THE IMPACT OF REGULATION ON PERFORMANCE

An empirical investigation at the industry level in OECD countries

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and

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ABSTRACT

This paper studies the impact of regulations on productivity growth at the industry level, while most related research is at the aggregate, economy-wide level. Since regulations pertain to specific industries this is the appropriate way to study such an effect. Despite all data limitation involved, we do find a positive effect of deregulation on productivity growth in retail and aviation. Moreover, with a simple regulation indicator over time, an inverted U-shape between regulation and performance could be identified in retail trade and utility services. Nevertheless, before any firm inferences on such a relation can be made more high quality data on both regulation and performance at the industry level are needed.

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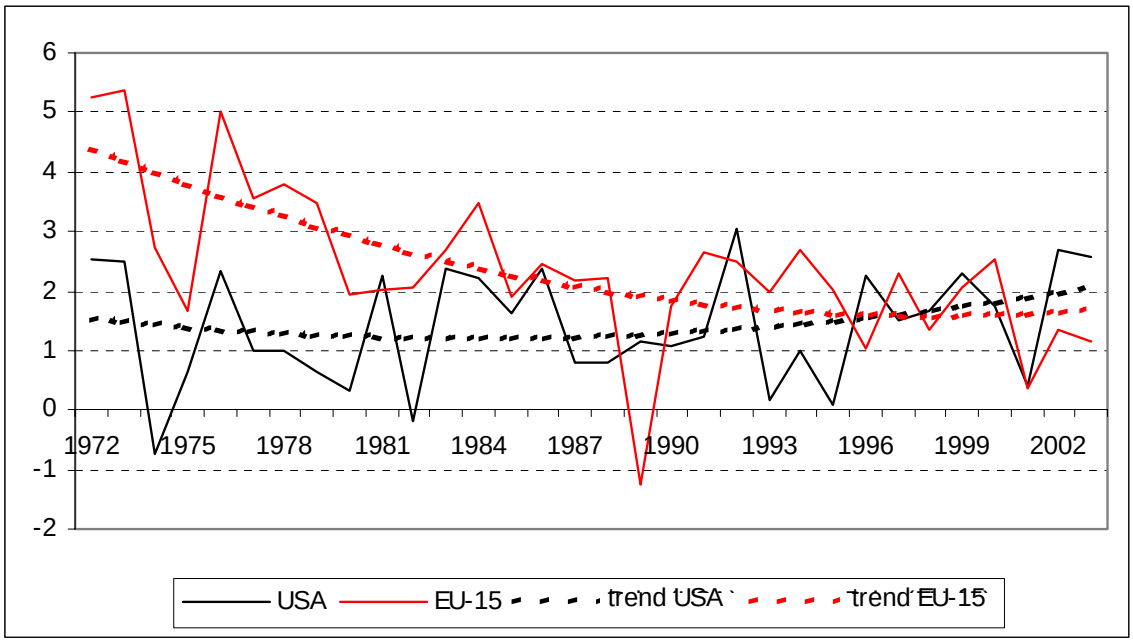
1. Introduction

The increasing productivity gap between the USA and Europe since the second half of the 1990's has now widely been recognised (see figure 1). In the 1970's and 1980's Europe's productivity growth rate exceeded that of the USA because it was catching up to the US production frontier. However from the 1990's onwards productivity growth in Europe slowed down, while in the US it accelerated. From an analytical perspective there are two categories of explanations for these differences in productivity growth rates. First, one can look at the direct proximate sources of growth, which include differences in labour force participation, differences in capital intensity, and – within the category of physical capital – the share of ICT versus non-ICT capital in understanding differences in productivity performance.[1] Second, when these were the only factors justifying the EU lag, it is reasonable to assume that eventually the EU will follow the US productivity performance. However, when particular structural features have created obstacles to the diffusion of ICT in the EU it cannot be expected that the EU will realise a similar performance as the US, unless such structural rigidities are removed. No doubt these issues have important ramifications for policy making. This second aspect is addressed in this paper.

Figure 1. The decline of European and rise of US real productivity growth 1972-2003



Source: GGDC Total Economy Database (www.ggdc.net)

[1] See e.g. Jorgenson and Stiroh (2000), Oliner and Sichel (2000,2002), Inklaar et al. (2003) and McGuckin and van Ark (2004).

