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Innovation and competition in EU15: Empirical evidence on the Lisbon Decade and beyond

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Abstract

In March 2000, the Lisbon Summit set the European Union the goal of becoming ‘the most dynamic and competitive knowledge-based economy in the world’ by 2010. This paper aims to ascertain the extent to which various indicators of innovation in EU15 have improved and whether such improvement has been driven by higher levels of competition in EU15 economies. To this end, we provide a descriptive account of the competition and innovation indicators from 1980-2008. Then, we discuss the relationship between market structure (level of competition) and innovation; and estimate the impact of the former on the latter. We report that aggregate innovation measures for EU15 have been increasing over the 1980-2008 period and there does not seem to be a significant change in the trend during the Lisbon decade (200-2008). Furthermore, increasing levels of innovation have been associated with increasing economic rents – i.e., with further departures from the perfect-competition baseline. Fixed-effect panel-data regression results point out a positive and statistically significant relationship between economic rents and various measures of innovations.

JEL Classification: D43, L1, O31, O38

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Introduction

In March 2000, the Lisbon Summit set the European Union the goal of becoming ‘the most dynamic and competitive knowledge-based economy in the world’ by 2010. This target was set against a backdrop of lacklustre economic performance in the EU despite the fact that the information technology boom had been in full swing. Specific targets set by the Lisbon Summit included the following: achieving an average annual growth rate of 3% from 2000-2010; creating 20 million jobs; increasing the employment rate from around 64% to 70% of the population aged 15-64; and increasing private and public research and development (R&D) expenditures to 3% of the gross domestic product (GDP). According to Commission and European Union (EU) institutions with interest in the so-called Lisbon Agenda, these goals would be achieved through *increased competition* in goods and services markets, and *increased policy coordination* between member states.

This paper aims to ascertain the extent to which the expected increase in competition has materialised in 15 EU economies (EU15) and whether various indicators of innovation in EU15 has been related negatively or positively to the overall levels of competition. To that end, Section 1 summarises the policy considerations that have informed the adoption of the Lisbon Agenda in 2000 and its evolution from 2000-2010. In Section 2, we provide a descriptive account of the competition and innovation indicators from 1980-2010. This section will enable us to track the trend in EU15 performance with respect to these criteria, and also to ascertain the extent to which the Lisbon decade (2000-2010) reflects some structural break in the trend. In Section 3, we refer to the literature on the relationship between market structure (level of competition) and innovation; and estimate the impact of market structure (level of competition) on innovation measured in terms of business expenditures on research and development (input for innovation) and number of patents (innovation output). Finally, the conclusion will summarise the main findings and comment on the appropriateness of extending the Lisbon Agenda to 2020 through the Europe 2020 Project.

1. Why does Europe need Lisbon-Type reforms? The case of market opening and innovation

Although some progress was made towards achieving some of the Lisbon goals, it became evident by 2005 that the goals might not be achieved by 2010. For some, this was mainly due to the slow pace of the required reforms (Sapir et al, 2004). For others, there were multiple reasons, including overloaded agenda, poor coordination, conflicting priorities, and structural reform being used as a codeword for deregulation and weakening workers’ rights (Kok, 2004). Against these pessimistic assessments, the Lisbon Agenda was re-launched in 2005 with renewed emphasis on job creation and innovation, and with a call on the Commission to play a greater coordinating role.

Immediately after the re-launch, in April 2005, the Commission published integrated guidelines for implementing the Lisbon Agenda and specified the relative roles of the Commission and national governments (EU Commission, 2005). One of the main novelties of the second period was the greater emphasis placed on national government reporting on the implementation of National Reform Programmes (NRPs). In the first half of 2008, the Commission has published

the 3rd Lisbon Report and the revised integrated guidelines that would cover the period 2008-2011.

The launch of Lisbon in 2000 followed a familiar presentation format: Just as the Single Market Programme (SMP) was justified by referring to *Euro-sclerosis* as the ‘cost of not having a single market’, the Lisbon Agenda was also justified by referring to the cost of not completing the single market. This was done by presenting an array of indicators that pointed out the extent to which the United States (US) has outperformed the EU on a number of economic indicators. Table 1 below presents a selection of these indicators for EU-25 and US economies. For all indicators, EU-25 performance is normalised to 100 in order to make the comparison more straightforward.

Table 1: EU and US average performance indicators: 1995-2005

	1995-2000		2000-2005	
	<u>EU-25</u>	<u>US</u>	<u>EU-25</u>	<u>US</u>
Real GDP growth rate	100	136	100	177
Real GDP per head*	100	152
Employment growth rate	100	175	100	116
Employment rate*	100	110
Labour productivity growth rate	100	100	100	169
TFP growth**	100	125	100	300

* = Figures for 2000-2005 only

** = EU-15

The table suggests that the EU economy has been performing less satisfactorily than the US economy across all of these indicators; and that the relative underperformance of the EU economy has been worsening over time. The relative under-performance of the EU economy with respect to employment has a long history and therefore may not be surprising. However, the relative stagnation in EU labour productivity and total factor productivity (TFP) was alarming as the EU has historically had higher labour productivity growth rates than the US since the 1950s. Higher labour productivity growth in Europe was mainly due to the latter’s catching-up in terms of capital deepening after the World War II. Given that this process appeared to have come to an end by 2000, total factor productivity can be increased mainly through innovation and technological deepening. That is why increased R&D expenditures were considered as essential in the Lisbon strategy.

