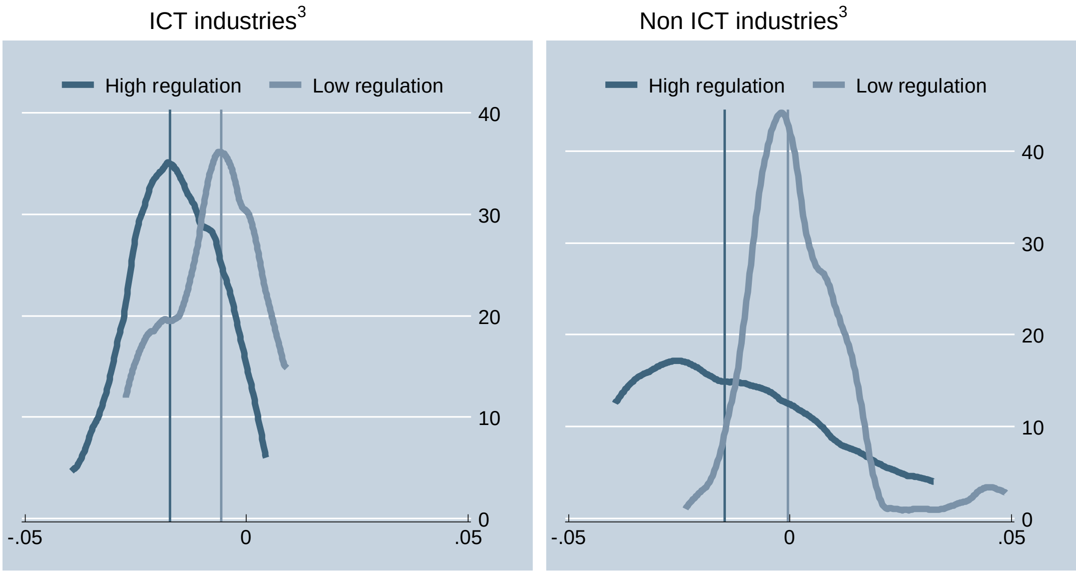
Several features emerge. For both groups of countries, the overall distribution is skewed to the left, indicating prevalence towards weak productivity growth rates, but has a long right tail, indicating cases of high productivity growth. Interestingly, the right tail of fast growing industries is longer and thicker in English-speaking countries than in EU countries that have a higher concentration among relatively slower growing industries. As a consequence, English-speaking countries tend to have a higher median productivity growth than EU countries. While the asymmetry between the two groups of countries is similar in both ICT and non ICT industries, the difference between the country groups with respect to the cumulative density of fast growing industries is particularly pronounced in ICT industries. Moreover, the dispersion of productivity growth rates is also higher in the ICT-using industries of these countries. It would seem therefore that above-median productivity growth, in the context of higher overall dispersion, is more common in the US, the UK and Ireland than in the large continental and southern European countries, especially in industries that are intensive in ICT.

In the light of our previous discussion, it is natural to relate these differences in productivity growth distributions to underlying product market policies that are more or less prone to help sustain fast growing firms within each industry. Before exploring this conjecture more in depth with firm-level data, it is useful to verify whether there is any association between differences in productivity growth distributions and our measures of the "knock-on" effects of restrictive non-manufacturing regulations at the industry level. To this end, Figure 12 replicates the three productivity growth distributions pooling together all countries, but now distinguishing between high and low-regulated cases (each observation being for a country/sector/period, purged as before from idiosyncratic factors), with the two sets of cases 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 (see Annex 1 for details).

Figure 12. Productivity growth distributions across countries and industries, 1995-2005[1]
High and low regulation[2]

All industries





1. Productivity growth, HP filtered and purged of country and industry means.
2. Observations are classified into low or high regulation if they fall in the first or last quintile, respectively, of the distribution of the regulation impact indicator. These indicators reflect the 'knock-on' effects of anti-competitive regulation in non-manufacturing sectors on industries that use the output of these sectors as intermediate inputs into the production process. See Annex 1 for details.
3. See Annex 2 for the classification of sectors into ICT-using and non ICT-using.
Source: EU-KLEMS, March 2007, and Conway and Nicoletti (2006)

The figure strongly suggests that regulation plays a role in shaping the distribution of productivity growth rates. Where regulation encourages competition and does not impose excessive costs to businesses, median productivity growth is higher than where regulations are restrictive and costly. These phenomena are particularly evident in ICT sectors where cases of fast-growing productivity are notably more frequent in low regulated cases than where regulation is high, and cases of poor productivity growth are much less frequent than elsewhere. A possible interpretation of these findings is 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. To verify this interpretation, in the remainder of this paper we look at the possible impact of product market policies on the process of resource reallocation and firm growth using cross-country firm-level data.

The role of reallocation across firms

A natural question that emerges at this point is why have some countries been able to quickly reallocate resources towards industries having a high potential for exploiting at best new general-purpose technologies and what are the mechanisms through which inappropriate regulations affect reallocation across sectors and firms. Previous studies (see e.g. Van Ark, 1996; Scarpetta *et al.* 2000) have shown that, over the past two decades, aggregate productivity growth in OECD countries was largely due to efficiency improvements within broadly defined industries.[50] Nevertheless, there is evidence of large differences in

50. A shift-and-share decomposition is generally used to assess the role of within-industry effects *vs.* effects due to reallocation of resources across sectors. In Scarpetta *et al.* (2000), the shift-share analysis is performed using 3-4 digit ISIC (Rev. 3) industry breakdown for manufacturing, and 2-digit ISIC for services. This decomposition bears several limitations other than the lack of detail for services (Timmer and Szirmai, 1999). First, it focuses on labour productivity and not on multi-factor productivity. Second, it assumes that marginal productivity of factor inputs moving in or out of an industry is the same as average productivity. Finally, if output growth is positively related to productivity growth (the so-called Verdoorn effect), the impact of structural change may be underestimated, since part of the shift to rapid-growth sectors will be counted in the within-effect.

productivity growth rates across industries at a finer level of disaggregation as well as over time. Reallocation across services industries appears to have played an increasingly important role in some countries (see *e.g.*, Bosworth and Triplett, 2007, for the US). Thus, the ability to reallocate resources to new dynamic industries may have played an important role in driving aggregate performance over the recent past.

The significant heterogeneity of industry-level productivity levels and growth rates is compounded by an even higher dispersion at the firm level within each industry and a continuous process of reallocation of resources through the entry of new firms, the exit of obsolete units and the expansion and contractions of incumbents. This continuous reallocation process was found to play a major role for aggregate productivity and output growth in a number of OECD countries (e.g. Olley and Pakes, 1996; Foster *et al.* 2002; Griliches and Regev, 1995; Bartelsman *et al.* 2004; and Aghion and Howitt, 2006). Resource reallocation is driven by incumbent firms adapting to market and technological changes, but also by firm dynamics – the entry of new firms, their expansion in the initial years of life and the exit of obsolete units. Firm dynamics is sizeable: several studies suggest that about 10 to 15 percent of all firms are either created or closed down every year in industrialized and emerging economies (see Caves, 1998; Bartelsman and Doms, 2000 and Bartelsman *et al.*, 2004 for reviews). Many of the new firms that enter the market fail in the initial years of life, but those that survive tend to grow, often at a higher pace than incumbents firms (see e.g. Geroski, 1995; Sutton, 1997; Bartelsman *et al.* 2004).