Structural differences between the EU and the US that might be potentially detrimental to the adoption and diffusion of ICT refer to institutions and regulations on both product markets and markets of production factors that firms operate in. As a first structural difference, labour market rigidities might be an obstacle to technical change, because the introduction of ICT offers wide opportunities to restructure production and reduce the size of the labour force. Labour market rigidities might distort the incentive to implement labour saving technologies in the EU. Lower firing costs and a more flexibly operating labour market, have made ICT investment in the US more profitable and have stimulated the introduction of labour saving technologies.

A second structural difference between the EU and the US is the intensity of competition, forcing firms to innovate and find ways of cutting costs. Hence, the more intense competition in the US favours technical progress and, as a consequence, the entrepreneurial culture in the US favours more rapid expansion of new sectors. Regulatory reform and deregulation policies that started in the 1970s and 1980s in the US have certainly stimulated the competitive nature of the economy (Winston, 1993 and OECD, 1995). Other advantages in the US markets compared to European ones are mature financial markets that accommodate young and innovative enterprises to raise funds, sufficient linkages between public and private R&D efforts and less administrative and regulatory burdens for new firm start ups. See OECD (2002) for a review.

Recent theoretical and empirical research suggest that labour and product market regulation and public ownership affects entrepreneurial incentives and competitive pressure so that the ability of firms to successfully engage in productivity enhancing activities, like innovation, are restrained and hence productivity growth is falling behind. See Pilat (1997, 2001), Nicoletti (2001), Ahn (2002), Bassanini and Ernst (2002) and Scarpetta et al. (2002). Aghion et al. (2002), Nicoletti and Scarpetta (2003) and Gust and Marquez (2004).

All these studies make country comparisons on the relation between regulation and performance at an economy wide scale. Only large aggregate sectors like manufacturing and services are sometimes being distinguished. It is however always the case that regulation refers to very specific industries, particularly in services like trucking, rail transport and telecommunication. In such economy-wide studies industry-specific effects may easily cancel out, giving rise to spurious results. What is new about our study in relation the previous ones is our focus on the productivity-regulation trade-off for very specific industries.

Our point of departure is the industry-specific information on regulatory environments in the OECD International Regulation Database. Distinction is made between competitive industries: retail, road freight and mobile telecommunication, and network industries: electricity generation and distribution, rail transport, aviation and fixed telecommunication. Regulations in these industries are also used in the OECD studies mentioned above, but not so much in their relation to industry performance. The premise we start from is that the regulatory environment of an industry affects the growth of output, employment and productivity of that same industry.

This paper is organised as follows. In section 2 we closely follow the summary indicators of regulation per industry based on the OECD International Regulation Database (IRD) and relate them to growth of output and employment of these industries drawn from the Groningen Growth and Development Centre (GGDC) 60-Industry Database[2] and when relevant from other OECD Databases. Since the product market regulations from the OECD refer only to the situation in 1998 and basically represent the level of competitiveness in the industry, we try to establish in section 3 for which industries the price-cost margin serves equally well as an indicator of regulation. The industry price-cost margin refers to a much longer time period than the indicators from the OECD IRD. Section 4 exploits this advantage based on pooled country data by industry. This implies a substantial increase in the number of observations that allows inclusion of other explanatory variables and testing whether an inverted U-shape exists between regulations for a particular industry and its performance. In that case the best policy is not to just deregulate, but there exists some optimal level of regulation at which productivity growth is flourishing. Finally section 5 summarises and concludes.

2. Relation between regulation and performance using the OECD IRD

Data availability

This section shows whether a relation between industry regulation from the OECD International Regulation Database (IRD) and industry performance can be found. However, it is at this stage important to note that the level of detail of the regulations in the IRD for road freight (ISIC 6024), electricity generation and distribution (ISIC 401), railway transport (ISIC 601) and telecommunication for fixed and mobile phones does not match the level of detail of performance indicators in the GGDC's 60-Industries Database, which does not go beyond a

[2] Downloadable from www.ggdc.net.

2-digit ISIC level. Hence only for retail trade (ISIC 52) and aviation (ISIC 62) we have indicators for both regulation and performance pertaining to the same industry classification. For the other industries other sources and other performance indicators are used that refer to exactly the same industry classifications.