The need to increase TFP growth rates is also related to the main avenue through which Lisbon targets will be met – namely increased competition in product, services and labour markets. The reason is that competition is assumed to be conducive to innovation which, in turn, is the major determinant of TFP growth when the capital-labour ratio is near its equilibrium level. In addition, innovation, TFP growth and competition are also interlinked in terms of their impact on GDP growth. As can be seen from the table above, US GDP growth from 200-2005 has been 75% higher than the EU-25 average. To close this gap, increased competition is a necessary condition for increased innovation and TFP growth, which would help EU-25 GDP growth rates catch up with those of the US economy.

The Commission tended to derive two policy implications from the relative under-performance captured in Table 1 above. First, the absence of Lisbon-type reforms aimed at increasing

competition, innovation and growth has been costly for the EU. Secondly, failure to implement the Lisbon Agenda will increase the cost further by having significant adverse consequences for EU economic growth and employment. The way out is to instigate a virtuous circle of competition-innovation-growth through market liberalisation. Once in motion, the virtuous circle will generate not only higher GDP growth rates, but also higher levels of employment.

The literature on the Single Market reforms provides some support for the Lisbon reforms. For example Griffith et al (2006) report that the product market reforms associated with the SMP have led to a reduction in economic rents (mark-ups) at company level. This is an indication of increased competition, which, in turn, can induce firms to increase their level of innovation – measured as R&D expenditures (input) or as numbers of patents (output). However, the connection between competition, innovation and growth is much more complex than this. Therefore, the rationale for the Lisbon strategy needs to be assessed more critically.

2. Why Lisbon-type reforms may not deliver? The second-best problem and the complicated relationship between competition and innovation

One reason why Lisbon-type reforms may not deliver is the second-best problem that arises when liberalisation (i.e., market-opening) reforms do not constitute a move from a *second-best* environment with *imperfect* competition to a *first-best* environment where competition is *perfect*. If the move remains within the second best environment, the theory of the second-best suggests that such move is not necessarily conducive either to first-best Pareto-optimality or welfare improvement. As Lipsey and Lancaster (1956: 12) have indicated;

... in a situation in which there exist many constraints which prevent the fulfilment of the Paretian optimum conditions, the removal of any one constraint may affect welfare or efficiency either by raising it, by lowering it, or by leaving it unchanged.

The reason why a partial move towards the first best does not necessarily improve welfare or efficiency is that the satisfaction of necessary conditions (e.g., market opening and deregulation of services or network industries) does not necessarily imply the satisfaction of sufficient conditions (i.e., the removal of all distortions that prevent the achievement of a perfectly competitive general equilibrium). This is why Lipsey and Lancaster (1956: 17) criticise ‘piecemeal welfare economics’ for basing its policy recommendations on the ‘belief that a study of the necessary conditions for a Paretian welfare optimum may lead to the discovery of sufficient conditions for an increase in welfare.’ A similar conclusion is derived by Baumol (1965: 138), who states that ‘partial policy measures which eliminate only some of the departures from the optimal arrangement may well result in a net decrease in social welfare.’

Policy recommendations based on computable general equilibrium simulations may be based on too optimistic assumptions that ignore the complications highlighted by the theory of second best. This may be the case for two reasons. First, we may never be able to identify and implement all of the sufficient conditions for Pareto efficiency. Secondly, even if it is possible to identify the sufficient conditions the cost of implementing the policy designed to satisfy them may outweigh its benefits. These problems are stated explicitly in a recent article by Lipsey (2007: 5), in which he draws attention to the following:

Market structures are rarely competitive enough to make marginal cost equal to price: oligopoly, monopolistic competition and monopoly vastly outnumber cases where firms are price takers. Some price setting behaviour occurs because of technologically determined factors such as scale economies, some because of firm-determined entry barriers and product characteristics and some because of policy.’

To the extent this is the case, it may not be possible to distinguish between the technology-induced and policy-induced wedge between marginal costs and prices. Trying to eliminate the wedge when it is induced by policy or firm behaviour may be welfare-improving if all other distortions are also removed. However, liberalisation policy aimed at eliminating a technology-induced wedge will be welfare-reducing. Of course, the existence of such problems does not imply that liberalisation reforms are necessarily welfare-reducing. For example, Bhagwati et al (1969: 1009) argue that

A small dose of a policy that has some effect on the distorted margin is better than no policy at all, because the initial marginal gain from mitigating the distorted market is of first order while the initial welfare cost from introducing the new distortion is of second order.

Similarly, Rakowski (1980) states that a movement towards Pareto optimality may not necessarily increase welfare, but if distortions are ‘sufficiently minor and insignificant’ departures from Pareto optimality are likely to be ‘minor and insignificant’. In other words, a partial move towards Pareto-optimality may reduce the *welfare loss* even if it does not ensure the achievement of Pareto optimality.