Are there significant differences in the degree of firm heterogeneity, and thus in the scope for resource reallocation? To shed light on this issue we rely on the firm-level Amadeus database (a commercially available collection of company-level accounting data). Our version of the database includes about 1.5 million European companies, including large numbers of unlisted SMEs, and covers the period from the late-1990s to 2004.[51] Available information allows for a detailed analysis of firm level performance at a fine sectoral disaggregation.[52] Figure 13 shows the distribution of firm-level labour productivity for two countries –France and the United Kingdom – and for four representative sectors – two ICT-producing sectors, *electrical and optical equipment* (ISIC Rev.3 30-33) and *post and telecommunication* (64), one ICT-using industry, trade (50-52), and a traditional manufacturing industry, textile, clothing and footwear (17-19).[53] For each year, industry and country we plot the distribution between the 5th and the 95th percentile of labour productivity. The upper bound of the grey bar represents the 75th percentile, the lower bound the 25th percentile and the line in the middle of each grey bar being the median.

51. This database includes all companies that fulfil at least one of the following three size criteria: i) operating revenue equal to at least 1.5 million euros, ii) total assets equal to at least 3 million euros and iii) number of employees equal to at least 20. The provider of the Amadeus database is a private company, Bureau Van Dijk.

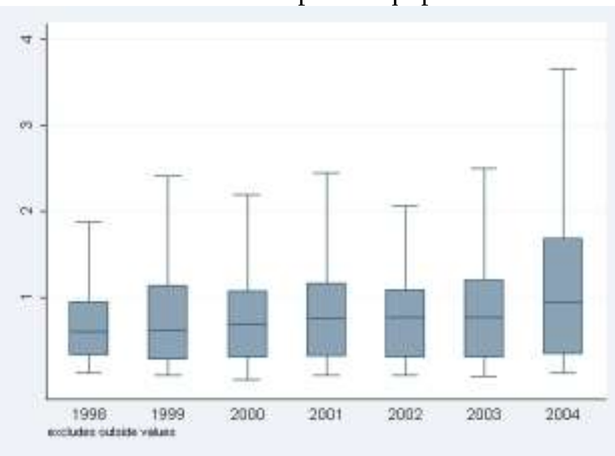
52. Some questions are worth considering regarding the Amadeus database. The first question pertains to the degree of representativeness of the population of firms in each of the countries included in the sample. For the 1.5 million companies version of Amadeus used in this paper, the data provider, Bureau Van Dijk, ensures that 95% of companies fulfilling the size criteria are indeed included in the database. This implies that the data have a selection bias based on size, but one that is well identified and can be controlled for. We have used a re-sampling procedure to calibrate the distribution of firms by size and industry to the distributions observed in the entire population of firms with at least 20 employees, as recorded by Eurostat (see Annex 3). The second question regards the harmonisation of the accounting items reported in the database across countries, as accounting standards and regulations differ in details. In all our empirical analyses in this paper, we control for such cross-country differences by including country fixed-effects or, in the econometric analysis (see below), by including both country and firm size specific effects to control for the possibility that the differences are related to firms of a certain size.

53. We focus on labour productivity here to allow for cross-sectoral comparisons. Since our estimates of TFP are based on a production function approach, they are industry and country-specific and do not allow for either cross-country or cross-industry comparisons in levels.

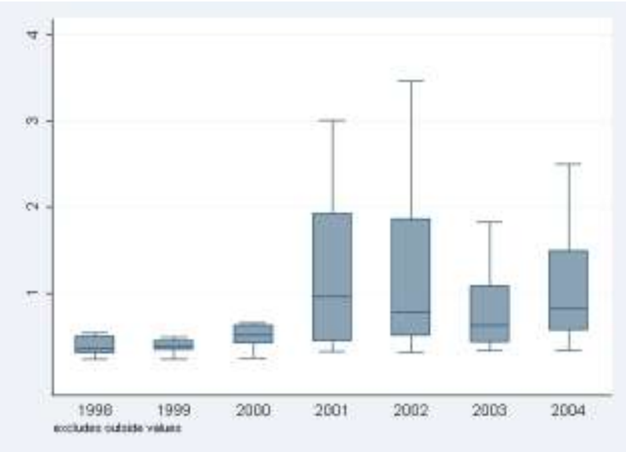
Figure 13. Evolution and dispersion of labour productivity: selected countries and sectors[1]