For road freight Eurostat data drawn from the *Panorama of Transport 2003* on the growth rates of freight capacity in tonkilometres are used as output measure, the number of trucks as input measure. For electricity generation we rely on the OECD Structural Statistics for Industry and Services, which provide information for ISIC 401 on gross production (output) and employment (input) for a number of years. Finally performance indicators for fixed and mobile telephony are drawn from the OECD Telecommunications Database on revenue and employment of the Public Telephone Operator (PTO) by origin: fixed vs. mobile services. Drawback is that there is no information of other telecom companies. We have not been able to find performance indicators for rail transport for a sufficient number of countries, so this industry is removed from the analysis. Fifteen countries are distinguished, viz. the USA and the EU-15 except Luxembourg, and 6 industries: retail, aviation, electricity generation and distribution, road freight and fixed and mobile telephone services. The regulation indicators are all dummy variables ranging from 0-6, i.e. from least to most restrictive. Performance indicators are average growth annual rates of output, input and productivity over the period 1995-1998 and as an alternative over the period 1998-2001. The first assumes that regulation and productivity growth refers to roughly the same period, the latter assumes a lagged effect of the regulatory status.

Analysis

At this stage only a mere 15 observations are available so only a simple linear regression analysis based on a cross section of country data for each industry is feasible. For each of the six industries (*i*) the following relation is estimated. Central issue is here whether α_1 differs significantly from zero and whether deregulation boosts performance ($\alpha_1<0$)? The estimation results are presented in table 1.

$$\Delta \log(performance_i) = \alpha_0 + \alpha_1 regulation_i \qquad (1)$$

Table 1 – Estimation results of the impact of regulation on growth of performance in six industries in the second half of the 1990's

State of regulation in: 1998	Performance in period: 1995-1998	Retail[1]	Aviation[1]	Electricity[2]	Road freight[3]	Telecom – fixed[4]	Telecom – mobile[4]
Overall	output growth	-2.46*	-2.45*	-1.19	0.33	0.80	28.5
	input growth	-0.41	-2.41*	0.46	0.87	-0.13	-13.0*
	productivity growth	-2.06	-0.04	-1.56	-0.54	0.93	41.6*
Barriers to entry	output growth	-1.51	-1.06	0.05	0.07		16.5
	input growth	-0.93*	-3.34	0.23	0.54***		2.61
	productivity growth	-0.58	2.28	-0.18	-0.48		13.91
Involvement in industry	output growth	-0.91	-0.61	-0.51	0.44	-1.03	0.94
	input growth	-0.91	-0.27	0.07	0.65	-1.01***	8.21*
	productivity growth	-0.00	-0.34	-0.58	-0.21	-0.02	-9.15
1998	1998-2001						
Overall	output growth	-0.70	0.40	-0.36	0.67	3.79***	-3.31
	input growth	-0.39	-1.03	0.05	0.43	-0.69	-10.4**
	productivity growth	-0.30	1.43	0.40	0.24	4.47***	7.13
Barriers to entry	Output growth	0.06	1.01	0.33	0.30		5.42*
	input growth	-0.40	-1.56	-0.02	0.37		-1.64
	productivity growth	0.43	2.57	0.35	-0.07		7.05**
Involvement in industry	output growth	-0.53	-0.45	-0.48	0.48	-0.29	4.11**
	input growth	-0.49	-0.38	-0.03	-0.57	-0.74	3.04
	productivity growth	-0.04	-0.07	-0.45	1.05	0.45	1.06

Significance based on heteroscedasticity consistent covariances of White: * is significant at 10%; ** is significant at 5%; *** is significant at 1%.

Regulation indicators are drawn from the OECD International Regulation Database

[1] Output growth is average annual percentage growth of real value added; input growth is average annual percentage employment growth (source: GGDC, 60 Industry Database)

[2] Output growth is average annual percentage growth of real gross production; input growth is average annual percentage employment growth (source: OECD, Structural Statistics for Industry and Services, Vol 1)

[3] Output growth is average annual percentage growth of road freight capacity (tonkilometres); input growth is average annual percentage growth rate of the number of trucks (source: Eurostat, Panorama of transport 2003)

[4] Output growth is average annual percentage growth rate of real revenue due to fixed / mobile telephone activities of the PTO; input growth is average annual percentage growth rate of the staff involved in fixed / mobile telephone activities of the PTO (source: OECD, Telecommunications Database 2003)

