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Salvador Barrios* and Jean-Claude Burgelman*

Europe Needs More Lisbon to Make the ICT Investments Effective

While the renewed Lisbon strategy has emphasised the potential role that ICT can play in meeting the challenges of boosting growth and competitiveness in the EU, there is no clear understanding of the way ICT could complement the structural reform programme which is at the core of that strategy. The evidence presented in this paper suggests that higher market rigidities in the EU have deterred ICT investment and ICT contribution to GDP growth.

Information and Communication Technologies (ICT) have been shown to be at the heart of the growing economic divergence between the USA and the EU since the mid-1990s.¹ This assessment has engendered a number of EU-level policy initiatives. The Lisbon strategy, in particular, puts special emphasis on the potential role that ICT can play in meeting the challenges of boosting growth, competitiveness and cohesion throughout the EU. Within this context, the i2010 Communication states, "in launching the partnership for growth and jobs as a new start for the Lisbon strategy, the 2005 Spring European Council called knowledge and innovation the engines of sustainable growth ... Information and communication technologies are seen a powerful driver of growth and employment".² The recent report produced by the European Commission on the fulfilment of the i2010 objectives acknowledges that Europe is making sustained progress in ICT diffusion. However, this diffusion is far from achieving its potential in terms of improving the EU's productivity and growth performance.³ The main argument of the present paper is that ICT diffusion in Europe will succeed in improving EU growth potential only if (market-oriented) structural reforms are given strong impetus in order to ease ICT adoption by private business and to favour the emergence of new types of activities. The reason for this is that ICT, in order to have a visible economic impact, require deep changes in business organisation and skills, both of which are crucially needed to facilitate the use of ICT for productive activities. The evidence provided in this paper suggests that the EU/US recent growing economic divergence is due to a different impact of ICT investment on growth and

that the EU economies' rigidities are one of the main culprits for this state of affairs. ICT diffusion can substantially increase EU economic growth but this can only take place if markets are flexible enough to favour the emergence of new production processes and new types of activities. ICT diffusion and the Lisbon agenda of market reforms must then be seen as two sides of the same coin: the EU economy badly needs structural reforms in order to increase EU growth potential and, at the same time, structural reforms are needed to make ICT investments more effective.

Why should market reforms and ICT diffusion be seen as two complementary elements favouring growth? The underlying idea is that, since the mid-1990s and in a context of increased global competition and sluggish EU growth performance, the EU needed to reduce the impact of regulations and public policy interventions on its economy. The Lisbon strategy has placed market reforms, i.e. the need to make EU labour, capital, product and service markets more flexible, at the core of its policy agenda for nearly a decade now. This broad objective encompasses a wide variety of domains including the promotion of competition in service industries such as telecoms, postal services,

¹ See in particular B. van Ark, R. Inklaar: Catching-up or Getting Stuck? Europe's Troubles to Exploit ICT's Productivity Potential, Research Memorandum GD-79, Groningen Growth and Development Centre 2005; and G. Carone, C. Denis, K. McMorrow, G. Mourre, W. Röger: Long-term labour productivity and GDP projections for the EU25 Member States: a production function framework, European Economy Economic Papers No. 253, Directorate General for Economic and Financial Affairs, Brussels 2006.

² Cf. European Commission: i2010 – A European Information Society for growth and employment, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions, COM(2007) 146 final, SE(2005) 717.

³ Cf. European Commission: i2010, Annual Information Society Report 2007, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions, COM(2007) 146 final.

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energy distribution, the opening up and integration of EU countries' financial markets, the lowering of administrative burden to business creation etc. The National Reform Programmes (NRP) in particular provide a very useful synthesis and detailed information at country level of the different policy issues related to structural reforms in the EU.

While the benefits of the Lisbon strategy in terms of boosting the EU's growth potential are easily understood, it is not always clear or at least straightforward, however, how these reforms could help to modernise the EU economy by improving its innovative capacity and by fostering technological change in the EU economy. Consider for instance the need to promote competition in EU markets which are still segmented, such as many services industries for instance. The existing literature on innovation and competition show that the relationship between these two variables is far from clear-cut. For instance when considering innovation, in a recent paper, Aghion et al.⁴ argue that, because firms innovate in order to increase their profits and to escape from competition, competitive pressure and innovative behaviour do interact either positively or negatively depending on the technological distance between firms and the relative benefits these may obtain before and after innovating. When considering technological change and, more specifically, ICT diffusion, the evidence tends to be more conclusive, however. A now large number of micro-level studies tend to suggest that competitive pressure and ICT adoption go hand in hand. For instance, the existing micro-level literature on ICT adoption shows that, in order to have a visible economic impact, ICT diffusion calls for changes in the production process and the organisation of firms and that these elements are more present in competitive markets. From a macroeconomic perspective, this evidence would suggest that, because ICT has wide encompassing effects on the organisation of production, markets need to be flexible enough, i.e. to promote the re-allocation of resources from old to new types of activities and modes of production. Two recent studies by Gust and Marquez, and Conway et al. have provided such macroeconomic evidence.⁵ However, to date no study has undertaken to examine

the impact of market regulation on ICT investment and economic growth in the same analytical framework. The present paper provides novel evidence on this issue by summarising the results of ongoing research on the link between market rigidities, ICT diffusion and growth.⁶

The data on ICT investment and ICT contribution to GDP growth recently released by the Groningen Growth & Development Centre (GGDC) provides a growth accounting decomposition of the contribution of production factors, including ICT, on GDP growth in a number of EU countries and for the USA.⁷ This data in turn allows one to see whether market rigidities do influence both ICT and the contribution of ICT investment to GDP growth. The present paper makes use of this data to consider the link between market rigidities and the contribution of ICT to GDP growth. First, we provide a number of stylised facts regarding ICT investment in the EU compared to the USA from the early 1980s onward, and consider in particular how differences in industrial specialisation and past ICT investment performance could help explain the EU lag in exploiting the economic benefits from ICT investment compared to the USA. We then examine more specifically the role played by market rigidities in explaining differing EU and US experiences as regards ICT and growth. Finally, we present a number of policy implications.