France

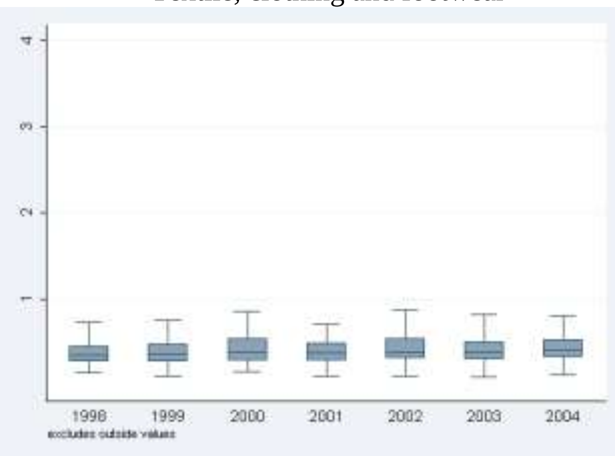
Electrical and optical equipment



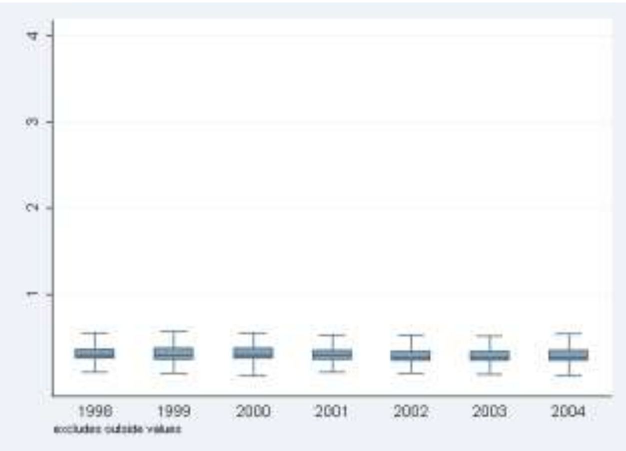
Telecommunications



Textile, clothing and footwear

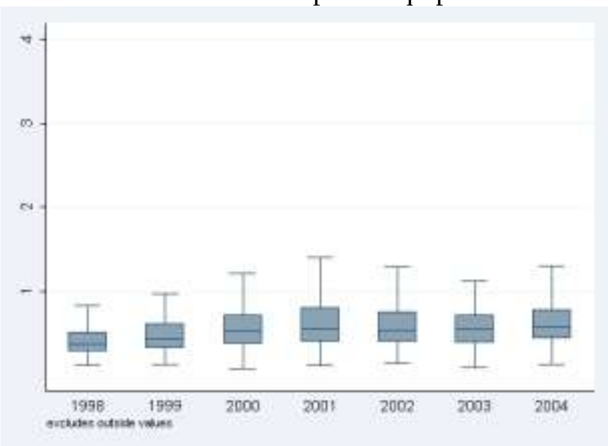


Wholesale and retail trade

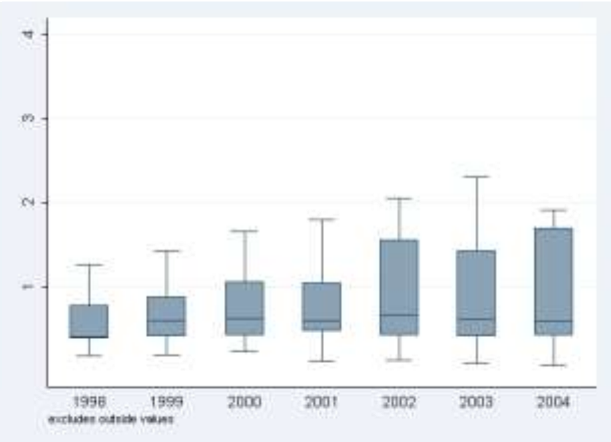


United Kingdom

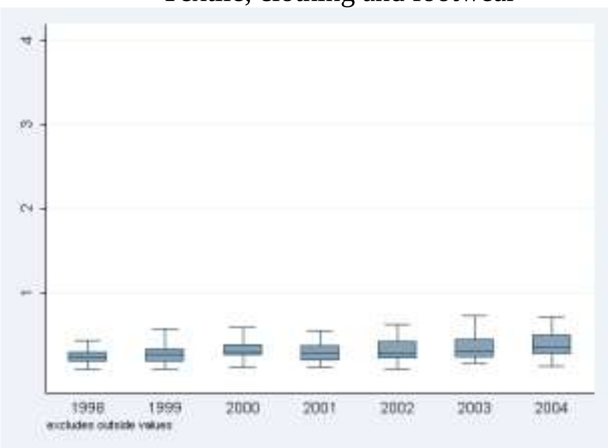
Electrical and optical equipment



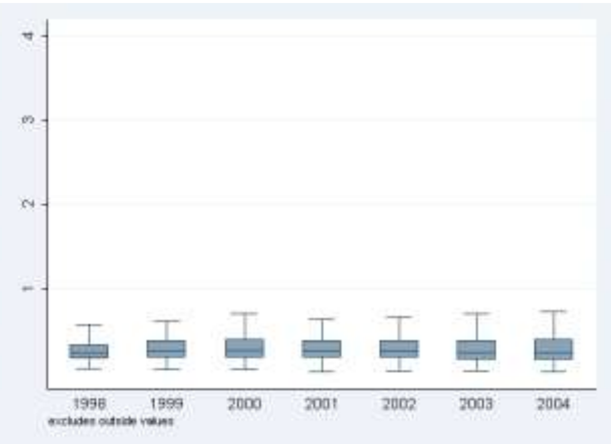
Telecommunications



Textile, clothing and footwear



Wholesale and retail trade



1. The figures present the distribution of labour productivity in each industry and year between the 5th and 95th percentiles. The upper bound of the grey bar represent the 75th percentile, the lower bound the 25th percentile and the line in the middle of each grey bar being the median. Labour productivity is measured as value added per worker in 100 thousands of 1995 Euros, using value added deflators from EU Klems. The numbers are not fully comparable across countries because of differences in purchasing power parities are not taken into account.
Source: Authors' calculations, AMADEUS database.

All industries display persistent productivity dispersion confirming the fact that at any point in time all industries are characterised by a (more or less) wide heterogeneity in the performance of its firms, some of them being young businesses that are learning their way into the market, others being obsolete firms on their way out, but others again being firms undergoing significant investment and retooling. Interestingly, the degree of productivity dispersion varies significantly across sectors. In line with our discussion so far, the ICT-producing industries show a higher average productivity, but also a wider heterogeneity in productivity performance and, especially in the case of the telecommunication sector, an increase in dispersion over time largely because of the development of high productivity firms at the top of distribution.[54] The traditional manufacturing sector – textile, clothing and footwear – shows a much

54. Griffith, Redding and Simpson (2006) present a similar figure for the U.K. focusing on the narrower office machinery and computer equipment industry and the footwear and clothing industry. Their data covers a much longer period – 1981-2000 – and suggest a significant acceleration in productivity in the office and computer sector with a widening of

narrower distribution of productivity growth rates across firms as does the trade sector, especially in France, despite the potential for its firms to exploit the productivity bonus provided by ICT. Indeed, UK retail firms seem to experience – though on a much smaller scale – the same increase in productivity dispersion at the top as observed in ICT-producing sectors.

Given the wide dispersion in the firm-level productivity performance and the wider heterogeneity in the ICT sectors, the natural question is whether market forces tend to reallocate resources towards firms with higher efficiency levels. There are different ways to assess the importance of reallocation for productivity. A number of studies have focused on dynamic efficiency, assessing the role for productivity growth of reallocation among incumbents, as well as through the entry and exit of firms, (Foster *et al.* 2006; Griliches and Regev, 1995; Bartelsman *et al.*, 2007). However, this analysis of dynamic efficiency, while inherently interesting, is fraught with interpretational and measurement difficulties mainly related to the comparability across countries of the entry and exit of firms. In an attempt to overcome these difficulties, these studies tend to exploit sectoral variations within countries and then, in turn, compare such sectoral differences across countries – a difference-in-difference approach. They generally find a significant role of entry and exit for productivity growth in all countries and a stronger role of entry in dynamic industries, where new firms may better harness new technologies in production and organization processes.

A simpler way to assess the importance of reallocation for productivity is to ask the question – are resources allocated efficiently in a sector/country in the cross section of firms at a given point in time? This approach is based upon a simple cross-sectional decomposition of multifactor productivity levels developed by Olley and Pakes (1996). They note that, in the cross section, the aggregate level of productivity for a sector at a point in time, *t*, can be decomposed as follows:

$$P_t = (1/N_t)\sum_i P_{it} + \sum_i \Delta\theta_{it}\Delta P_{it} = AP_t + WP_t \qquad (1)$$

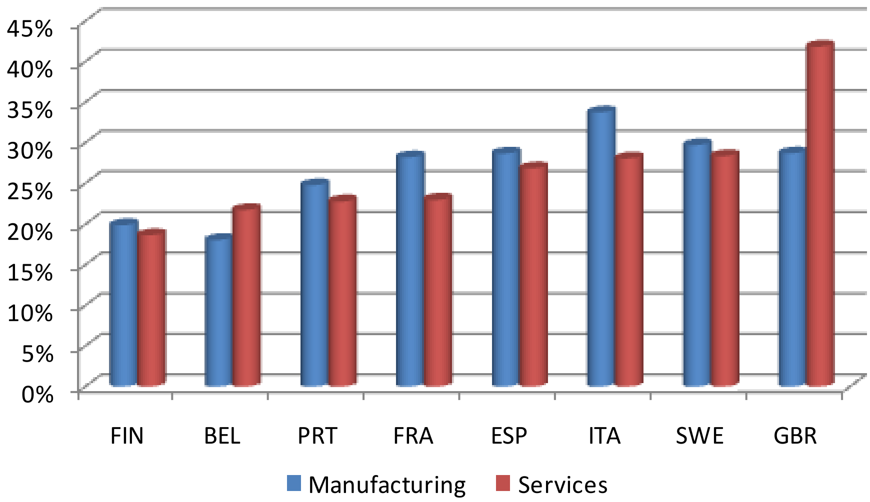
where N is the number of businesses in the sector and Δ is the operator that represents the cross sectional deviation of the firm-level measure of productivity (P) from the industry simple average. The simple interpretation of this decomposition is that aggregate productivity can be decomposed into two terms involving the un-weighted average of firm-level multifactor productivity plus a cross term that reflects the cross-sectional efficiency of the allocation of activity. The cross term captures *allocative efficiency* since it reflects the extent to which firms with greater efficiency have a greater market share (θ). This simple decomposition is very easy to implement and essentially involves just measuring the un-weighted average productivity *versus* the weighted average productivity. Measurement problems make comparisons of the TFP levels of either of these measures across sectors or countries very problematic but focusing on the relative contribution of the latter of these two measures reflects a difference-in-difference approach where most measurement problems are controlled for.