These arguments are intuitive and inform economic policy decisions to a large extent. However, as Lipsey (2007) indicates, these arguments would hold water only if the policy introduces a new distortion that was previously zero! In other words, a partial movement towards the first best may not even guarantee a reduction in welfare losses if it affects existing distortions. This is very likely to be the case because the main aim of the policy is to remove existing distortions. That is why Blackorby (1990: 757) remains convinced that ‘moving prices closer to marginal costs would not lead to an improvement in welfare, actual or potential.’

One can refer to further evidence indicating that liberalisation reforms may be just a move from one second-best state to another. For example, Veugelers et al (2002) examined the determinants of industrial concentration in the EU and found that the Single Market reforms have forced leading manufacturing companies to focus on their core activities as access to multiple markets have become easier. This is conducive to increased economic efficiency and welfare. However, their findings concerning the extent to which new entry has occurred and whether the risk of imperfect competition has fallen are not encouraging. For example, the share of 5 largest incumbents in the manufacturing sector has increased from 17.3% in 1987 to 19.3% in 1997. The increase in concentration was even higher in the computer/office equipment sector, which is one of the leading sectors in terms of innovation. In addition, the largest 200 firms in the manufacturing industries have remained the same over the period.

In addition, Lisbon-type reforms may be a double-edged sword. On the one hand, liberalisation *a la Lisbon* may induce firms to maintain or increase their market shares by increasing efficiency and reducing prices. On the other hand, however, it may induce firms to react strategically and coordinate their pricing strategies. Which effect dominates is an empirical question and cannot be answered *ex ante*. Nevertheless, there is evidence suggesting that the Single Market project that preceded the Lisbon Agenda had not been associated with falling excess profits, measured as the ratio of value added to the total cost of capital and labour. In fact, the evidence indicates that economic rents (mark-ups) that European firms have been able to extract have increased – as Table 2 below demonstrates.

**Table 2: Mark-up rates in selected countries:
Manufacturing sector in 1986 and 2000**

Country	1986	2000
Belgium	1.15	1.25
Denmark	1.12	1.20
Finland	1.10	1.20
France	1.20	1.28
The Netherlands	1.12	1.20
Sweden	1.15	1.20
Simple Average	1.14	1.22
UK	1.22	1.38
USA	1.34	1.44
Simple Average	1.28	1.41

(Source: Griffith et al, 2006a: 116)

Mark-up = (value-added) / (cost of capital + cost of labour)

What is also interesting is that the mark-up rates in the Anglo-Saxon model that the Lisbon Agenda is suspected of emulating have been historically higher than the continental European countries. Griffith et al (2006a) reason that increasing rates of mark-up rates across the board and higher rates in the UK and the US may be related to the business cycle and workers' bargaining power rather than the degree of competition per se. Even if this is the case, two questions remain un-answered: (i) is market liberalisation necessarily conducive to increased competition? (ii) How can one justify the argument that labour market rigidities (including union power to extract higher wages) have been one of the main reasons for EU's underperformance relative to the US? The second question will not be addressed in this paper, but it remains pertinent in this context because economic rents extracted by the firms have been higher in the US despite the stylised facts about the flexibility of the US labour market.

Finally, the relationship between competition and innovation as well as that between innovation and growth may not be linear. The debate on this relationship goes back to early 1900s when Schumpeter (1912, 1942) proposed two hypotheses. On the one hand, competition may be conducive to innovation as it forces incumbents to innovate to maintain their market positions; or new entrants have to enter with superior technology to be able to compete with the incumbents. On the other hand, competition may inhibit innovation because increased competition reduces economic rents and thereby reduces the incentive to undertake innovation. This is because innovation is a risky undertaking and it requires higher returns that will compensate the higher risks.

A large volume of theoretical literature on imperfect competition and endogenous growth tend to support Schumpeter's second hypothesis (See, for example, Dixit and Stiglitz, 1977; Aghion and Howitt, 1992; and Grosman and Helpman, 1991). In a more recent review of the literature, Gilbert (2006) lends further support to this view. The empirical literature reports conflicting findings, even though the majority of the empirical studies tend to report a positive relationship between innovation and rents.

For example, Griffith et al (2006a) examines the relationship between innovation and rent at country level for 13 OECD countries and find a positive relationship. However, this result is sensitive to country choice. When Finland, Sweden and Norway (high-innovation countries) are excluded, the relationship is negative. Griffith et al (2006b) examines the same relationship in 9 OECD countries and reports a negative relationship. Yet, in his review of the literature, Gilbert (2006) reports that higher levels of innovation by companies tend to be related to monopoly power derived from exclusive patent rights. Finally, Aghion et al (2005) demonstrate that there is an inverted-U relationship between innovation and competition – with innovation being associated with increasing rents up to a certain level before the relationship becomes negative.