ICT Investment in the EU and the USA

The data used here covers the period 1980-2004 for the EU15 countries and the USA.⁸ Investment in ICT refers to investment of the whole economy in software, hardware and communication equipment.⁹ Table 1 provides a first idea of the differences in the relative importance of ICT investment in the aforementioned countries.

Overall, investment in ICT has tended to increase steadily in the USA since the early 1980s, going from 4.3% of GDP to 5.8% between 1995 and 2004. More

⁴ Cf. P. Aghion, N. Bloom, R. Blundell, R. Griffith, P. Howitt: Competition and Innovation: An inverted-U relationship, in: *Quarterly Journal of Economics*, Vol. 120, No. 2, 2005.

⁵ C. Gust, J. Marquez: International comparisons of productivity growth: the role of information technologies and regulatory practices, in: *Labour Economics*, Vol. 11, 2004, pp. 33-58; P. Conway, D. de la Rosa, G. Nicoletti, F. Steiner: Regulation, Competition and Productivity Convergence, OECD Economics Department Working Papers No. 509, Paris 2006.

⁶ A more extended report of the results presented here, including econometric evidence, can be found in S. Barrios, J. C. Burgelman: Information and Communication Technologies, Market rigidities and Growth: Implications for EU policies, IPTS Technical Report 23027, Institute for Prospective Technological Studies, Joint Research Centre, European Commission, 2007, available at <http://www.jrc.es/publications/pub.cfm?id=1508>.

⁷ Cf. EU KLEMS: EU KLEMS Growth and Productivity Accounts, Part 1 Methodology, 2007, available at: <http://www.euklems.net/>.

⁸ This database is available at the EU KLEMS website, March 2007 release, <http://www.euklems.net>.

⁹ More details on the definition of ICT investment can be found in EU KLEMS, op. cit.

Table 1
Investment in ICT, Specialisation in ICT Industries
and Specialisation in ICT-intensive Industries¹

	EU15*			USA		
	1980	1995	2004	1980	1995	2004
ICT investment in % of GDP	2.5	3.4	3.4	4.3	5.8	5.8
Non-ICT investment in % of GDP**	24.0	28.7	29.8	24.0	24.3	25.0
ICT-producing industries as % of total employment	3.8	3.8	4.0	4.8	4.3	3.6
ICT-intensive use industries as % of total employment	24.60	28.01	28.86	27.49	29.85	30.49

¹ ICT-intensive industries refers to sectors of activity with a relatively high use of ICT. See Appendix 1 for a definition and sources of this sectors classification.

* Weighted average (weight given by countries' GDP in PPP). Excludes Greece, Portugal and Ireland.

** Concerns non-ICT equipment investment.

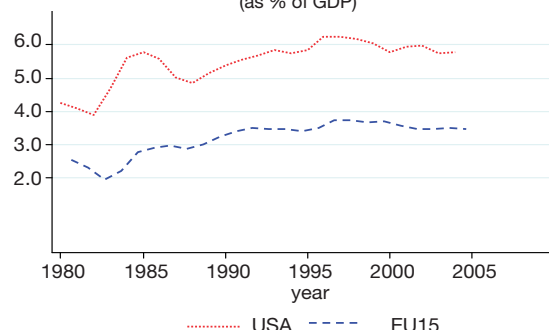
Source: EU KLEMS and authors' computations.

detailed annual figures on ICT investment show in fact that the stagnation in ICT investment during the period 1995-2004 can be related to the economic downturn following the year 2001 and the burst of the IT bubble. In the EU, the evolution has been rather similar to that in the USA but with a persistent gap in the percentage of GDP invested in ICT, as shown by Figure 1.

ICT investment measured in percentage of GDP rose from 2.5% in 1980 to 3.4% in 1995 and stabilised around that level thereafter. Detailed figures not reported here show that a number of (small) EU countries have also experienced high ICT investment percentages such as, for instance, Denmark, Finland, Sweden and Luxembourg. Overall, however, the striking feature shown in Table 1 is clearly the persistent gap in ICT investment as a percentage of GDP, independent of the year considered.

What could reasonably explain such persistent differences in ICT investment between the USA and the EU? A first possibility could be that the evolution of ICT investment has simply followed the overall evolution of capital goods investment as a whole. In that case, similar patterns in non-ICT goods investment should also be observed between the different countries considered here. The second row of Table 1 tends to repudiate this hypothesis since, over the whole period considered here, the EU has consistently experienced higher percentages of non-ICT investment. The higher investment rate of the EU has even been

Figure 1
Investment in ICT 1980-2004 (Average):
USA versus EU15
(as % of GDP)



Sources: EU KLEMS and authors' computations.

growing over the whole period so that the gap in non-ICT investment has tended to widen towards the end of the period, with the USA investing around 24% of its GDP in non-ICT equipment while the EU invested around 29% in 2004.

In fact, the differences in ICT and non-ICT investment patterns between the USA and the EU could be linked to differences in industrial specialisation between the US and EU economies. These differences could, in turn, explain why ICT investment has followed different paths in the USA and the EU. In order to investigate this possibility, the third row of Table 1 displays the percentage of employment in ICT-producing industries following the definition provided by the OECD.¹⁰ The descriptive evidence tends to show that the US specialisation in ICT-production has been decreasing. Interestingly, the US share of employment in ICT-production has converged towards EU levels, i.e. around 4% of total employment. These developments suggest that specialisation in ICT-production is unlikely to be a sufficient explanation for the differing share in ICT investment as a percentage of GDP. In fact, the opposite tends to be true, given that the USA has tended to lose its initial lead in the early 1980s in terms of specialisation in ICT-production.