Figure 14 presents the estimated indicator of efficiency (OP=WP/(AP+WP)) in the allocation of resources in a sample of EU countries for which we have consistent firm-level data from the Amadeus database. It focuses on manufacturing and services separately and for each of the two broad sectors a weighted average of 2-digit industry level OP cross terms was used. The OP decomposition suggests that in all countries allocative efficiency accounts for a significant fraction of the overall observed TFP levels: between 20-40 percent of the observed productivity levels can be ascribed to the actual allocation of resources with respect to a situation in which resources were allocated randomly across firms in each sector. However, there are also interesting differences across the two broad sectors – manufacturing and business services – and across countries. In particular, cross-country differences in allocative efficiency in

the dispersion as of the mid-1990s when the IC technology shock was fully unfolding, while the dispersion remained broadly constant in the traditional clothing and footwear sector.

manufacturing are smaller than those observed in business services, where regulatory reforms have been more hesitant in a number of continental EU countries and where foreign competition is less acute. The United Kingdom, arguably a country that, as discussed above, has introduced already in the 1980s market-friendly regulations in most service industries, stands with the highest degree of allocative efficiency in services, almost 15 log points above that of the second highest country in the service sector.[55]

Figure 14. Contribution of resource allocation to sectoral TFP levels
Based on Olley-Pakes productivity decomposition[1]



1. The data reported in the Figure represent the contribution of the cross-term of the Olley and Pakes decomposition, which is defined as the log difference between the weighted and un-weighted averages of firm-level productivity.
Source: Amadeus data base, authors' calculations

As a further step in our analysis of allocative efficiency, Figure 15 plots firm growth by firms belonging to the four quartiles of the productivity distribution. The quartiles divide firms according to their TFP (relative to the median of the sector and country for which the production function was estimated, on average over 1998-2004.) Thus, the top quartile represents the 25% most productive firms in each industry. Firm growth is measured in terms of real value added, also averaged over 1998-2004, and normalised by the country/sector average (which is set equal to 1 in the figure).[56] In theory, an efficient allocation of resources should promote the expansion of most productive firms; in other words, firms with relatively high productivity levels should be gaining market shares, while those at the bottom of the distribution should be contracting and eventually exiting. Of course, this is a partial analysis that does not consider dynamic processes – i.e. some of the low productivity firms may be new ventures that are involved in a learning-by-doing process and catching up to the efficiency of more mature businesses, while some of the high productive businesses may have less scope for further expansion. Bearing these caveats in mind, the Figure suggests that in all but one country (Spain), more productive firms indeed experience a

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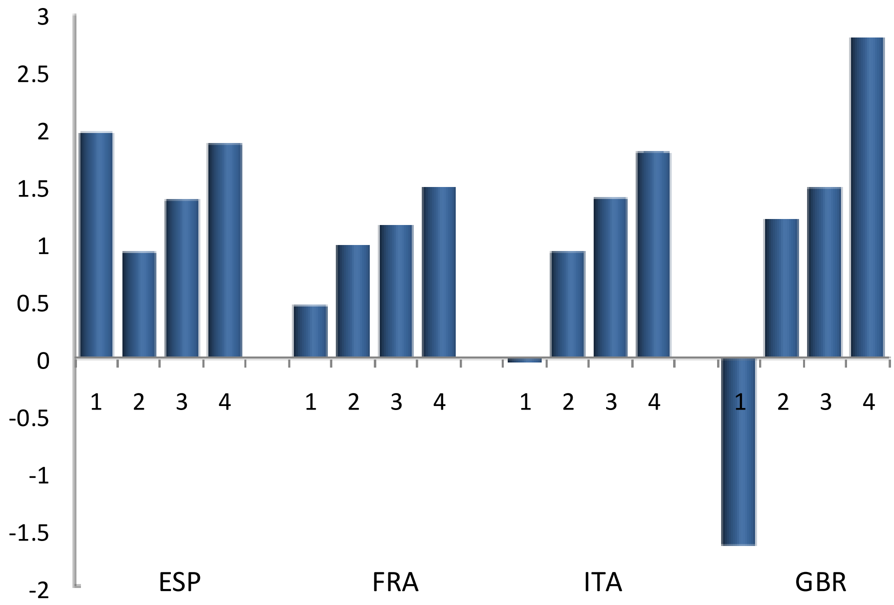
55. A similar analysis is presented in Bartelsman *et al.* (2004) with reference to labour productivity in manufacturing in the 1990s in a sample of OECD countries that also includes the United States. Interestingly, the United States stands in this analysis as the country with a much higher degree of allocative efficiency as compared with the other OECD countries. In these data (drawn from census and enterprise surveys) the degree of allocative efficiency in the UK is fairly low. However, the data refers to the manufacturing and to the 1990s, while in the evidence of a high allocative efficiency reported in this paper the focus is on the early 2000 and to the business service sector.

56. In other words, a value of 2.5 for the highest quartile in the United Kingdom means that these firms grew on average 2.5 times faster than their peers in the same sector/country cell. To minimize endogeneity problems, the growth in firm value added is calculated as the average of t_{+2} and t_{+3}.

higher growth than their lower productivity counterparts. However, the difference in the growth of low and high productivity firms varies significantly across countries. While in Spain there is no clear relationship between productivity levels and expansion, in France the most productive 25% have an average growth that is twice as high as the 25% least productive firms, while in Italy it is three times as high and in the United Kingdom it is 5 times as high. This confirms our finding based on the cross-sectional OP productivity decomposition, namely that some countries are better able at channelling resources towards high productivity firms, thereby encouraging them to grow rapidly and strongly contributing to the overall productivity performance.

Figure 15. Do better firms grow faster?[1]



1. The Figure presents the average real value added growth of the four quartiles of the TFP (relative to the median of the sector and country for which it was estimated) distribution of firms in each country. Firm level real value added growth are normalised by country/sector average to improve comparability.
Source: Amadeus data base, authors' calculations

While in the next section we provide a more formal econometric analysis of the links between firm-level productivity performance and regulations, here we simply correlate our OP indicator of allocative efficiency across countries, sectors and time with the OECD indicators of the knock-on effects of non-manufacturing regulation on all sectors of the economy (Table 1). We use a fixed-effect specification in which, in addition to our regulatory impact indicator, we include a full set of time-varying country-specific and sector-specific effects.[57] The results for the overall business sector suggest a negative effect of anti-competitive regulations on the efficiency of the allocation of resources. However, breaking down the sample into manufacturing and services suggests that the negative effect of regulation originates from services. This is not surprising, since cross-country differences in the regulatory environment, and regulatory reforms over the past decade mostly concerned the service sector. Interestingly, if we split the industry sample between ICT using and non-ICT using sectors we find that anti-competitive regulations affect more strongly the ICT sectors. In other words, in those sectors where there was more heterogeneity

57. The sample includes a set of OECD countries for which the Amadeus database has a good coverage of firms: Austria, Belgium, Finland, France, Germany, Italy, Portugal, Spain, Sweden, United Kingdom; the period is 1998-2004.

in firm performance because of greater experimentation and learning by doing around this new general purpose technology, regulations that restricted competition and entry of new firms have had a strong negative effect on the ability of the market to quickly channel resources towards those firms with the highest realised performance. This echoes nicely previous results obtained by Conway *et al.* (2006) on industry-level data, illustrating one channel through which restrictive regulations in ICT-using sectors may have curbed the ability of some countries to fully benefit from the diffusion of ICT over the past decade.

Table 1. Product market regulation and allocative efficiency

	Business Sector	Manufacturing only	Services only	ICT using sectors	Non-ICT using sectors
Regulation Impact Indicator	-0.36 **	0.34	-0.28 *	-0.67 ***	-0.41 *
	(0.15)	(0.64)	(0.15)	(0.16)	(0.24)
Country-year FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
N	849	629	220	242	607
R2	0.20	0.20	0.36	0.36	0.18

Standard Errors in parentheses. *, **, *** indicate statistical significance at the 10, 5 and 1 percent levels, respectively.
Agriculture, forestry, fishing, mining are excluded, as are public administration, education and health sectors.