Similarly, the relationship between innovation and growth may also be non-linear. Recent research points out that innovation at the technology frontier is conducive to increased total factor productivity and, therefore, it is conducive to higher levels of sustained growth. However, innovation below the technology frontier (mainly, emulation) has run its course and may not be conducive to higher levels of sustained growth. (See, for example, Acemoglu et al, 2002).

Given these findings, the Lisbon Agenda can and should be interrogated on two fronts: (a) have the Lisbon-type reforms led to higher levels of competition reflected in lower mark-ups (economic rents)? and (b) what is the relationship between competition and innovation? The next section addresses these questions by referring to evidence on the levels of competition and innovation in EU15.

3. Innovation and competition in EU15: the Lisbon decade and beyond

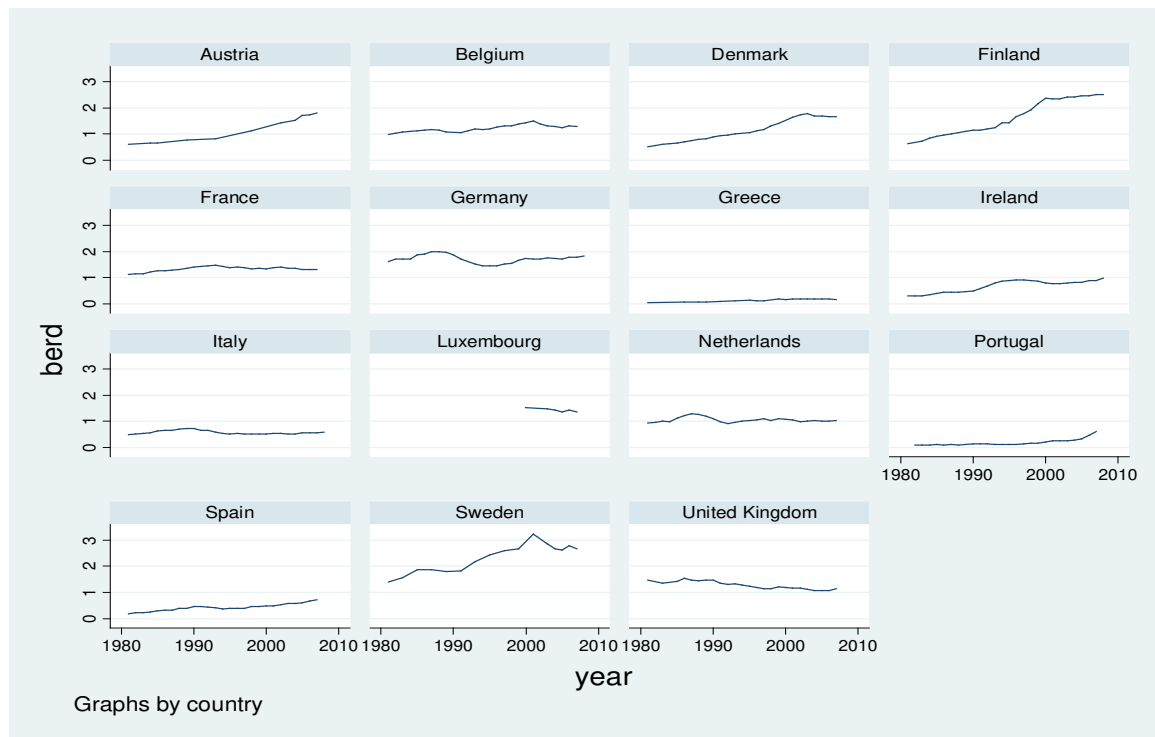
In this section, we use OECD data on innovation and macroeconomic data from the AMECO database of the European Commission to examine the trends in EU15 innovation and competition indicators, and estimate the relationship between competition (independent variable) and innovation (dependent variable).

Figure 1 below provides a summary of the trend in business enterprise expenditures on research and development as % GDP (BERD). In 8 countries (Austria, Belgium, Denmark, Finland, Ireland, Portugal, Spain and Sweden) BERD expenditures have been on an upward trend since 1980. In 5 countries (France, Germany, Greece, Italy and the Netherland), the trend has been flat, with fluctuations of about ½ percentage point around the average. In 1 country (UK) the trend has been downward.¹

The upward trend in business research and development expenditures in majority of EU15, however, does not provide sufficient support for a ‘Lisbon effect’ for two reasons. First, the evidence suggests that a ‘Lisbon effect’ is not observable in all countries – raising the issue of whether country-specific factors are more important than the Lisbon Agenda in explaining the BERD trend. Secondly, and more to the point, the major increase in BERD as % of GDP had occurred in the 1990s – before the Lisbon Agenda was adopted. This has been the case in

¹ The trend is similar with respect to enterprise expenditures on research and development as % of value added (BERDVA), but it is not reported here.