Rather than looking at ICT-producing sectors, it could also be expected that countries more specialised in ICT-intensive-use industries would also tend to invest more in ICT capital.¹¹ The last row of Table 1

¹⁰ See in particular M. Mas, J. Quesada: ICT and Economic Growth in Spain 1985-2002, EU KLEMS Working Paper No. 1, Groningen Growth & Development Centre, Netherlands, 2005.

¹¹ For a taxonomy of ICT-intensive industries, cf. also *ibid*.

Table 2
Value Added Growth and Contribution of ICT Investment to Value Added Growth in the USA and the EU Countries

	1980-1995		1995-2004	
	Value added Growth	Contribution of ICT capital to value added growth	Value added Growth	Contribution of ICT capital to value added growth
USA	3.0	0.5	3.7	0.8
EU15*	1.9	0.4	2.2	0.3
Austria	2.3	0.4	2.6	0.6
Belgium	2.3	0.6	2.4	0.6
Denmark	2.8	1.0	2.3	0.8
Finland	1.8	0.3	4.4	1.3
France	1.7	0.3	2.5	0.6
Germany	1.9	0.2	1.0	0.5
Italy	1.9	0.2	1.4	0.5
Luxembourg	6.1	0.5	4.3	0.2
Netherlands	2.1	0.4	2.8	0.9
Spain	2.4	0.4	3.6	0.7
United Kingdom	2.5	0.5	3.3	0.5

Sources: EU KLEMS: EU KLEMS Growth and Productivity Accounts, Part I Methodology, 2007, available at: <http://www.euklems.net/>; authors' calculations.

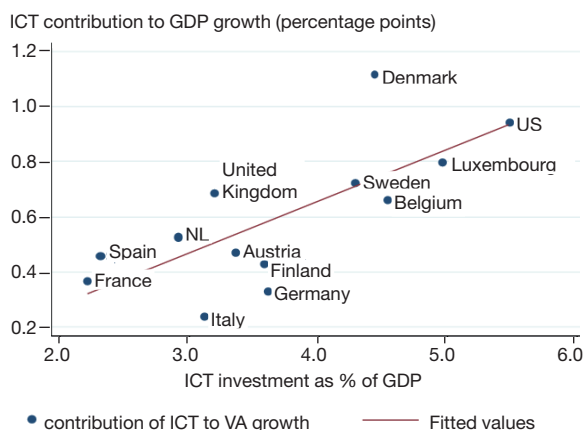
* EU15 figures exclude Greece, Ireland, Portugal and Sweden.

shows that the EU tends to be less specialised in ICT-intensive-use sectors than the USA, although at the end of the period considered here, the EU percentage of employment in ICT-using industries has tended to converge to the US percentage. It follows that while the higher specialisation of the US economy in ICT-intensive industries can explain part of the differences in the patterns of ICT investment compared to the EU, this difference does not appear to be large enough to explain them fully.

ICT investment and Growth

We now turn to the issue of the influence of differing ICT investment patterns between the EU and the USA in terms of GDP growth. We draw, as before, on the results of the growth accounting analysis undertaken by the EU KLEMS project for the USA and a number of EU countries. The figures presented here make use of the decomposition of the value added growth (which can be thought as a close approximation of GDP growth) in the overall economy into its main components including labour, ICT capital and non-ICT capital and the residual term which is the Total Factor Pro-

Figure 2
ICT Investment versus ICT Contribution to Growth in the EU and the US, 1980-2004 (Average)



Sources: EU KLEMS and authors' computations.

ductivity component.¹² Table 2 presents the results on the overall value added growth of the USA and the EU countries together with the contribution of ICT capital to this growth, omitting non-ICT factors.

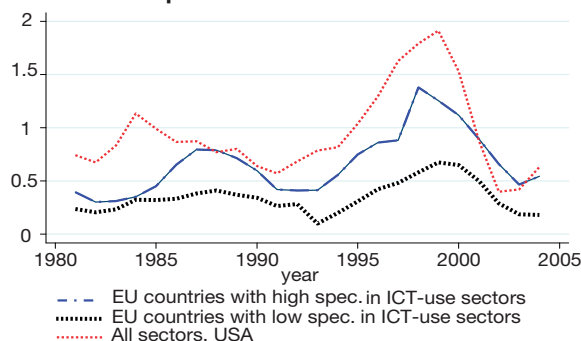
Table 2 shows that ICT investment has largely been responsible for the growth divergence between the USA and the EU15 since the mid-1990s. While some EU countries such as Finland and Denmark have also shown a substantial contribution of ICT investment to value added growth, these economies are relatively small and this has therefore not translated into a visible impact on overall EU figures. Taking the EU as a whole, ICT investment appears to explain approximately one third of the GDP growth differential between the USA and the EU since the mid-1990s.

Figure 2 provides a first overview of the link between ICT investment and its contribution to growth where the former is measured as a percentage of GDP and the latter as a percentage-point contribution to GDP growth during the period 1980-2004.

Figure 2 shows that countries that have invested a relatively high proportion of their GDP in ICT items have also largely benefited from a higher contribution of ICT to GDP growth. While the evidence depicted in Figure 2 seems logical, a detailed inspection of these results reveals some interesting patterns. For instance, a country like Denmark tends to have benefited more from its investment in ICT than other countries with a similar ICT investment percentage. In the case of Italy, during the whole period considered here this country

¹² Cf. EU KLEMS: EU KLEMS Growth and Productivity ... , op. cit., for details.