III.4 Firm-level evidence on regulation and TFP growth

The discussion so far has indicated that aggregate productivity growth is largely driven by some high growth ICT sectors and, within them, by the presence of a group of highly performing firms (the "gazelles"). While there is empirical evidence on the links between industry-level productivity growth and ICT investment and regulations, the evidence on how regulations influence the emergence and expansion of these high performing gazelles is very scant. In the previous section we have shown that inappropriate regulations, not only affect the dispersion in productivity across firms, but are also likely to hinder the allocation of resources towards the most productive ones. Here we move one step forward and look at the drivers of firm-level productivity, also by controlling for their underlying level of efficiency.

We adopt the same neo-Schumpeterian growth framework discussed in previous sections and used in the industry-level empirical work surveyed above. This model allows for two distinguishing features: i) persistent heterogeneity in firm level performance, even in narrowly-defined industries; and ii) the possibility of firms to catch up with the technological frontier through adoption of leading technologies. In particular, we consider a catch-up specification of firm-level productivity whereby, within each industry, the production possibility set is influenced by technological and organisational transfer from the technology-frontier firms to other firms.[58] In this context, firm-level multi-factor productivity for a given country c, industry s at time t (MFP_{icst}) can be modelled as an auto-regressive distributed lag *ADL(1,1)* process in which the level of MFP is co-integrated with the level of MFP of the frontier firm F. Formally,

58. Aghion *et al.* (2005) use a similar approach to study the effect of foreign entry on innovation incentives and productivity growth of UK incumbent firms. They use, however, a industry-level world technology frontier – based on the productivity levels of US industries – instead of the country/industry specific frontier as in our paper.

$$\ln A_{icst} = \alpha_0 \ln A_{icst-1} + \alpha_1 \ln A_{Fcst} + \alpha_2 \ln A_{Fcst-1} + \alpha_3 regimpact_{cst-1} + \gamma_s + \gamma_{ct} + \varepsilon_{icst} \qquad (2)$$

where A_{isct} is the TFP level of a non-frontier firm *i*, A_{Fsct} is the TFP level at the technological frontier *F*, *regimpact* is the lagged indicator of the impact of non-manufacturing regulations in each sector/country/period, and γ_s, γ_{ct} are sector and country-year fixed effects, respectively; ε_{isct} is a random error term. TFP at the firm level is obtained using the production estimation approach by OLS. All the results are robust to estimating TFP by the semi-parametric Levinsohn & Petrin (2003) method. TFP at the technological frontier is measured as the average TFP of the 5% most productive firms in country *c*, in sector *s* in year *t*. This ADL(1,1) process has the following simple Error Correction Model (ECM) representation:[59]

$$\Delta \ln A_{icst} = \alpha_1 \Delta \ln A_{Fcst} - (1-\alpha_0)\ln\left(\frac{A_{ics,t-1}}{A_{Fcs,t-1}}\right) + \alpha_3 regimpact_{cst-1} + \gamma_s + \gamma_{ct} + \varepsilon_{icst} \qquad (3)$$

Equation (3) is the baseline specification of the policy-augmented TFP equation. The ECM representation has many attractive statistical properties and a straightforward interpretation.[60] Productivity growth of firm *i* is expected to increase with productivity growth of the frontier firm *F* and with firm *i*'s distance from the frontier firm *F*. Notice that, even though the ECM representation is estimated, the underlying ADL(1,1) model is in productivity levels and not in growth rates. The model implies equilibrium firm heterogeneity in TFP levels because (i) the innovation potential of the frontier firm is higher than innovation potential of the non-frontier firms and (ii) convergence to the frontier takes time. Standard errors are clustered by country and sector to allow the error term to be correlated in an unrestricted way across establishments and time within sectors in the same country (Moulton, 1991, Bertrand et al., 2004). As in the analysis of allocative efficiency in the previous section, the firm-level data are drawn from the Amadeus database and cover the same countries and time period (re-sampled to match Eurostat population distributions).

It should be stressed at the outset that our analysis focuses on the effects of regulations on incumbent productivity growth across different industries and countries. There are, however, other mechanisms whereby regulations curb firms' productivity that we cannot explore with Amadeus data. The most important one is reallocation of productive inputs and outputs via the entry and exit of firms. In Amadeus it is not possible to accurately distinguish entry into the market from entry into the sample and exit from the market from exit from the sample. The importance of creative destruction in promoting productivity growth is empirically supported by Olley and Pakes (1996), Pavcnik (2002) and more recently by Aghion *et al.* (2007) who found that restrictive entry regulations curb entry of new firms in sectors naturally characterized by high firm turnover.

The first three columns in Table 2 present estimates of the baseline specification of the productivity equation focusing on the total business sector, ICT-using and non-ICT-using sectors respectively. In accordance with the theoretical framework and previous evidence at the sectoral level (Griffith *et al*., 2000; Nicoletti and Scarpetta, 2003 and Inklaar *et al*, 2007) and at the firm level (Griffith *et al*, 2006, for the UK), outward shifts in the technological frontier (*leader growth* in the Table) influence productivity of follower firms. Furthermore, other things being equal, the larger the distance to the industry-specific technology frontier (*gap to the leader* in the Table), the greater the scope for catching up

59. Under the assumption of long-run homogeneity ($1-\alpha_1=\alpha_2+\alpha_3$).

60. See Hendry (1996) for the statistical properties of the ECM model.

and experiencing strong productivity growth on the transitional path to the frontier.[61] Confirming industry-level results, the regulatory impact variable has a statistically-significant negative effect on firm-level productivity, but only in the ICT-using industries. As discussed earlier, these are the industries where most of the product market reforms took place, with different intensities across European countries, and where there was greater scope for competition-enhancing reforms to strengthen entry of new firms and promote escape entry strategies by incumbents via the adoption of IC technology.

The last two columns of the Table shed some light on which firms are potentially most affected by inappropriate regulations. In particular, in column 4 we test whether these regulations have disproportionate effects on dynamic firms (i.e. those with the potential to rapidly catch up) and in column 5 we test whether regulations have such effects on the high-productivity firms that, as discussed earlier, drive aggregate performance in high-performing countries.[62] In the first case, we interact the regulatory impact variable with dummies indicating firms that either have converged or not towards the frontier in previous years; while in the second we interact the regulatory variable with dummies indicating firms close or further behind the frontier. The empirical results clearly indicate that burdensome regulations – by curbing the entry of new firms and limiting the scope for escape entry strategies – affect predominantly the dynamic part of the firm population in each sector, both from a static (most productive firms) and a dynamic perspective (rapidly catching up firms). Interestingly, firms that are very distant from the frontier do not seem to be affected by regulation. These results are consistent with those of Aghion *et al.* (2004; 2005): using firm-level data for the UK and foreign entry as the key competition-enhancing factor, they also found that entry spurs innovation incentives and escape entry strategies mainly in technologically-advanced sectors. But how do they square with the industry-level results discussed in the previous section suggesting that market-unfriendly regulations affect in particular those industries further behind the world technology frontier? The two sets of results are not inconsistent: industry-level results includes entry and exit effects at the industry level, as well as reallocation among incumbents; while firm-level results, by construction only focus on individual firms' performance conditional on their survival. In particular, market-unfriendly regulations – by curbing entry and innovation incentives and permitting low productivity firms to survive– lower the industry-average productivity performance, and the effects are the largest the more the industry as a whole could benefit from adoption of leading technologies in world markets. Within each industry, however, and conditioning on the sample of surviving firms, regulations that curb competitive pressures and increase costs reduce only innovation incentives and entry escape strategies of the more advanced firms that have the greatest potential for adopting leading technologies available in the market.

