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Network Sectors Regulation Impact

on Innovation Process and Employment Rate

Océane VERNEREY and Jimmy LOPEZ

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« ETE – Equipe d'Economie des Territoires et de l'Environnement »

Pôle d'Economie et de gestion - 2 boulevard Gabriel - BP 26611 - F 21066 DIJON CEDEX
Secretariat.ledi@u-bourgogne.fr - Tél : 03 80 39 54 41 – Fax : 03 80 39 54 43

ledi.u-bourgogne.fr

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Abstract

We investigate, in a consistent framework, both the innovation and labor market effects of network sector regulations. Their estimated impact on the innovation process is based on the Community Innovation Survey and a system of equations modelling the firm's choice of R&D expenditure, propensity to innovate and performance. We then examine their impact on the labour market using the European Union Labour Force Survey. Using a sample of 330,604 firms and 8,594,055 individuals over the period 1998-2016 and 5 countries that have undergone important reforms (Czech Republic, Hungary, Portugal, Slovakia and Spain), we find a strong negative effect of network regulations on firm performance and individual employment probability. According to our estimates, the overall impact of the implemented reforms would be an average increase of 12.8% in the employment probability, almost entirely explained by an increase in firm performance.

I. Introduction

The role of competition in the economy and the policies that affect it have been widely debated. Among these policies, there is a rich literature on the effects of regulation that limits competition through entry barriers or direct government intervention in the network sectors, i.e. energy, transport and communication services (see, for example, Barone & Cingano, 2011, or Bourlès et al., 2013). Most of this literature uses OECD indicators measuring the extent to which regulation is anti-competitive and then finds, using cross-country industry panel data, a negative impact of these indicators on productivity, with a strong effect on unregulated sectors via the use of inputs produced by the network sectors.

There are also papers that investigate the impact of anti-competitive regulation on innovation, again using cross-country industry panel data, but with ambiguous results: Cette, Lopez and Mairesse (2017) find a negative effect on R&D investment, while Amable, Ledezma and Robin (2016) find mixed results on the number of patents, with sometimes positive effects for countries that are leaders in a given industry. At the same time, only a few papers investigate the employment effects of these regulations and find a detrimental impact (see, for example, Nicoletti and Scarpetta, 2005).

The purpose of our paper is twofold. First, to deepen the understanding of the impact of network regulation on innovation by estimating a system of equations modelling the innovation process using firm-level data on R&D investment, but also on product innovation and turnover growth. We then analyse the impact on employment using individual-level data. In particular, we examine the extent to which these employment effects can be explained by the effects of regulation on the innovation process. These two original contributions in a consistent framework allow us to provide policy recommendations that take into account both the effects on firm performance and on people's employment.

Our investigation of the effects on the innovation process is based on the rich literature following the seminal paper by Crépon, Duguet and Mairesse (1998), called CDM. The CDM approach is at once a system of equations modelling the firm's choice of R&D expenditure, its propensity to innovate and the impact of innovation on firm performance, and a set of estimation methods to deal with various endogeneity issues. The original CDM uses data from the 1990 French Community Innovation Survey (CIS), which provides numerous variables on the innovation process at the firm level. Our paper uses the CIS waves from 1998 to 2016 for 5 countries: Czech Republic, Hungary, Portugal, Slovakia and Spain.

Our study of the impact of regulation on employment is based on Vernerey and Lopez (2024). As workers are mobile across sectors, we use the European Labour Force Survey (LFS) individual database to examine the regional effects of regulation. The LFS database provides harmonised information for people aged 15 and over in all European countries. Our identification assumption is that the impact of a sectoral regulation on a regional labour market increases with the size of the sector in the region. In this paper, we introduce into the estimated employment equation the impact of network regulation on firm innovation and performance as predicted by the CDM approach.

Our main estimation sample covers the period 1998-2016 for 5 countries (Czech Republic, Hungary, Portugal, Slovakia and Spain), including 330 604 firm observations from 9 market sectors and 8 594 055 individual observations from 44 regions. The 5 countries available for our estimation sample have in common that they have implemented important network regulation reforms during our estimation period.