Figure 3
Contribution of ICT to VA Growth in the USA
and the EU: Highly Specialised versus
Low-specialised in ICT-use Sectors



* Note: Countries are classified according to the share of employment in ICT-intensive sectors using the USA average of ICT-intensive sectors in total employment as a benchmark. Given that the average percentage of employment in ICT-intensive sectors for the USA during the period 1980-2004 is 29.4%, high ICT-use share EU countries include countries with percentages above the USA value such as the UK (30.1%), Sweden (37.8%), the Netherlands (30.6%), Finland (34%) and Denmark (35.2%). Low ICT-use share EU countries include Austria (24.9%), Belgium (28.4%), Germany (28.4%), Spain (18.5%), Italy (21.8%) and Luxembourg (28.9%). Country-groups averages are the weighted (the weights are determined by the GDP in PPP) average of the contribution in percentage points of ICT to value added growth.

has invested slightly above 3% of its GDP in ICT while the contribution of ICT to GDP growth has been barely 0.2 percentage points. Interestingly, the UK, with an investment figure very close to that of Italy during the same period, benefited much more from ICT investment with a contribution of around 0.75 percentage points. More generally, Figure 2 shows that countries with similar ICT investment patterns tend to have benefited differently from this investment.

Given the evidence presented here, the key question is which factors could help us to understand why the contribution of ICT to value-added growth has been much smaller in the EU. Indeed, while the EU also seems to have benefited from growing ICT investment and productivity impact, it is quite striking that the economic benefits linked to ICT investment seem to have failed to materialise in the EU economy, at least when the US experience is taken as a benchmark.

Figure 3 shows that the EU countries with a relatively high degree of specialisation in ICT-intensive-use sectors have indeed benefited more from ICT investment in terms of value added growth impact than those EU countries with a relatively low specialisation in ICT-intensive-use sectors. This result tends to confirm the evidence put forward earlier concerning the influence of the differences in economic structures on the con-

Table 3
Country-level Average of Fraser Indicators on
Market Rigidities, 1980-2004

Country	Overall regulation	Business regulation	Labour market regulation	Credit market regulation
USA	7.54	7.27	7.48	9.29
UK	7.32	7.13	6.90	9.13
Luxembourg	6.98	6.65	5.98	9.30
Denmark	6.63	7.13	4.46	9.32
Finland	6.57	8.15	3.71	9.11
Netherlands	6.47	6.73	4.27	9.10
Sweden	6.19	7.33	3.54	8.66
France	6.14	6.05	4.52	8.43
Spain	6.08	5.80	4.61	8.23
Austria	6.03	6.65	4.27	7.89
Belgium	6.01	5.65	4.40	8.33
Germany	5.60	6.53	3.11	7.76
Italy	5.24	5.22	3.97	6.68

Sources: Fraser Institute and authors' calculations. Missing values obtained using simple extrapolation; cf. S. Barrios, J. C. Burgelman: Information and Communication Technologies, Market rigidities and Growth: Implications for EU Policies, IPTS Technical Report 23027, Institute for Prospective Technological Studies, Joint Research Centre, European Commission, 2007.

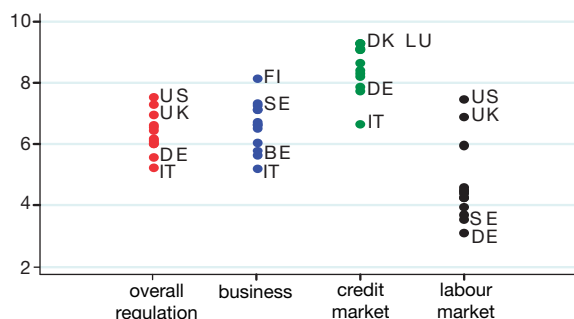
tribution of ICT to economic growth. Importantly, however, Figure 3 shows that even the EU countries that were more specialised in ICT-intensive-use industries have benefited less than the USA in terms of ICT impact on value added growth, although during the latter part of the period considered here (i.e. since 2001) they have tended to converge.

ICT investment, Market Rigidities and Growth

The evidence described above shows that the higher presence of ICT-intensive use sectors explains only part of the higher contribution of ICT to value added growth in the USA compared to the EU. The rest of this paper is mainly concerned with the role played by market rigidities in explaining the differing EU and US experiences regarding ICT contribution to GDP growth. In order to measure differences in market rigidities, we make use of a number of indices, coming mainly from the Fraser Institute Economic Freedom database.¹³ The Fraser database provides indicators rating most world economies from 1 to 10, 1 being the worst notation in terms of market flexibility and 10 being the best. Here we focus on the credit, labour and product markets regulation. Table 3 provides more details on these indicators. While other items also available in the Fraser database concerning the influence of public policies (such as, for instance, the level of trade barriers) on economic activity could possibly have an influence

¹³ This database is available at: <http://www.fraserinstitute.org/>.

Figure 4
Fraser Indicators Measuring Market Freedom,
1980-2004 (Average)



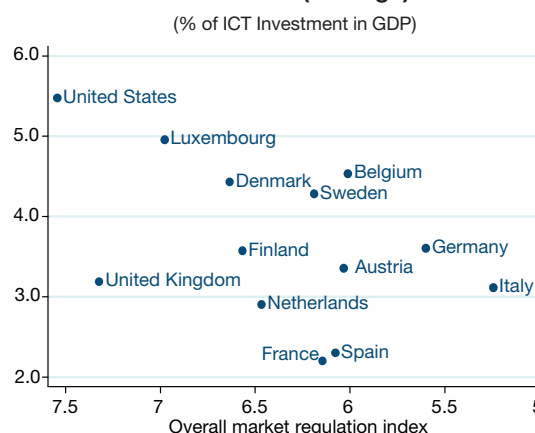
Source: Fraser Institute, <http://www.fraserinstitute.org>; authors' calculations.

on ICT diffusion and its growth impact, these links are much less direct than the one between market flexibility and regulation. In addition to the Fraser database we shall also make use of indicators on market rigidities provided by the World Bank and the OECD in order to check the robustness of our results.