Figure 1: Business Expenditures on Research and Development as % of GDP (BERD)



Source: [://www.research.fi/muut/MSTI_2008-1.xls/view](http://www.research.fi/muut/MSTI_2008-1.xls/view)

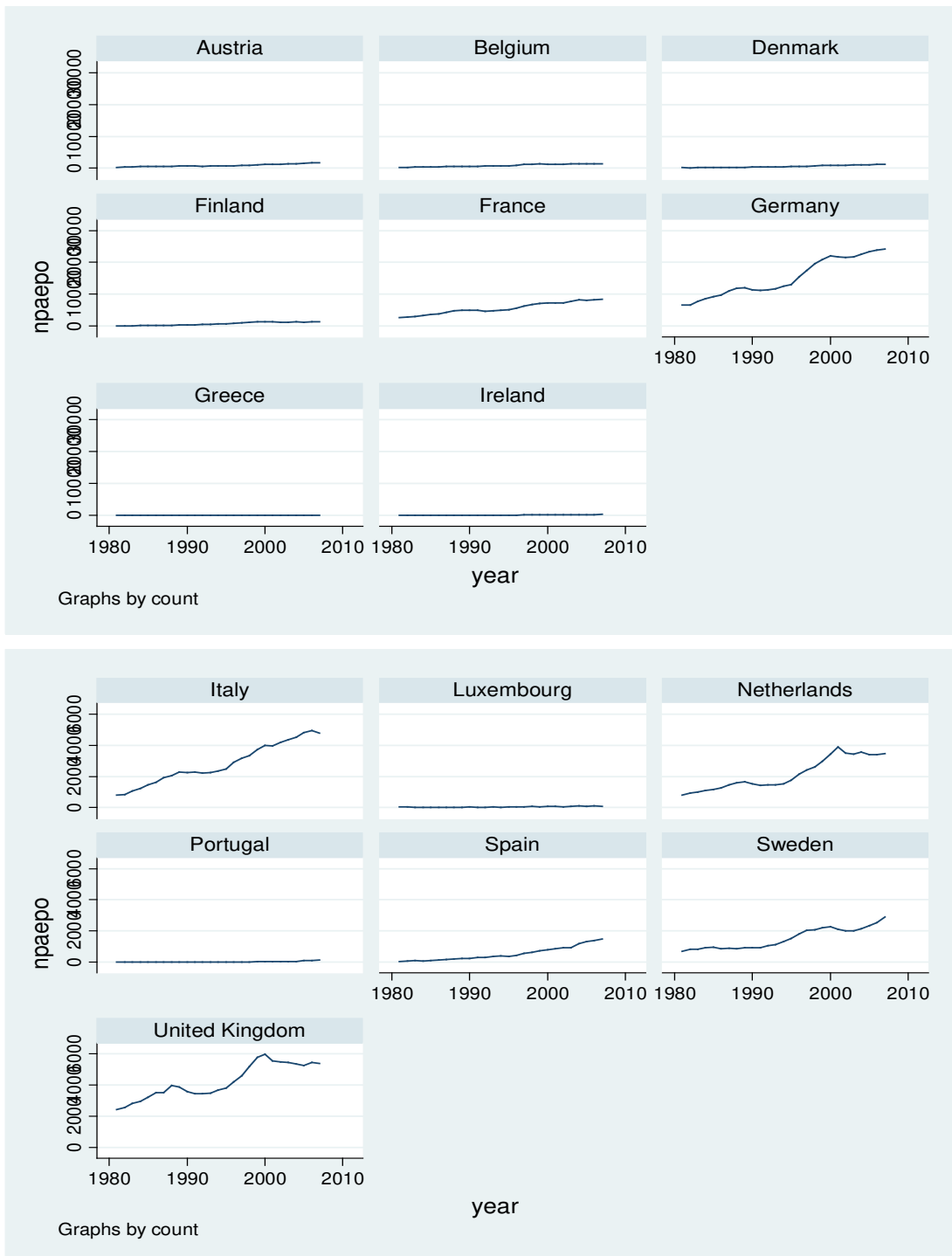
Austria, Denmark, Finland and Sweden – where the rate of increase in BERD had been much higher from 1990-2000 compared to 2000-2009. In the remaining countries, there is evidence suggesting that BERD as % of GDP has either declined or remained stable during the Lisbon decade (2000-2009). Both types of evidence constitute interesting reading because they suggest that business organisations have either committed relatively less resources to or cut down on research and development expenditures during the Lisbon Decade. This may be interesting but it is not surprising: simply put, business organisations have either reduced or slowed down research and development expenditures during the Lisbon Decade because total national R&D expenditures have been increasing slightly towards the 3% target. In other words, the Lisbon Agenda has led to an unintended consequence whereby business organisations tended to ‘free ride’ on tax-financed government expenditures on R&D.

Of course, BERD is only one measure of innovation (input measure) and as such may not provide adequate indication about whether EU15 economies have become more or less innovative during the Lisbon Decade. An alternative measure is the number of patents applications made to the European Patents Office (NPAEPO) or number of patents granted by the US Patents Office. This ‘output measure’ provides information about the effectiveness of the R&D expenditures in terms of patents generated. However, the patent data does not differentiate between patents in terms of quality – and as such may not provide an adequate measure of innovation. Despite this weakness, it is widely used as one of the innovation measures because none of the measures is necessarily perfect. (See, Rogers, 1998; OECD, 2010).