We find significant negative effects of anticompetitive network regulation: (i) on R&D expenses, propensity to innovate and firm performance, measured by turnover growth, within the regulated sectors; (ii) on firm performance of sectors that intensively use intermediate inputs from the network sectors; (iii) on people's employment probability, directly and through the effects on firm innovation and performance; and (iv) the employment effect is higher for the most vulnerable sub-samples, i.e. the low-skilled, the youngest and the oldest. According to our estimates, the effects of the reforms implemented in the five countries over the period 1998-2016 are substantial. The overall impact on the employment rate would be an increase of 12.8 percentage points, almost entirely explained by the impact of regulation on innovation and firm performance.

The paper is organised as follows. Section 2 presents our data. Section 3 presents the estimated model and our estimation methodology. Section 4 presents our main estimation results and the simulated effects, highlighting the economic significance of these results. Section 5 concludes the paper.

II. Data

Our investigation uses three main data sources with different statistical units: (i) the OECD Regulation database and Input-Output tables on sectors, (ii) the Community Innovation Survey database on firms, and (iii) the Labour Force Survey database on individuals. By merging these data sources, our cleaned estimation sample covers the period 1998-2016 and only 5 countries: Czech Republic, Hungary, Portugal, Slovakia and Spain. These countries are quite different, but have in common that they have implemented important reforms of network regulation during our estimation period. Our first step focuses only on the innovation process and its estimation sample includes 330 604 firm observations from 9 market sectors.[1] Then, in a second step, our sample to investigate the employment effects includes 8,594,055 individual observations from the 44 administrative regions of the 5 countries. This section presents these data sources and our calculations and descriptive analyses.

[1] The 9 sectors in sample are: “Mining and quarrying”, “Manufacturing”, “Energy”, “Construction”, “Wholesale and retail trade”, “Transport, storage and communication”, “Accommodation and food services”, “Financial and insurance activities”, “Professional services activity”.

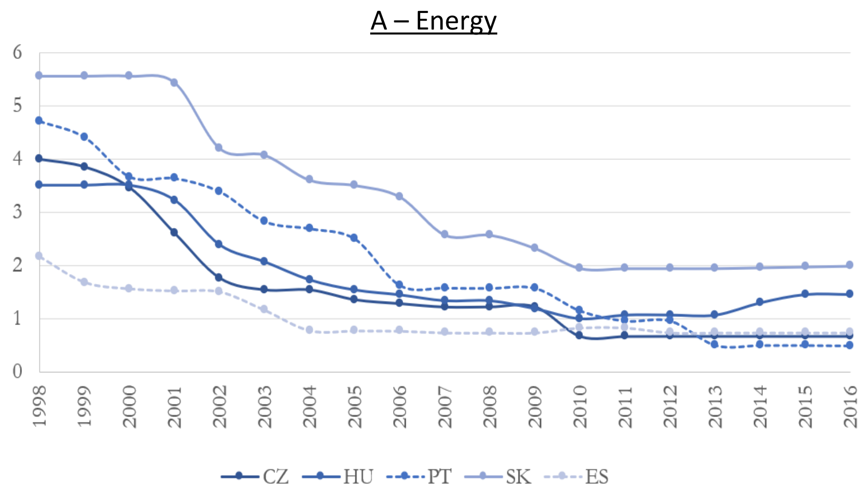
OECD indicators of anti-competitive regulation

The OECD regulation database provides indicators of anticompetitive regulation for all OECD countries, based on detailed information on laws, rules and market settings, to measure the extent to which competition and firms' choices are restricted when there is no a priori reason for government intervention, or when regulatory objectives could plausibly be achieved by less coercive means. The regulatory constraints on competition taken into account could be direct government intervention as well as barriers to entry (see Vitale et al., 2020, for details). The values of these indicators range from 0 to 6, with 0 representing the most pro-competitive regulation.