Figure 4 provides descriptive evidence concerning the values of the Fraser market rigidities indicators for the USA and the EU countries by considering, on the one hand, the aggregate measure of market regulation and, on the other hand, the decomposition of this measure into its components, business market regulation, credit market regulation and labour market regulation. We have named only the first and last two countries in each of these fields in order to get a visual overview of the persistence in ranking of some of the countries considered here (Table 3 provides detailed results by country). For instance, a country such as Italy appears to perform quite poorly in terms of market regulation, independently of the indicator considered. At the opposite end, the USA and, to some extent, the UK and Luxembourg perform well in all three segments of market regulation and, logically, these countries also do well in terms of overall market regulation. Some other countries have more nuanced ranking when considering each component individually. Interestingly for instance, the Nordic EU countries appear to perform quite well in terms of overall market regulation and, in particular, in terms of low business and credit market regulation. These countries, however, appear to have rather rigid labour market regulation. The countries just mentioned, like the USA and Luxembourg for instance, appear to have benefited more from ICT investment, as suggested by the results displayed in Table 2.

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Figure 5
ICT Investment and Overall Market Regulation:
1980-2004 (Average)



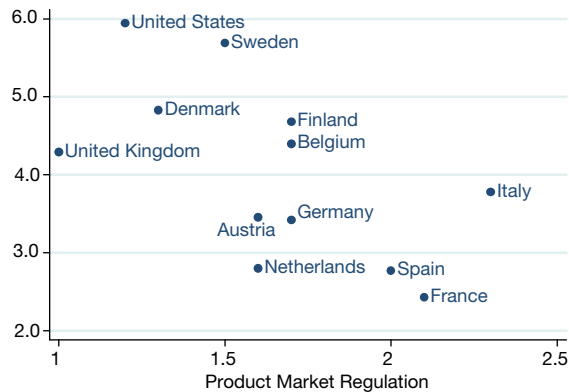
Sources: Fraser Institute, GGDC-EU KLEMS database and authors' computations.

The evidence depicted by Figure 4 means that there is no single or uniform relationship between market flexibility and ICT: every single country has specific features which, as indicated by the Fraser indicators of market rigidities, also correspond to specific features which could, for instance, be related to institutions, business models, technological changes etc. Put differently, each and every country must be considered as a specific case. The evidence presented in what follows also suggests, however, that despite these country-specific features, generally speaking countries with less flexible markets also tend to invest less in ICT and to benefit less from ICT in terms of GDP growth.

Figure 5 provides a first set of descriptive results in order to move a step further by plotting the overall market regulation indicator taken from the Fraser database and ICT investment as a percentage of GDP in the EU countries considered individually together with the USA.

In order to illustrate the importance of market rigidities, the values of the Fraser index have been reversed on the x-axis with, as mentioned earlier, the highest possible mark on the extreme left on the x-axis being 10 (corresponding to a fully deregulated market) while the lowest mark is 1 (on the extreme right on the x-axis). The results displayed in Figure 5 show that there is, overall, a negative relationship between the extent of market rigidities and the share of ICT investment as a percentage of GDP in the countries considered here. When considering countries individually, Italy appears to have the lowest mark in terms of market rigidities while its share of ICT investment as a percentage of

Figure 6
ICT Investment (% GDP) and Product Market Regulation, 1998-2003,
 (% of ICT Investment in GDP)



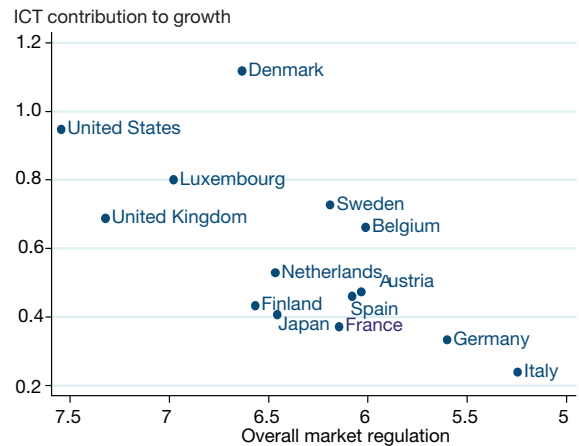
Sources: EU KLEMS, OECD (product market regulation database) and authors' calculations.

GDP has been one of the lowest, although not the lowest. Countries such as France and Spain, for instance, had lower investment in ICT as a percentage of their GDP than Italy. These countries also display low marks in terms of overall market regulation. The UK also stands relatively outside the overall negative relationship between the market regulation indicator and ICT/GDP ratio as it has had relatively good performance in terms of market flexibility but a relatively low ICT investment ratio. The other countries tend to be in line with our starting hypothesis, in particular the USA and to some extent Luxembourg and Denmark do have a relatively high ICT/GDP ratio and low market regulation burden.

Figure 6 provides additional evidence on the relationship between regulation and ICT investment using an alternative database for the market regulation indicator. Here we use the OECD database on product market regulation which is only available for a shorter time span, i.e. 1998-2003. The ICT/GDP ratio has therefore also been considered for this period of time as well. Please note that the OECD indicator attributes the score "1" to the least regulated country and, other than in the Fraser indicator, the scores increase with the intensity of regulation.