In case of an instantaneous effect of regulation on performance (the top part of the table), there is only a weak negative relation between the state of regulations and real value added growth in both retail and aviation. This can be interpreted as less regulations boosting output growth. In road freight there is positive relation between regulation and the number of trucks. This can be explained by the fact that lifting regulations on firm entry and on cabotage and 'third country transport' increases trucking movements and hence the number of trucks.[3] In fixed telephony deregulation implies a fall in employment of the PTO. This is also no surprise as breaking open the market for fixed telephony implies entry of competitors and hence

[3] See Broersma and Segers (2003).

falling influence (and thus employment) of the PTO (former monopolist). Finally the coefficient values for mobile telephone service show that the opening up of the particular market has positively affected productivity. In case of a lagged effect the relation between regulation and is far more difficult to apprehend. Apart from telecommunication services there is no significant relation at all. This is justified by the fact that deregulation started to set off in many industries only after 1998.

All in all the results of table 1 are disappointing, but this is entirely caused by the fact that despite the detailed aspects of regulation that the indicators touch up, the all refer to only one point in time. This is bound to cause weak results since deregulation was an ongoing process in many countries during the whole of the second half of the 1990's.

3. Can we expand indicators of regulation over time?

Data availability

Can alternative regulation indicators be found that do make it possible to compare the state of regulation in different time periods? Since most deregulation in the service industries discussed so far boils down to opening up markets for competition, we look for an adequate indicator of market concentration. Markets that have been deregulated will then indicate lower market concentration, i.e. are competitive, while market that that are still regulated have a higher market concentration, i.e. monopoly rents.

The so-called price-cost margin will be used as an alternative regulation indicator because it is both theoretically appealing an empirically viable. The price-cost margin equals the difference between price (p) and marginal cost (mc) as a fraction of price, that is $[p\text{-}mc]/p$. The price-cost margin is a well-known indicator of market power: the larger the margin, the larger the difference between price and marginal cost, i.e., the larger the distance between the actual price and the competitive price. In a competitive market the price equals the marginal costs so the price-cost margin is zero.

However, this alternative regulation indicator comes at a price. First, marginal costs are not observed so the price-cost margin is still not empirically operational. Instead we will calculate the 'price-cost average', define as the ratio of the operating surplus, i.e. value added minus labour costs, and production. See also Aghion et al. (2002). Another point is that the industry classifications of these 'price-cost averages' do not correspond to those of IRD. The indicators from the IRD refer to very specific aspects of regulation, ranging from shop

opening hours to presence of state owned monopolies, in very specific industries. Price-cost averages are a composite regulation indicator and can only be calculated for composite industry classifications. They are hence far less specific and far less detailed then the indicators from the IRD.

This is illustrated in table 2, which reviews the industry classifications for the regulation indicators from the IRD and the price-cost averages and performance indicators. Only for retail trade and aviation regulation indicators, based on the IRD, the industry concentration represented by the price-cost averages, and performance, real growth labour productivity, has bearing on exactly the same industry at 2-digit ISIC. The other industries are composed of different divisions of sub-industries that likely face different types of regulation. This goes first if all for inland transport (ISIC 60), which consists of all kinds of different means of land transport, like passenger transport by taxi, bus or train, but also freight transport by truck or train. All these different composite industries are likely to face different regulatory rules. So the regulations for trucking from the IRD do not correspond to land transport in general. The same is true for utility services (ISIC 4), where electricity generation and distribution is likely to face a different set of regulations than for instance gas and water distribution who are all joint in one industry. Likewise, the effect of regulations in postal services may offset those in telecommunication.

Nevertheless as far as industry concentration and performance is concerned all industries do correspond, so as a first step we will test the existence of a relation between industry competition (price-cost average) and performance (labour productivity) in all these industries. Specific focus will be on those industries for which also a whole range of indicators is available in the IRD: retail trade and aviation.