Figure 2 below provides a visual overview of the trend in EU15 patents applications to the European Patents Office (EPO). The evidence in Figure indicates that the correlation between R&D expenditures and number of patent applications is weak. This is to be expected because the number of patents application is a function of the national technological/innovation infrastructure that has developed over a long time. In other words, the trend in the number of patents is characterised by high levels of path dependence. Therefore, NPAEPO data indicates

clearly that EU countries with developed technological/innovation infrastructure (e.g., Germany, Italy, France, the Netherland, and the UK) have recorded increases in the number of patent applications to EPO. This is despite the fact that these business R&D expenditures as % of GDP in these countries have either remained stagnant or even declined. In remaining EU15 countries the NPAEPO trend has been either stagnant or declining.

Figure 2: Number of Patent Applications to European Patent Office (NPAEPO)



Given this evidence, it is difficult to argue to argue that the Lisbon Agenda has had a positive effect on innovation measured in terms of output too. Either pre-existing cross-country variations (i.e., path dependence) appear to be significant; or the increase in the number of

patents was less pronounced during the Lisbon Decade compared to the previous decade of 1990-2000.

What is even more troubling for the architects of Lisbon is the relationship between innovation and market liberalisation reforms – the second pillar of the Lisbon Agenda. As indicated above, the relationship between market structure (the extent of competition between firms) and innovation is not straightforward – either theoretically or empirically. Yet, the Lisbon Agenda lumps together the ‘innovation’ and ‘competition’ without due considerations of their compatibility or the trade-offs that may be involved between the two targets. In addition, the Lisbon Agenda has relied on a short-cut that assumes a direct and positive relationship between the level of competition in EU economies and the liberalisation reforms aimed at completing the Single Market - i.e., liberalisation of services trade and liberalisation of the Services of General Interest such as gas, electricity, communications, and transport, etc.

The evidence we present below suggests that neither the short-cut nor the lumping together of the targets was appropriate. Figure 3 below provides evidence as to why the short-cut from liberalisation to competition (and the assumption that underpins it) was problematic. The evidence suggests that economic rents extracted by firms have been increasing both before and after the launch of the Lisbon Agenda in 2000. As is well known, the pre-Lisbon Decade was the decade of the Single Market, which was ‘officially’ completed in 1992. Despite removal of non-tariff barriers to intra-EU trade (and the market liberalising effects of those reforms), the evidence in Figure 3 indicates that the macro-level (overall) rents extracted by firms has been high and increasing over the 1990s. The upward trend continued during the Lisbon Decade (after 2000) albeit the rate of increase has been slightly lower.

The economic rent captured in Figure 3 is calculated through the formula below and in line with previous studies (Aghion et al, 2005; Griffith, 2006a and 2006b):

$$rent = value\ added / (cost\ of\ capital + cost\ of\ labour)^2$$

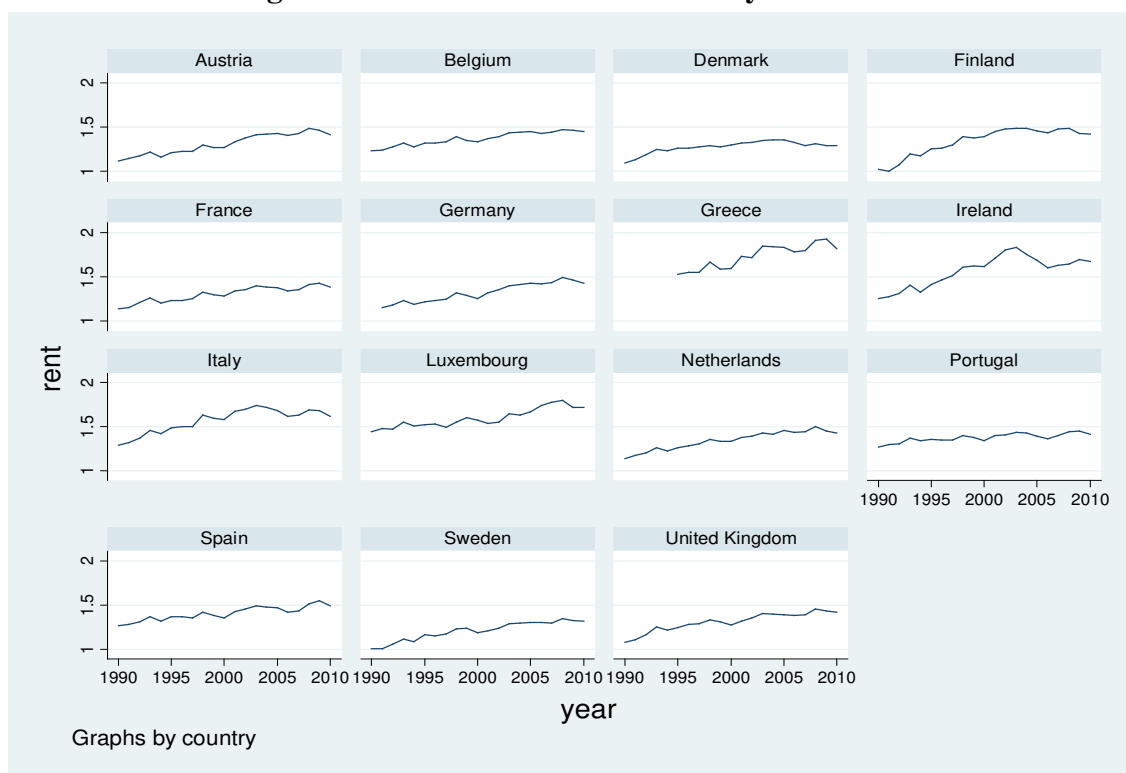
Value added is the value of output less the value of intermediate consumption, and as such it measures the value generated by any unit of production. It is measured in current prices and does not include the value of the output produced by financial intermediation services. The latter is treated as the intermediate consumption of a nominal sector with zero output; and the value-added of all sectors and industries is reduced by this amount. (Value-Added Metadata). The cost of capital is obtained by multiplying the value of the net capital stock in current prices with long-term US interest rates. The latter is taken as a proxy because we assume that firms can borrow on the international market. Under this assumption, the cost of capital we calculate may underestimate (overestimate) the cost of capital for non-US countries if the interest rates in the latter have been higher (lower) than the US. However, adjusting the EU15 interest rates by some (say x) percentage points upward or downward does not alter the trend in the cost of capital (and hence the trend in rent) – ceteris paribus. Finally, the cost of labour is measured in current prices and includes wages, salaries, and employers' social contributions for resident as well as non-resident labour working for resident producer units. (Labour Cost Metadata). All components of the rent are whole-economy (macro-level) measures.