Figure 6 provides a picture very similar to Figure 5. The same observation indeed holds here regarding the relative disadvantage of countries such as France and Spain and the lead of countries such as Denmark and the USA. Italy appears here in a somewhat better position in terms of ICT investment than when considering the whole period 1980-2004. Here again, the UK ap-

Figure 7
ICT Growth Impact and Overall Market Regulation, 1980-2004 (Average)



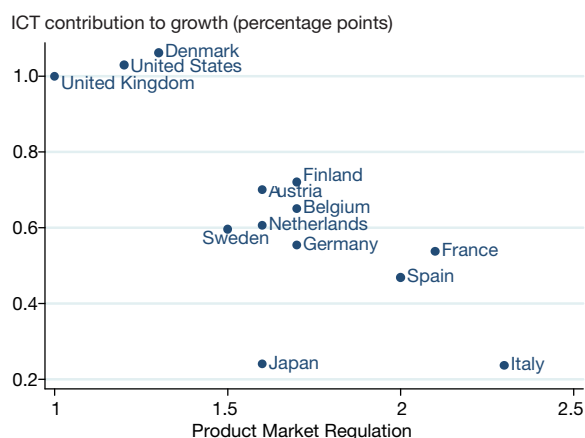
Sources: Fraser Institute, GGDC-EU KLEMS database and authors' computations.

pears to display a rather good mark in terms of product market regulation but a low ICT investment to GDP ratio. Overall, the evidence provided by Figure 5 tends to confirm the negative relationship between market regulation and ICT investment put forward earlier.

In the following we investigate the relationship between market regulation and the return to ICT investment as measured by the contribution, in percentage points, of ICT to value added growth in the same country-group as considered above.

Figure 7 plots the contribution of ICT investment to value added growth against the degree of market regulation taken from the Fraser database. It shows that there is a negative relationship between the degree of overall market regulation and the economic benefits related to ICT investment. Not surprisingly, the picture depicted by Figure 7 is broadly similar to Figures 5 and 6 since the countries that have tended to invest relatively little in ICT have also tended to have a lower impact of ICT on their value added growth. Italy and Germany appear to have benefited relatively little from their ICT investment and, at the same time, were among the two most regulated economies during the period considered here. On the other hand, the USA, the UK and Luxembourg, which are also the least regulated market economies in the sample of countries considered here, have also benefited most from ICT investment. Interestingly, the UK experience in terms of ICT contribution to growth appears to be much more in line with its mark in terms of market rigidities. Indeed, we have shown earlier that the UK appears to have invested relatively less in ICT than its

Figure 8
ICT Growth Impact and Product Market Regulation, 1998-2003



Sources: OECD, EU KLEMS and authors' calculations.

EU counterparts. Denmark is distinct from the other countries, as it has benefited from strong specialisation in ICT-(intensive using and producing) industries so this may explain the especially large contribution of ICT to this country's growth. A big difference shows for ICT-use industries, however: Denmark had a percentage equal to 32% in 1980, i.e., already well above the EU15 average (and also the US) and 37% in 2004. The result concerning the contribution of ICT to GDP growth may thus appear rather puzzling at first glance. Other factors (than market structures) may also be at play, however. In particular, recent papers have shown that the UK may have benefited from ICT-related innovation and productivity gains through its trade (and foreign investment) relationships with the USA. Generally speaking, therefore, it could be considered that international trade and investment openness could act as a transmitter for ICT-related economic benefits. This issue will be investigated later on in this paper.

Figure 8 provides supplementary evidence using the OECD product market regulation as an alternative indicator for market regulation for the period 1998-2003.

Generally speaking, except for a few differences in the positioning of countries regarding the degree of product market regulation, the relationship between market regulation and ICT impact on value-added growth seems to hold here too. In particular, the USA, Denmark and the UK appear to have performed outstandingly in terms of both market flexibility and ICT contribution to growth during the period considered here.

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Table 4
Changes in Market Regulation and the Economic Impact of ICT Investment

Country	(1)	(2)	(3)	(4)
	ICT contribution to GDP growth	Market regulation performance	Catching-up in regulation*	Catching-up in regulation*
	1995-2000	1995	1995-2000	1985-1995
Austria	0.54	0.72	0.10	-0.11
Belgium	0.64	0.74	0.15	-0.06
Germany	0.41	0.74	0.00	-0.03
Denmark	1.11	0.91	0.00	0.11
Spain	0.40	0.72	0.17	-0.09
Finland	0.49	0.87	0.00	0.02
France	0.41	0.73	0.13	-0.13
Italy	0.22	0.59	0.15	-0.19
Netherlands	0.55	0.84	0.10	0.08
Sweden	0.62	0.78	0.06	-0.04
UK	0.84	1.01	0.00	0.04
USA	1.00	1.00	0.00	0.00
<i>Spearman rank correlation with (1)</i>	-	<i>0.81</i> (0.00)	<i>-0.55</i> (0.06)	<i>0.69</i> (0.01)

* Note: The ICT contribution to GDP growth is derived from a growth accounting framework, see EU KLEMS: EU KLEMS Growth and Productivity Accounts, Part I Methodology, 2007 for more details. The catch-up rate in regulation is measured by the following statistics: $MR(t) - MR(t-1) / MR(t-1)$, where MR measures the relative performance of each of the country following the data used to construct Figure 5 for the periods of reference as indicated in the columns headings above.

We shall now consider in more detail which of the different components of the market rigidities indicators tend to offer a better explanation of the differences in the contribution of ICT to GDP growth in the countries considered here. Figure 9 then provides an overview of the evolution of the contribution of ICT to GDP growth using the results from the growth accounting approach provided in the EU KLEMS database by differentiating between countries with a high or low regulation in the business sector, credit and labour markets respectively. The reference used to classify countries is the mean value for each of the criteria considered.