Table 2 – Industry classification of indicators of regulation and performance

Regulation indicators from IRD; 1998	Regulation: Price-cost average; 1990-2001	Performance: Growth rate of real labour productivity; 1990-2001
ISIC 52 (retail trade)	ISIC 52 (retail trade)	ISIC 52 (retail trade)
ISIC 62 (aviation)	ISIC 62 (aviation)	ISIC 62 (aviation)
ISIC 401 (electricity generation/distribution)	ISIC 4 (utilities)	ISIC 4 (utilities)
ISIC 6024 (trucking)	ISIC 60 (land transport)	ISIC 60 (land transport)
ISIC 642* (telecommunication- fixed)	ISIC 64 (post and telecom)	ISIC 64 (post and telecom)
ISIC 642* (telecommunication-mobile)		

* There is no distinction in the classification system between fixed and mobile telecom services.

4. Price-cost averages and performance by industry

Data availability

When price-cost averages, defined as the ratio of industry operating surplus, i.e. value added minus labour costs, and production are used as alternative indicators of regulation the number of observations expands substantially. We will examine the relation between performance and this regulation indicator and include other explanatory variables as well. The reason why additional explanatory variables were not included in equation (1) was the very limited number of observations available.

When a Cobb-Douglas production function with constant returns to scale is assumed to represent the underlying production process, an additional explanatory variable in the specification for labour productivity growth is the growth rate of the capital-labour ratio. This variable however does imply calculation of the capital stock for each industry and country. This requires long time series of investment data, investment prices and deprecation rates by industry along with a number of simplifying assumptions. Unfortunately for some countries and industries these data are not available, notably for Denmark, Greece, Ireland, Portugal and Spain. Moreover the length of the investment series allows only feasible capital stock estimates for the period 1995-2001. This limits the number of observations to 70 for each industry, which is however still far larger than the mere 15 observations of table 1.

In our model specification performance is measured as the annual percentage real growth rate of value added per employed person. Regulation is measured as the price-cost average of the corresponding industry lagged two periods. This lag is necessary to evade simultaneity bias. The operating surplus, which is part of the price-cost average on the right hand, is in essence equal to value added minus labour costs and value added is also part of the dependent variable. A lag of two periods is necessary to not include the same variables at both left hand side and right hand side of the estimated equation.

Analysis

An extended specification of equation (1) based on a standard Cobb Douglas production function using pooled data over all countries, *c*, for each industry *i*, yields

$$\Delta \log\left(\frac{Y_{c,t,i}}{L_{c,i,i}}\right) = \alpha_0 + \alpha_1 \Delta \log\left(\frac{K_{c,i,t}}{L_{c,i,t}}\right) + \alpha_2 PCA_{c,i,t-2} + \alpha_3 PCA^2_{c,i,t-2} +$$

$$+ \alpha_4 PCA_{c,i,t-2} \cdot \Delta \log K_{c,i,t} + \alpha_5 PCA_{c,i,t-2} \cdot \Delta \log L_{c,i,t} \qquad (3)$$

where the index *t* refers to time, *Y* stands for real value added, *L* for total employment and *K* for the real capital stock. The price-cost average PCA_i for industry *i* and each year *t* is defined as before.

The interpretation of the cross-terms is straightforward. Besides the direct effect of the *PCA* on productivity growth, there is also an indirect effect that allows *PCA's* to interact with growth of capital and growth of employment. The idea is that regulation in terms of market concentration reduces the growth rate of capital e.g. because certain leading technologies are not adopted (Nicoletti and Scarpetta, 2003) or it may reduce employment growth e.g. because of less need for high skilled workers. Hence, a negative value of α_4 and α_5 implies a positive effect of *PCA* on productivity growth, provided capital and employment growth are positive.

Table 3 gives the estimation results of the simplified version of equation (3) for each industry based on pooled time series data. We start with estimation of the entire specification of (3) and test whether it can be simplified by removing variables with insignificant coefficients. Since the data allow for testing the existence of an inverted U-shaped relation between deregulation (*PCA*) and productivity growth, we do report both coefficients α_2 and α_3. For a valid inverted U-shaped relation it is necessary that $\alpha_2 > 0$ and $\alpha_3 < 0$.