The ‘rent’ measure of market structure has been used at sectoral and industry levels in the literature (see, Aghion et al, 2005; Griffith, 2006a and 2006b). This measure was preferred to

² Data for the components of the rent equation is from AMECO database of the European Commission at: http://ec.europa.eu/economy_finance/ameco/user/serie/SelectSerie.cfm

other measures such as market share of largest firms, and its variations such as the Hirschmann-Herfindahl Index (HHI) or the Lerner Index (LI). This is because market share or the HHI provides information about the size of firms in the market, but does not provide direct evidence about the extent to which these firms can exercise market power and extract economic rents. On the other hand, the Lerner Index captures the ability of a firm to extract economic rent, but it cannot be calculated at industry or total economy level. (See, Aghion et al, 2005; Griffith, 2006a and 2006b). The ‘rent’ measure in Figure 3 differs from the previously-used measure in the sense that it captures rent at the whole economy level rather than industry or sectoral level.³

Figure 3: Economic rents extracted by all firms in EU15



The evidence in Figure 3 indicates clearly that the level of rent extracted by firms (the owners of capital) has been increasing in EU15 since 1990. Bluntly put, this simple observation implies that the market liberalisation reforms introduced under the Single Market or the Lisbon Agenda has not led to lower market power enjoyed by all firms in EU15. Whether this persistently high market power has been due to imperfect competition or inadequate consumer protection or weak union power that dampened wage costs is irrelevant in this context. The important and meaningful observation to be made here is that the Single Market and Lisbon reforms have been compatible with persistently high levels of rents extracted by firms as owners of capital.

The final piece in the Lisbon jigsaw concerns the compatibility of the twin objectives of increasing competition and innovation at the same time. The Lisbon strategy aims to make the European economy ‘the most dynamic and competitive knowledge-based economy in the world’

³ It can be argued that the measure of rent at the whole economy level may be problematic because of the relatively small physical and relatively large financial capital employed in the financial sector, including banking. This is a valid criticism, but does neither offer a better measure nor does it invalidate the measure proposed here. This is because there is a high degree of correlation between the whole-economy rent ratio reported in Figure 3 and manufacturing industry rent ratio reported by Griffith (2006a and 2006b).

by 2010. This objective would be achieved by market-opening and market-deepening reforms that would increase competition across all markets. As indicated above, however, the effect of competition on innovation is a contentious issue. On the one hand, increased competition may lead incumbent firms to increase innovation in order to maintain or increase market shares. It may also cause new entrants to enter the market via innovation. However, increased competition leads to lower economic rents and thereby reduce the incentives for both incumbent firms and new entrants to invest in innovation – which is a risky investment. This will be the case to the extent that incumbent firms or new entrants require economic rents as an insurance against the risk associated with innovation and/or as a source of financing the investment in innovation. In what follows, we analyse the impact of competition (measured as economic rents) in EU15 on various measures of innovation, including R&D expenditures, number of patents and technology import/export. The models to be estimated are as follows:

$$\begin{aligned}
 berd_{it} &= \beta rent_{it} + \alpha_i + u_{it} \\
 berdva_{it} &= \beta rent_{it} + \alpha_i + u_{it} \\
 npaeop_{it} &= \beta rent_{it} + \alpha_i + u_{it} \\
 npauspto_{it} &= \beta rent_{it} + \alpha_i + u_{it} \\
 tbpr_{it} &= \beta rent_{it} + \alpha_i + u_{it} \\
 tbpp_{it} &= \beta rent_{it} + \alpha_i + u_{it}
 \end{aligned}$$

We use an un-balanced panel dataset from 1980 to 2008 for EU15 and run both fixed and random-effect regressions, regressing various measures of innovation on economic rents. Estimated coefficients of the rent variable are found to be all positive and statistically-significant in both fixed- and random-effect models. Fixed-effect models estimate the relationship between the predictor (rent) and outcome variables (measures of innovation) within countries over time. Random-effect models, on the other hand, assume that variation across countries is random and estimate the impact of cross-country variations in the predictor (rent) on the observed outcome (measures of innovation). Our findings from the EU15 data suggest that both fixed-effect (within-country) and random-effect (cross-country) estimations are positive and statistically significant.