61. Similar results are obtained by a number of studies focusing on UK firm-level data and using foreign entry as the key competition-enhancing factor. See Aghion et al. (2004), Aghion et al. (2005) Griffith et al. (2002) and Haskel et al. (2002).

62. Catch-up firms are defined as those that reduced the gap with the frontier during the past year. Firms close to the frontier are those with a productivity gap below the median in absolute value.

Table 2. Firm-level TFP and regulations

	Business Sector	ICT using sectors	Non-ICT using sectors	Catch-up	Distance from frontier
Leader Growth	0.19 ***	0.15 ***	0.26 ***	0.49 ***	0.70 ***
	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)
Gap to the Leader	-0.17 ***	-0.16 ***	-0.20 ***	-0.09 ***	-0.27 ***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.04)
PMR	-0.03	-0.09 **	-0.04		
	(0.05)	(0.04)	(0.09)		
Catch-up firms: PMR				-0.14 ***	
				(0.03)	
Non-catch-up firms: PMR				-0.04	
				(0.04)	
Dummy for catch-up firms				0.24 ***	
				(0.02)	
Catch-up firms close to frontier: PMR					-0.03 **
					(0.01)
Catch-up firms far from frontier: PMR					0.00
					(0.01)
Dummy for close to frontier					0.13 ***
					(0.01)
Country-year FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
N	173137	83654	89483	83654	72979
R2	0.12	0.12	0.14	0.45	0.39

Standard Errors are in parentheses. *, **, *** indicate statistical significance at the 10, 5 and 1 percent levels, respectively. Agriculture, forestry, fishing, mining are excluded, as are public administration, education and health sectors. Catch-up firms are defined as those that approached the frontier during the past year. Close to the frontier is defined as a productivity gap below the median in absolute value.

IV. Concluding remarks

In this paper, we review growth patterns in the OECD countries over the past two decades at the aggregate, sectoral and, whenever possible, firm-level and shed some light on the role of product market reforms in shaping these patterns. We were mainly motivated in this study by the apparent dichotomy between widening disparities in growth performance and a significant process of regulatory convergence across countries. The paper confirms that differences in investment in new technologies – in particular the information and communication technology – and MFP growth in both ICT-producing and, increasingly, ICT-using industries underpin the observed growing disparities in growth across OECD countries. These factors contributed to boost growth in the United States, Australia, the United Kingdom and a number of smaller EU countries, while they held back growth in large continental EU countries. Our findings suggest that the pace and intensity of product market reforms were crucial in shaping the growth process at the time when a new general-purpose technology fully emerged. Despite efforts in almost all OECD countries to make product market regulations more market friendly, the dispersion in regulatory regimes widened in the 1990s and only started to converge in the most recent years. In particular, despite the Single Market Programme, EC competition policies and the European Monetary Union, EU member countries have been characterised by disparate reform patterns until the late 1990s. In European countries that delayed reforms, rates of ICT investment remained relatively low and these countries were unable to fully exploit the opportunities offered by the new technology. Moreover, despite the fact that most EU countries have deregulated network industries in the most recent years and that this would have positive effects in other sectors in the years to come, there remain persistent rigidities in the regulatory settings of key ICT-using sectors that not only affect the productivity of these sectors directly but also propagate to the rest of the economy making it difficult to use ICT as efficiently as in the countries with more market-friendly regulations. Further deregulating these ICT-using sectors seems to be a priority for raising the productivity potential of the large continental EU countries and, thereby, of the EU as a whole.

The paper explores in some details the mechanisms through which inappropriate product market regulations have affected productivity performance and the take up of IC technology at the sectoral and firm-level in the OECD countries. Confirming previous evidence from country studies, we found a significant dispersion in productivity performance across industries and, within each of them, across firms. ICT-intensive sectors tend to have a wider dispersion in productivity performance with a fat right tail of rapidly growing firms (the “gazelles”) that drives the overall sectoral performance. Inappropriate product market regulations tend to reduce the efficiency of the resource allocation process towards these highly dynamic firms. Indeed, not only does the productivity distribution of ICT-intensive sectors show a fatter right tail in the more market-friendly countries, but lighter regulations are also found to facilitate an efficient allocation of resources, by promoting the entry of new innovative firms and the expansion of the most productive businesses. Moreover, countries that have deregulated ICT-intensive sectors have seen a significant increase in the dispersion of productivity, largely because of the emergence of very high productivity firms at the top of the distribution.

Our econometric results at the industry and firm-levels provide complementary evidence from a multivariate perspective, in which we can take into account a host of other factors that could potentially influence productivity performance over and above product market regulations. While there is evidence in the data that inappropriate regulations bite the most in countries far behind the frontier, largely by reducing the incentives for firms to adopt globally available leading technologies, our preliminary firm-level analysis suggests that the mechanism through which this occurs is by curbing the expansion of the most dynamic businesses. Firms with relatively better productivity levels and growth performance are the one with the potential to further raising the domestic technological frontier, by adopting the leading technologies and innovating, and regulations that shelter them from foreign competition and allow low productivity firms to survive curb their incentives to exploit at best their potentials.

All in all, our analysis is consistent with the view that delaying market-oriented reforms in a number of OECD countries, including the large continental European ones, has not only reduced the scope (if not the magnitude) of the creative destruction process (the entry and exit of firms and reallocation among incumbents), but also, by curbing market contestability, weakened the incumbents’ incentives to shift to IC technologies in key sectors of the economy where such technologies would have otherwise allowed for strong efficiency gains.

Much work remains to be done to further explore the mechanisms through which regulations affect economic performance. Consistent with a growing body of comparative firm-level studies, the key message from our paper is that assessing these mechanisms requires going beyond aggregate data and explore how regulations affect the performance of individual sectors and, within each of them, the process of creative destruction and allocative efficiency. The good news is that harmonised industry-level as well as firm-level data are becoming available for a growing group of countries. At the same time, significant progress has been made in characterizing the different aspects of product market regulations, distinguishing between pure barriers to entry, from red tape and state control for each individual sector, while more work is still required to assess whether certain firms enjoy preferential treatments, either because of their size, age or geographical location.

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Annex 1

Product market indicators

The OECD indicators of non-manufacturing regulation (NMR)

Measuring cross-country differences and changes in the regulation of non-manufacturing sectors is important for at least two reasons. First, these sectors represent around two thirds of economic activity and are the most dynamic part of the economy (in terms of productivity growth and employment) in many OECD countries. Second, non-manufacturing is the area in which most economic regulation is concentrated and where domestic regulations are most relevant for economic activity and the welfare of consumers. Because import penetration is much more limited than in manufacturing sectors, final and intermediate consumers of non-manufacturing products have little alternative than to purchase these products on the domestic market. Domestic regulations affect the quality, the variety and the price of such products in a number of ways.

Clearly, many of these regulations serve the public good, either by addressing market failures or by pursuing non-economic objectives. Accordingly, it is particularly important that the analysis of non-manufacturing regulations be driven by well-defined criteria. The overarching criterion on which this paper surveys and assesses regulations is their effect on competition where competition is viable. Therefore, each of the OECD sectoral indicators reflects regulations that curb efficiency-enhancing competition, whereas regulations in areas in which competition would not lead to efficient outcomes (e.g. natural monopolies) are not considered. This approach yields indicators that are well-focused and account for the different technological characteristics of sectors. At the same time, the indicators are silent on the quality of regulation according to criteria other than competition or the extent to which regulations achieve non-economic policy goals.