The grouping of countries according to their level of regulation clearly tends to suggest that that highly regulated countries, i.e. countries where government intervention and regulation have a strong influence on market outcomes, have generally benefited less from ICT investment in terms of GDP growth than countries where regulation was less binding. While this assertion seems to be more clear-cut when splitting countries according to the level of regulation in the labour and

credit markets, the results concerning the business regulation indicator tends to go in the same direction.

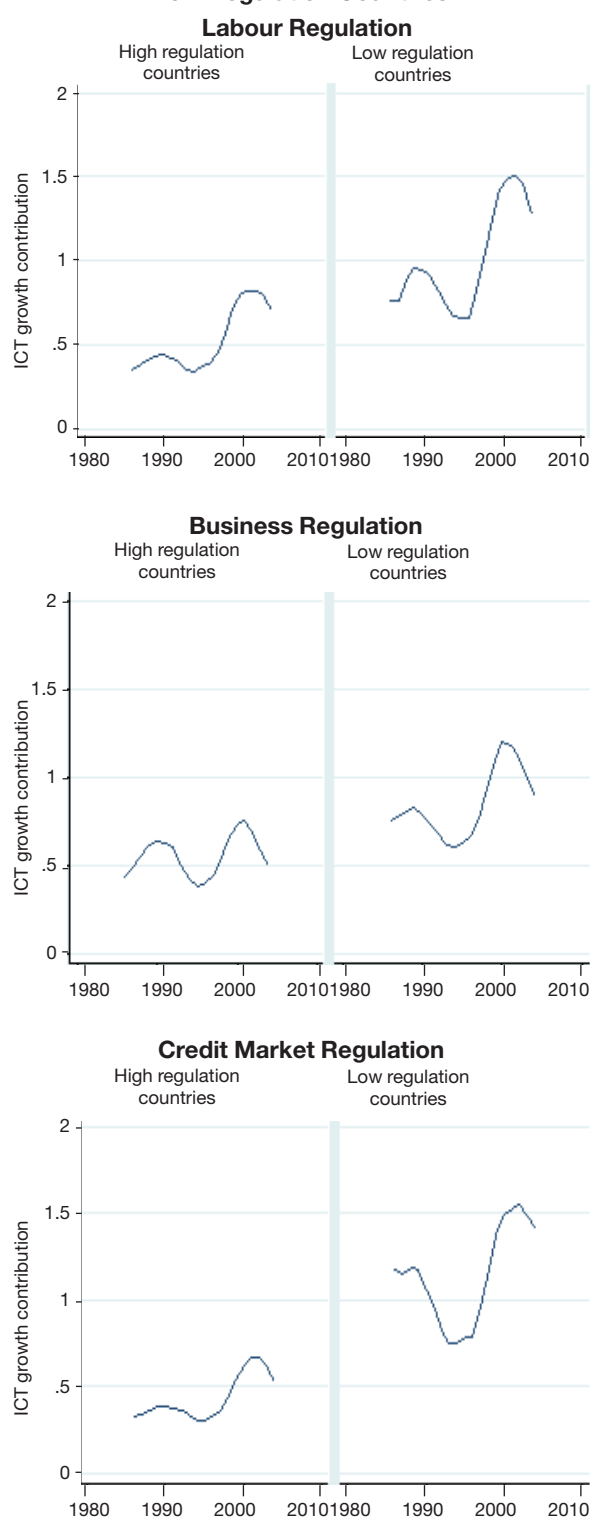
Market Reforms Take Time to Deliver

Market reforms usually take a relatively long time to deliver in terms of increasing growth potential.¹⁴ More specifically in the case of ICT, the evidence above suggests that the negative influence of market rigidities on ICT investment and ICT contribution to growth has been especially important since the mid-1990s. One way to verify this would be to consider the influence of past regulation levels on future ICT investment and ICT contribution to growth. This also means that countries that have undertaken structural reforms prior to, or during, the period 1995-2000 were also more likely to benefit from greater ICT investment and, in this way, to increase their GDP growth rates. Table 4 provides a number of results that help clarify these issues.

Column (1) of Table 4 shows the figures for the contribution of ICT investment to GDP growth in the sample of EU countries and the USA. For instance, in the case of the USA, investment in ICT has, on average during the period 1995-2000, generated an addition of one percentage point to GDP growth rate. None of the EU countries considered here have experienced a similar contribution of ICT, except Denmark. Column (2) of Table 4 provides the Fraser indicator on market regulation used above. This indicator is simply the arithmetic mean of the regulation indicators of the labour and credit markets and of the business regulation indicator. A higher value of this indicator indicates more flexible markets in the fields mentioned. When comparing the ranking of countries according to the figures provided in columns (1) and (2), it can be observed that the countries which have had the best performance in terms of market flexibility such as the USA, the UK and Denmark, are also the countries that have benefited most from ICT investment. The last row of Table 4 provides an indication of the extent to which the ranking of countries according to the variables of Columns (1) and (2) is correlated; the Spearman rank correlation is used for this purpose. The correlation coefficient is 0.81, which denotes a rather high and significant correlation, as indicated by the p-values in parentheses. This result is very similar to the one evidenced earlier, except that here we consider only the period during which the contribution of ICT to GDP growth has been especially pronounced in the USA.

¹⁴ For a recent review cf. J. Babetskii, N. F. Campos: Does Reform Work? An Econometric examination of the Reform-growth Puzzle, CEPR Discussion Paper No. 6215, London 2007.

Figure 9
Contribution of ICT to GDP Growth: High versus Low Regulation Countries



Note: Grouping of countries according to Table 2 results.