**Table 3: Fixed-Effect Regression Results:
Measures of Innovation Regressed on Rent**

Dependent variables	Coefficient of <u>rent</u>	Standard error	t	P(t)	Observations	Groups
berd	0.94	0.12	7.42	0.00	234	15
berdva	1.60	0.19	8.57	0.00	234	15
npaeop	5780.06	715.83	8.07	0.00	264	15
npauspto	5581.83	696.47	8.01	0.00	264	15
tbpr	25371.08	3455.22	7.34	0.00	187	15
tbpp	17003.65	2223.14	7.65	0.00	187	15

rent : Value added as proportion of total labour and capital cost (whole economy)
berd : Business Expenditure on R&D as % of GDP
berdva : Business Expenditure on R&D (BERD) as % of value added in an industry
npaeop : Number of patent applications to the EPO
npauspto : Number of patents granted by the USPTO
tbpr : Receipts form export of technology (million current dollars)
tbpp : Payments for import of technology (million current dollars)

To establish which model would be more appropriate, we conduct the Hausman test for fixed and random effects (see, Green, 2008: chapter 9). The Hausman test involves testing for the null hypothesis that the random-effect estimation is more appropriate. Test results suggest that the fixed-effect estimation should be preferred to random-effect estimation for all measures of innovation reported in Table 3 below. Therefore, the estimated coefficients in Table 3 capture the impact of within-country variations in rent on the measures of innovation.

The results indicate clearly that all measures of innovation are related positively to the level of economic rents extracted by all firms. A one-unit increase in rent (defined as the ratio of value-added to total labour and capital cost) is associated with 0.94 percentage point increase in business R&D expenditures as % of GDP, and with 1.6 percentage points increased business R&D expenditures as % of value-added. Similarly, a one-unit increase in rent is associated with an increase of 5,780 in patents submitted to EPO or an increase of 5,581 in patents granted by USPTO. Our estimations also show that firms tend to be more involved in technology exports and imports as the level of rents increases within each country. A one-unit increase in rents is associated with an increase 25 billion dollars in export of technology and an increase of 17 billion dollars in imports of technology. Given that the increase in exports is 50% larger than the increase in imports for a unit increase in rent, it is safe to argue that improvement in the technology balance of payments (i.e., the difference between receipts from and payments for technology trade) would depend on the extent of rent extracted within each country.⁴

Conclusions

The analysis above suggests that the ambitious targets set in Lisbon Agenda may be based on too optimistic assumptions about the impact of market opening reforms and about the linkage between market structure and competition. The evidence indicates clearly that market-opening reforms in network industries and gradual liberalisation services have not been conducive to higher levels of competition within or between EU15 markets. Economic rents extracted at the macro level have continued to increase during the Lisbon Decade (2000-2008) – albeit the rate of increase was slightly lower than the 1980-2000 period. True, the upward trend in the rent levels may be related to factors other than the extent of competition in relevant markets. These factors may include recessions and bargaining power of the labour force (See, Griffith, 2006a). However, the upward trend in EU15 economic rent levels has been persistent for a long time and as such cannot be explained by fluctuations in the business cycle or union power.

Even if the business cycle or labour's bargaining power have contributed to increasing levels of rent, such effects do not alter the positive relationship between rent levels and levels of innovation. The evidence here indicates that the level of economic rents has a positive and statistically significant effect on innovation activity, measured in terms of inputs or outputs. The policy implication (or dilemma?) here is that innovation in EU15 is driven by the ability of firms

⁴ Technology receipts and payments relate to transfer of techniques (through patents and licences, disclosure of know-how, etc.), transfer of designs, trademarks and patterns (through sale, licensing, franchising, etc.) and industrial R&D. Unlike R&D expenditure, however, technology receipts and payments are for production-ready technologies. Therefore, they should be considered as indirect rather than direct measures of innovation. They reflect the extent to which firms are able to export innovative designs, trademarks or patents; or the extent to which firms import these innovative technologies to maintain or enhance their market shares.

to extract economic rents beyond the level implied by perfect competition. At the end of the Lisbon Decade, the excess rent tended to be 40% - 50% higher than the baseline for perfect competition (Figure 3 above). Put differently, it is safe to conclude that the positive impacts of the innovation driven by excess rents must be discounted by the likely costs of market imperfections in terms of allocative and productive efficiency losses.

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