By and large, all the indicators are constructed in a similar way. They cover information in four main areas: state control, barriers to entry, involvement in business operations and, in some cases, market structure. The information summarised by the indicators is "objective", as opposed to survey-based, and consists of rules, regulations and market conditions. All of these regulatory data are vetted by Member country officials and/or OECD experts. The indicators are calculated using a bottom-up approach in which the regulatory data are quantified using an appropriate scoring algorithm and then aggregated into summary indicators by sector of activity in each of the four areas or across them. While this approach involves a degree of discretion, notably in choosing scores and aggregation weights, it has the merit of transparency and makes it possible to trace each indicator value to the underlying detailed information about policies and market conditions.

The resulting indicators of non-manufacturing regulation cover energy (gas and electricity), transport (rail, road and air) and communication (post, fixed and cellular telecommunications) over the 1975-2003 period in 21 OECD countries, and retail distribution and professional services for 1998 and 2003 in 30 OECD countries. In addition, indicators of the "knock on" effects of anti-competitive regulation in these sectors (plus the finance sector) on sectors that use the outputs of these sectors as intermediate inputs are also calculated. To the best of our knowledge, these indicators provide the broadest coverage, of sectors and areas, and the longest time-series currently available for comparing product market regulation across countries. They are complementary to indicators of economy-wide anticompetitive regulation already published by the OECD (Conway *et al.* 2005). All indicators are updated on a regular basis and their values as well as background documentation are publicly available at www.oecd.org/eco/pmr.

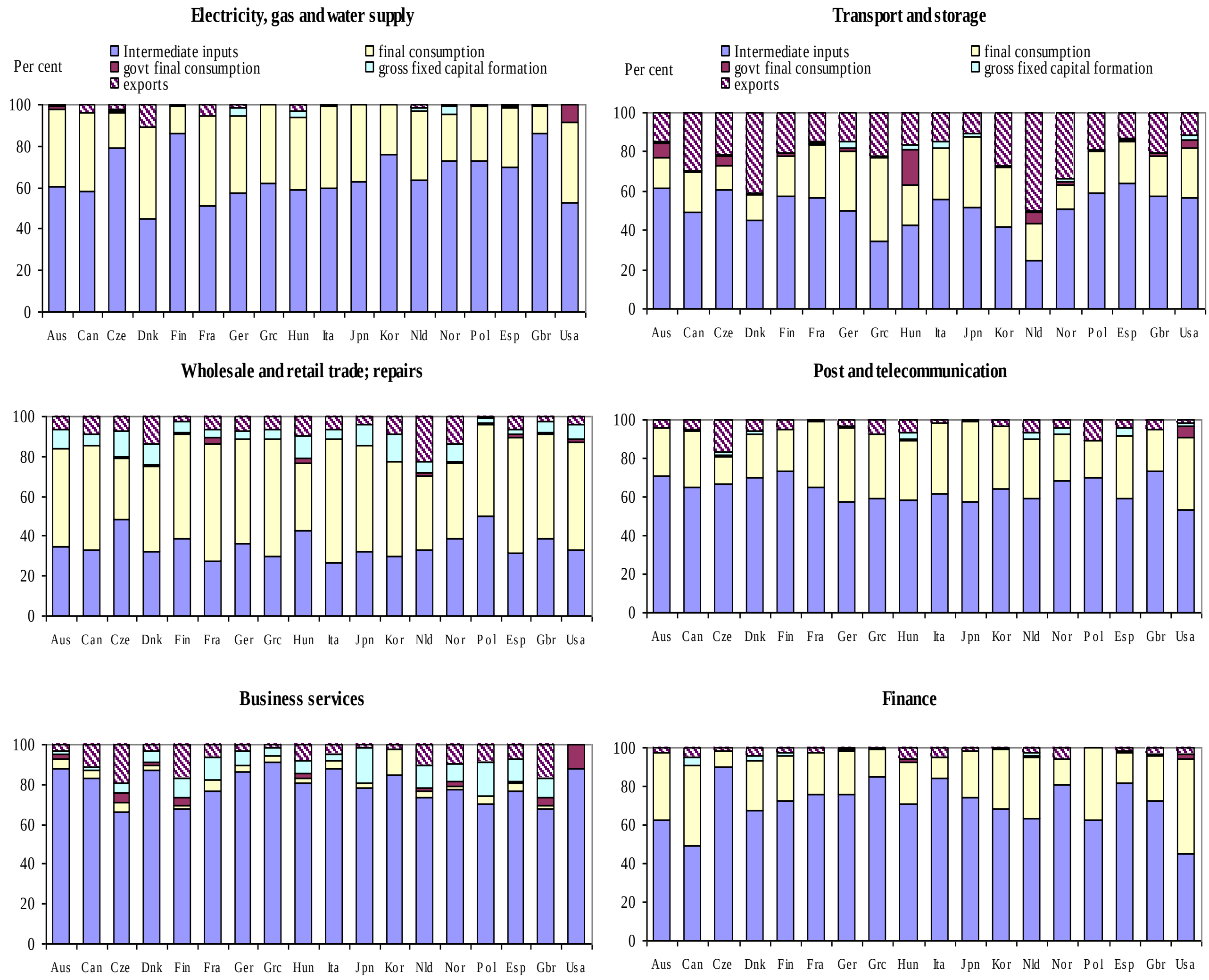
Measuring the 'knock-on' effects of anti-competitive non-manufacturing regulation: the regulatory impact indicators (RI)

The effect of product market regulations that restrict competition in non-manufacturing sectors is by no means confined to these sectors. It will also have a less visible impact on the cost structures faced by firms that use the output of non-manufacturing sectors as intermediate inputs in the production process.[63] For example, if product market regulation in the business services sector in a particular country is restrictive of competition then the prices charged by firms operating in this sector will tend to be higher and/or the quality of service lower than for firms operating in a competitive business services environment. In turn, this will affect the costs of entry for new firms that need to use these services, the extent to which existing firms outsource these services, the organisation of work within firms, the allocation of resources between firms and, ultimately, the scope for the associated productivity improvements.

These "knock-on" effects of non-manufacturing regulation are likely to have become particularly salient over recent years given the large and increasingly important role of the non-manufacturing sector as a supplier of intermediate inputs in OECD countries. For example, on average across countries for which (harmonised) input-output data exist, in the late 1990s almost 80 % of the output of the business services sector was used as an intermediate input in the production processes of other sectors in the economy (Figure 1.1). Similarly, between 50 and 70 % of the output of the finance, electricity, and post and telecoms sectors is destined to be used as intermediate inputs to the production process. In addition, the importance of non-manufacturing sectors as a source of intermediate inputs has been growing rapidly over recent decades, along with the rest of the services sector. For example, Kongsrud and Wanner (2005) report that the service sector now accounts for roughly 70% of all jobs and value-added in the OECD area, which is more than 5 percentage points higher than in 1990.

63 . The 'knock-on' effects of regulation in the non-manufacturing sector 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, focusing 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.

Figure 1.1 **Share of intermediate and final demand in gross business sector output: selected non-manufacturing sectors**



Source: OECD harmonised input-output tables. The countries included in the graphs reflect data availability. For most countries the input-output tables are for a given year in the mid- to late-1990s.

In any given country the magnitude of these 'knock-on' effects of non-manufacturing regulation on the economy will be a reflection of two factors:

- the extent of anti-competitive regulation in non-manufacturing sectors, and
- the importance of these sectors as suppliers of intermediate inputs.