Table 3 – Results of estimating equation (3) with pooled country data (based on ten countries between 1995-2001) by industry‡

	α_0	α_1	α_2	α_3	α_4	α_5	R^2	Obs.
Retail trade	-0.12	0.59	1.35	-2.42	-4.18		0.19	65
	(-2.91)	(3.81)	(3.98)	(-4.05)	(-4.77)			
Aviation	-0.01	0.87					0.17	67
	(-0.50)	(2.17)						
Communication	0.07	0.36					0.05	67
	(6.20)	(3.24)						
Utilities	-0.17	1.80	1.03	-1.21	-6.35	2.73	0.37	65
	(-1.52)	(3.47)	(1.75)	(-1.74)	(-3.20)	(1.82)		
Land transport	-0.05	0.84	0.14				0.73	65
	(-3.27)	(5.86)	(1.80)					

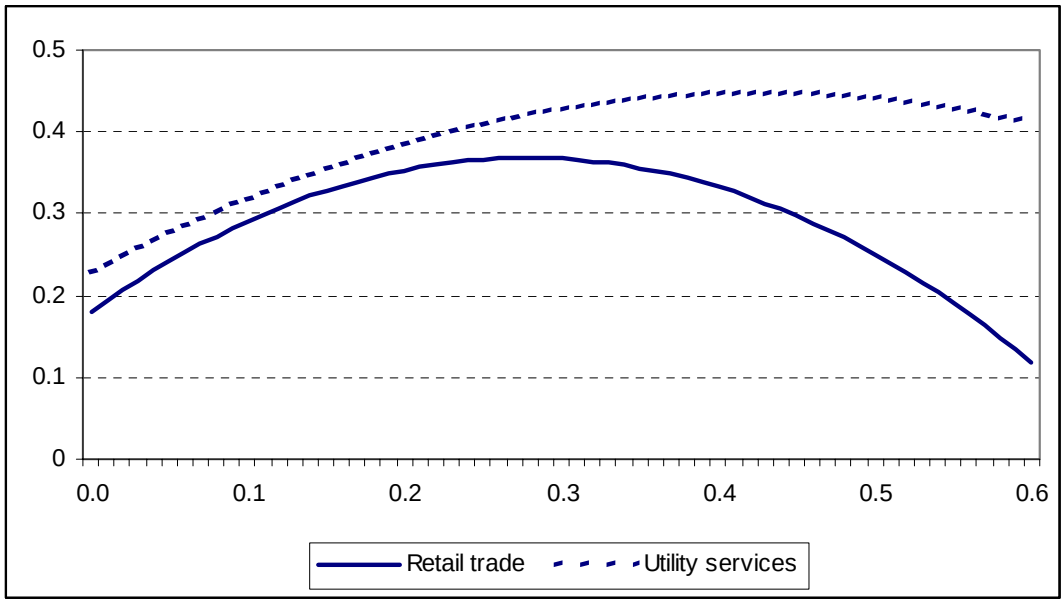
‡ These ten countries are: USA, Austria, Belgium, Germany, Finland, France, Italy, Netherlands, Sweden, UK. Between parentheses are the *t*-values for the heteroscedasticity and autocorrelation consistent covariances of Newey and West (1987).

Table 3 clearly shows that the requirement for an inverted U-shape ($\alpha_2>0$ and $\alpha_3<0$) is only found in retail trade and utility services. In the other industries no evidence of a U-shape is found, nor of any negative relationship between industry concentration and performance. In fact for land transport a weak positive effect was found. The composite character of the industry of inland transport can cause this latter relation, because each building sub-industry is facing different regulatory measures. This makes it difficult to get a clear picture of the overall relation of this industry. The absence of any relation in communication, build up of postal services and telecommunications, may be attributed to the same problem. Another phenomenon hampering a possible relation is the fact that deregulation takes time to have an effect and the period 1995-2001 may be too short a time span. This is particularly true for industries that have faced strong deregulations, like telecommunication and aviation. A third aspect that has to be mentioned is the fact that the price-cost average (*PCA*) that we use is only a crude approximation of what we are really interested in, viz., the price-cost margin. The estimation results could easily be biased because the average and marginal costs in an industry are completely different. Fourth, the *PCA*-measure not only reflects industry concentration, but also differences in capital compensation, because capital compensation is part of the operating surplus.

Focusing on the possible inverted U-shape in retail trade and utilities, figure 2 shows the relationship between the *PCA* and real labour productivity growth for retail and utilities based on the estimation results of table 3. When all other explanatory variables are fixed, we find that when *PCA*=0, i.e. in case of complete competition, the labour productivity growth rate is some 0.2%. When the *PCA* increases markets become more concentrated, i.e. when some firms increase their market power at the expense of others, productivity growth doubles at certain levels of industry concentration and drops beyond that. For retail trade a maximum productivity growth rate is reached at a *PCA* of 0.28, while for utility services it is much higher at 0.43.