Sources: Fraser database and author's calculations.

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One direct interpretation of the results described in Columns (1) and (2) is rather obvious: in order to benefit from ICT countries must have more flexible markets, i.e. markets where regulation and public intervention play a minor role in determining market outcomes. The policy implication of this result is unlikely to be that straightforward, however. Indeed, as mentioned above, structural reforms usually take time to deliver and the indicator of market flexibility performance used in Column (2) of Table 4 may simply mean that, in fact, past structural policies have in fact delivered only later on, such that the positive correlation observed between market flexibility and ICT is only the result of past policy measures and ICT investment. In order to see this, Column (3) of Table 4 now provides a measure of the change experienced by the indicator on market flexibility during the period 1995-2000, i.e. the period during which the contribution of ICT to GDP growth is observed. A positive change in the catching-up rate of the regulation indicator means that countries have tended to make their markets more flexible.¹⁵ No clear relationship seems to emerge in this case as indicated by the spearman correlation coefficient which is now negative, but rather weak, as indicated by the p-value in parentheses. Interestingly, when the changes in regulation during the decade prior the 1995-2000 period, i.e. 1985-1995, are considered, a different picture emerges. In this case, changes in market flexibility performance and the contribution of ICT to GDP growth tends to be positively and significantly correlated. Countries that have undertaken to make their economies more flexible during the 1980s and early 1990s were, therefore, also the ones that were more likely to benefit from ICT diffusion. All in all, these last results suggest that, while there is indeed a positive and significant relationship between market flexibility and ICT contribution to GDP growth, policy measures aimed at making economies more flexible must take into account the time delay in the impact of structural reforms.

Summary and Policy Implications

This paper has provided a number of stylised facts that tend to support the view that ICT investment and its related growth impact are strongly tied to market rigidities, especially so when comparing the EU and US economies. These results can be summarised as follows.

¹⁵ Note that a value equal to zero for the catch-up rate in regulation means either that no significant changes have taken place or that the countries have obtained a slightly better mark than the USA in 2000.

- First, the EU economy has been slow to invest in ICT capital compared to the USA and, when this investment has significantly increased, it has done so at a lower rate than that of the USA. The impact of ICT on GDP growth has also been much less pronounced than in the USA during the past ten years or so. While some EU countries seem to have caught up with the US growth rate, these countries are, in general, relatively small, so that their overall influence on EU evolution has so far been modest.
- Second, one possible explanation for the differing experiences in the USA and the EU concerning ICT may relate to structural differences between the two areas in their specialisation in ICT-producing and ICT-intensive-use sectors of activity. However, the relatively similar specialisation in ICT-producing and ICT-intensive-use industries between the USA and the EU suggests that other structural factors are at play in explaining why ICT diffusion is still slow and its relative economic benefits still hardly perceptible in the EU economy, at least by US standards. Our results show that larger market rigidities in the EU constitute one of the main culprits for this state of affairs. The negative influence of market regulation on GDP growth through ICT investment deterrence has only become more apparent during the period 1995-2000, precisely when the benefit of ICT to US economic growth and the concomitant US/EU growth divergence has been especially pronounced.
- Third, the evidence presented here suggests that the EU may benefit especially from structural reforms, i.e. reforms aiming at making EU capital, labour, product and services markets more flexible and competitive, given that market rigidities have deterred ICT investment and ICT contribution to GDP growth in most EU countries. However, the evidence presented here suggests the existence of a time-lag for structural reforms aimed at making product and factor markets more flexible in order to increase growth potential via ICT investment. In addition, EU countries are characterised by a high diversity in the degree of their market rigidities, especially when considering individual markets (i.e. labour, capital, product etc.) separately.

Two main policy implications can be derived from our results.

- Our results suggest that the EU economy has been characterised by high market rigidities and low ICT investment and that this has tended to deter the necessary re-organisation of production at firm level, and the skills improvement called for by ICT diffusion

seem to explain why the EU economy is still slow to invest in ICT. It follows that market-oriented reforms, of the type proposed by the renewed Lisbon strategy, cannot be considered as stand-alone policies and that radical changes at the firm/business level, as well as reforms improving labour skills, are called for in order to promote technological change in the EU economy.

- Second, our results concerning the influence of past market reforms suggest that the benefits of market reforms (here in terms of ICT diffusion) take time to bear fruit. Maybe more importantly, policy measures should be tailored to country-specific conditions, given that we show here that EU countries tend to differ widely in terms of the degree of rigidity of their economies, depending on the market considered.

Appendix Taxonomy of ICT-Producing and ICT-Intensive User Sectors

ICT-intensive user sectors	Isic rev.3 code
Pulp, paper & paper products	21
Printing & publishing	22
Office machinery	30
Insulated wire	313
Other electrical machinery and apparatus nec	31-313
Electronic valves and tubes	321
Telecommunication equipment	322
Radio and television receivers	323
Scientific instruments	331
Other instruments	33-331
Electricity, gas and water supply	40-41
Inland transport	60
Water transport	61
Air transport	62
Supporting and auxiliary transport activities; activities of travel agencies	63
Communications	64
Financial intermediation, except insurance and pension funding	65
Insurance and pension funding, except compulsory social security	66
Activities auxiliary to financial intermediation	67
Computer and related activities	72
Health and social work	85
ICT-producing sectors	
Office machinery	30
Insulated wire	313
Electronic valves and tubes	31-313
Telecommunication equipment	322
Radio and television receivers	323
Scientific instruments	331
Computer and related activities	72
Communications	64

Source: M. Mas, J. Quesada: ICT and Economic Growth in Spain 1985-2002, EU KLEMS Working Paper No. 1, Groningen Growth & Development Centre, The Netherlands 2005.