The first of these factors is captured by the OECD indicators of regulation in non-manufacturing sectors;[64] the second factor is measured using total input coefficients derived from (harmonised) input-

64 . As mentioned above, an indicator of anti-competitive regulation in the finance sector – described in detail in de Serres *et al.* (2006) – is also used as part of the analysis of anti-competitive regulation in non-manufacturing and the calculation of the RI indicators.

output tables, which provide a snapshot view of the purchases and sales of intermediate inputs between different sectors in a given year.[65]

Using total input-output coefficients, the sectoral regulation impact indicators (RI) are calculated as follows in each country:[66]

$$RI_{kt} = \sum_j NMR_{jt} \bullet w_{jk} \qquad\qquad 0 < w_{jk} < 1$$

where the variable NMR_{jt} is an indicator of anti-competitive regulation in non-manufacturing sector j at time t and the weight w_{jk} is the total input requirement of sector k for intermediate inputs from non-manufacturing sector j. The (harmonised) input-output data for OECD countries, and therefore the w_{jk}, exist at the 2-digit (ISIC rev3) level, implying that the NMR must also be calculated at this level of sectoral aggregation. Accordingly, the NMR indicators are mapped into the ISIC system as shown in Figure 1.2. If more than one of the NMR indicators map into a given 2-digit ISIC sector then NMR_{jt} is calculated as a simple average of the constituent indicators.

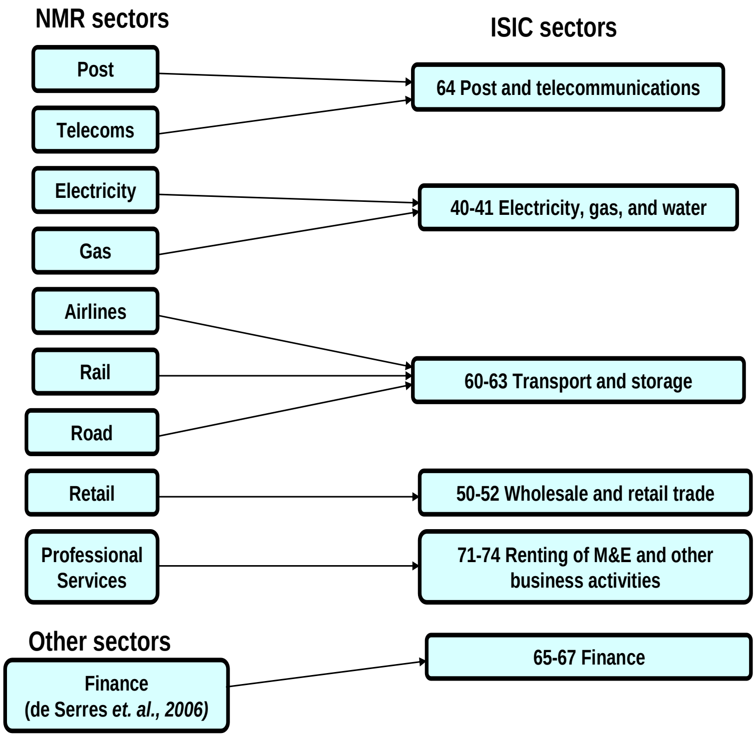
65 . Total input coefficients are calculated as follows. If Y is a vector of industry gross outputs, D a vector of demand for final goods, and A a matrix of technical coefficients – that is, the share of inputs from industry j used in producing one unit of output of industry k – then the basic relation between output and final demand can be expressed as:

$$D=(I-A)Y, \quad \text{or alternatively,} \quad Y=(I-A)^{-1}D$$

In this equation $(I-A)^{-1}$ is the Inverse Leontief Matrix of the input-output coefficients and describes how many units of an industry's output have to be produced at any stage of the value chain in order to produce one unit for final demand.

66 . This technique for calculating the regulation impact indicators is a variant of that used by Faini *et al.* (2006). Total input-output coefficients have also been used by Allegra *et al.* (2004) to derive the impact on export-oriented sectors of economic activities that are problematic from the point of view of antitrust law.

Figure 1.2 **e correspondence between the indicators of non-manufacturing and ISIC sectors**



For non-manufacturing sectors, where $k=j$ in the above formula, the total impact coefficient for the sector's own output (w_{jj}) is typically relatively large, implying a large weight on the own indicator of anticompetitive regulation (NMR_{jj}) in the RI indicator for that sector. As a result, the RI indicators for the non-manufacturing sectors where $k=j$ are measured in a consistent way as for the other sectors where $k \neq j$ but are highly correlated with the original NMR indicator for that sector.

The RI indicators are calculated in this way for 39 (ISIC rev3) sectors in 21 OECD countries over the period 1975 to 2003 and provide a large database on the sectoral impact of non-manufacturing regulation in OECD countries. It should be noted that, in the formula, NMR_{jt} is equal to either the ETCR indicators, for which complete time-series data are available, or the RBSR (plus finance) indicators for the other sectors, which have been estimated for only one or two years. Thus, due to data limitations, the variability of the RI indicators over time reflects mostly changes in the regulation of the energy, transport and communication sectors.

Annex 2

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% 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% of ICT investment. The classification of ISIC rev.3 sectors into ICT-producing (P), ICT-using (U), and non-ICT intensive (N) sectors used in this paper 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

Legend: P=ICT-producing sector; U=ICT-using sector; N=non ICT sector

Annex 3. Estimation of firm-level productivity

The Amadeus database

In the firm-level analysis of productivity we use a sample of firms extracted from the commercial database Amadeus of the Bureau van Dijk. This database covers European OECD members and in our version it includes 1.5m firms.

The productivity estimates

For the productivity analysis we calculate two sets of total factor productivities (TFPs), one using OLS and the other using the semi-parametric estimation technique of Levinsohn & Petrin (2003).[67] We use the first in the analysis and the second for robustness checks. In both cases we use a value added specification. For value added we use primary information after correcting for extraordinary profits. In case primary information on value added is not available we impute value added as the residual between operating revenue and material inputs. For capital stocks we use primary information on net capital stocks. For labour we use primary information on the total wage bill. Nominal values are deflated using price indices from the EUKLEMS or OECD STAN databases. We do not use estimated TFP values which either the coefficient on capital stocks or the wage bill is negative. Productivity observations for which the sum of the coefficients is smaller than 0.6 are also dropped.

Re-sampling procedure

Since only a subset of the firms in the Amadeus data reports information on all production factors, the size of our original Amadeus dataset is significantly reduced.[68] In particular, the resulting set of firms cannot be considered to be representative of the population distribution of firms across size classes, sectors, and countries. The TFP sample of firms is brought in line with the distribution of the true firm population using a re-sampling procedure. The objective of the procedure is to match the number of firms in Amadeus to the population distribution along three dimensions: (i) Employment size class distributions within sectors and countries (ii) inter-industry distributions within countries and (iii) inter-country distributions of firms. The set of these three parameters are drawn from the Eurostat *Structural Business Statistics* database for the year 2000. The procedure followed different steps. First, population weights for every size-sector-country strata have been calculated from Eurostat data on the population distribution of firms across employment size classes, sectors and countries. Second, random draws from each size-sector-country strata in the TFP sample have been taken until the weight of each strata corresponds to its population weight.[69] This results in a sample that is representative of the population distribution along the dimensions size, sector, and country for the years 1998-2004 (Table 3.1).

67 Note that it is not possible to follow the methodology of Olley & Pakes (1996). The reason is that we do not have primary information on investment in Amadeus so that investment has to be calculated as the residual between current and lagged capital stock after correcting for depreciation. This clearly violates Olley & Pakes' (1996) orthogonality condition between lagged capital stock and investment.

68 In addition, the data have been cleaned for outliers and obvious keypunch errors. For instance, we eliminate observations with value added < 0, depreciation > net capital stock and with extreme year to year variation in one of the production function variables.

69 We restrict our re-sampling procedure to firms above 20 employees since coverage for firms below these thresholds is unsatisfactory.

Figure 3.1 ES population vs. Sample : size distribution and industry distribution