Hence, the optimal rate of industry concentration in retail trade is much lower than in utilities. The shape of the curve is also sharper for retail than for utilities, so the reaction of retail firms to changes in industry concentration is stronger than a similar change in concentration for utility firms.

Figure 2. Inverted U-shaped relation between industry concentration and real labour productivity growth (10 OECD countries, 1995-2001)



In order to evaluate these optimal *PCA's* table 4 compares the actual values for the *PCA* for all ten countries used in the estimations. The most competitive markets, i.e. lowest *PCA's* are found in the USA. Utility is the most noticeable exception, but also retail trade is less concentrated in Belgium and Italy than in the USA. We have to note that in this respect *PCA*'s are only indirectly linked to regulation in an industry, namely in their effect on the industry competition. Retail trade in Belgium or Italy may indeed consist much more of small companies than in the USA so that the whole retail industry is far less concentrated in these countries. It does not necessarily imply fewer regulations, because economies of scale in it self, i.e. concentration, is likely to have positive effect on productivity growth.

Table 4 – Industrial average price-cost averages between 1995-2001 for ten countries

	USA	Austria	Belgium	Germany	Finland	France	Italy	Netherlands	UK
Retail trade	0.20	0.20	0.13	0.20	0.36	0.29	0.15	0.26	0.22
Aviation	0.10	0.14	0.06	0.33	0.34	0.16	0.15	0.20	0.29
Communication	0.19	0.31	0.08	0.41	0.33	0.35	0.42	0.35	0.23
Utility	0.34	0.24	0.34	0.30	0.37	0.33	0.34	0.24	0.24
Inland transport	0.18	0.16	0.11	0.03	0.30	0.18	0.16	0.18	0.42

5. Concluding remarks

In the long run deregulation is associated with more productivity growth (Winston, 1998). There is also empirical evidence of an inverted U-shaped relationship between deregulation and innovation (Aghion, 2002). Since innovation is assumed to boost productivity growth, this gives rise to the possible existence of an inverted U-shaped relation between deregulation and productivity growth. This paper puts the existence of such a U-shape in some service industries to the test. Service industries, notably retail, aviation, telecommunication, electricity generation/distribution and trucking, have in recent years been exposed to large-scale deregulation. These deregulations are however extremely difficult to quantify over a longer period of time. Therefore the level of regulations is measured indirectly by the price-cost average (*PCA*), i.e. the ratio of operating costs and production. This *PCA* is an approximation of the price-cost margin, which measures industry concentration and hence competition. When prices equal marginal costs the price-cost margin equals zero and we have perfect competition, so no firm dominates another. The higher the price-cost margin, and hence the higher the *PCA*, the more monopoly power there is and hence the less concentrated the industry is.

Only in retail trade and utility services, we found evidence of an inverted U-shaped relation between regulation (*PCA*) and productivity growth. The optimal level of industry regulation in retail is much closer to a competitive market than for utilities. The U-curve for utilities is also much flatter than for retail, so the reaction of retail firms to changes in industry concentration is stronger than a similar change in concentration for utility firms.

There was no strong effect of regulation on productivity growth in any of the other industries. We do have to take account of the fact that the absence of this relation is likely caused by the fact that there are hardly appropriate data with which such a relation can adequately be tested at the industry level. The *PCA* we use is a crude measure, which in a broad sense relates to the extent of competition on the market that the industry operates on. Moreover, the level of detail for which data are available is still not sufficient to represent the state of regulation in a specific market. Industries beyond a 2-digit ISIC level, like telecommunication (ISIC 642), road freight (ISIC 6024) or electricity generation and distribution (ISIC 401) cannot be distinguished when price-cost averages are calculated, while these industries do face specific measures of deregulation.

For a better understanding of the relation between regulation and economic performance at the industry level, to which these (de)regulation measures are directed we need higher quality

data than currently available. First, the OECD International Regulation Database, which is the sole source for internationally comparable regulation data at industry level, needs to be updated for more years. Second, performance indicators need to be available at the exactly same level of industrial detail as the regulation indicators. Third, deregulation is a lengthy process that does not have instantaneous effects (Winston, 1998), so a sufficient number of observations in time of both regulation and performance are essential when a relationship between the two is being studied.

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