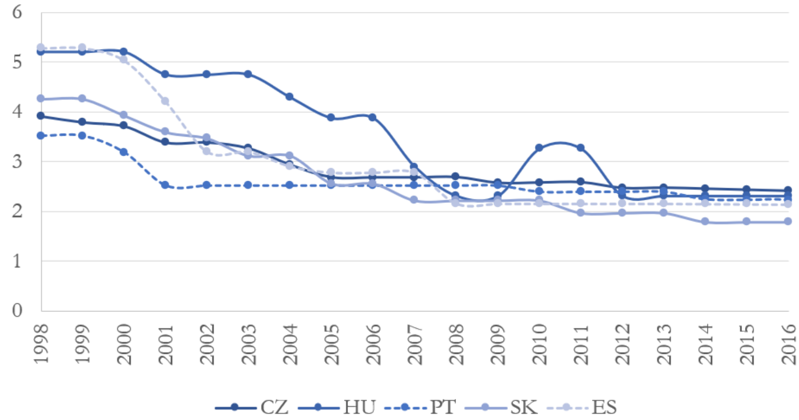
The OECD regulation indicators cover several sectors: (i) the network sectors, including energy (gas and electricity), transport (rail, road and air) and communications (post, fixed and telecommunications); (ii) retail distribution; and (iii) professional services (accountants, lawyers, notaries, architects, engineers, real estate agents). This paper focuses on the regulation of the first three network sectors, as many pro-competitive reforms have been implemented in the countries in our sample.

Chart 1 shows the impact of these reforms on the values of the OECD indicators. At the beginning of our sample estimation period, the regulation of the network sectors was high according to these indicators, but with considerable heterogeneity across countries. There is then a rapid convergence towards very pro-competitive regulation for all countries in the communications sector in the first half of the period. We also observe a significant fall in the indicators for the energy and transport sectors, but this phenomenon is more heterogeneous across countries and some restrictions on competition remain at the end of the period.

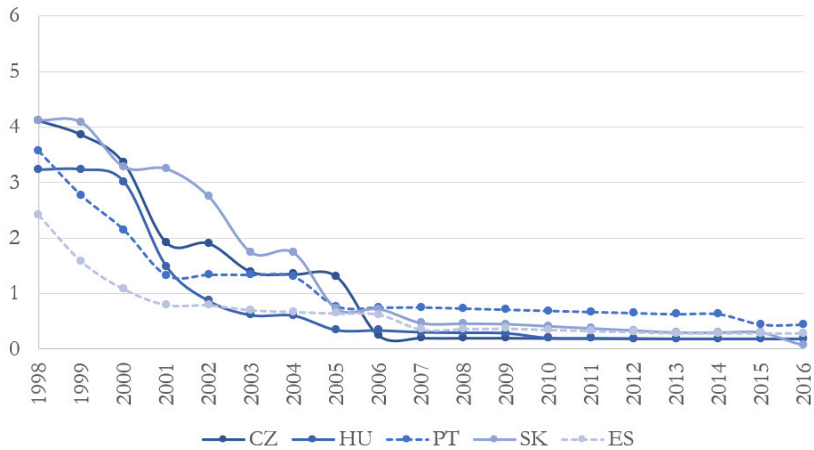
Chart 1 – OECD indicators of network sectors regulation
Scale 0-6, 0 for the most procompetitive regulation



B – Transport



C- Communication



Community Innovation Survey

Our firm-level variables come from the European Community Innovation Survey. This is a harmonised survey covering firms in each Member State of the European Union as well as Norway and Iceland. However, the survey database provided by Eurostat covers only nine countries. Of these, two are not members of the OECD and two others have recently joined, so we have CIS data and OECD regulatory indicators for a significant period for only five countries: Czech Republic, Hungary, Portugal, Slovakia and Spain. Each wave of the survey corresponds to three years, with some variables measured for the whole period or only for the last year, and some also for the first year. We use 8 waves covering the period from 1998 to 2016. Firms from all market sectors are surveyed, except for the sector 'Agriculture, forestry and fishing'.

The CIS database provides many variables related to the innovation process.[2] In this paper, our main measures of this process are: (i) innovation input, calculated as the ratio of R&D expenditure to

[2] The CIS database for research provided by Eurostat is anonymised. As a result: (i) we are not able to follow firms over time; (ii) some variables are excluded; and (iii) the values of others are aggregated at a higher level. In particular, the number of employees is not reported with a continuous variable but in three classes.

turnover for firms that report internal continuous R&D expenditure;[3] (ii) innovation output (hereafter referred to as innovation intensity), calculated as the share of sales of new products in turnover over the three-year period, where a new product is a product that is new to the market, new to the firm, or substantially improved; and (iii) firm performance, calculated as the growth of the firm's turnover over the wave period.[4]

Table 1 shows for each country: (i) the share of firms that report internal continuous R&D expenditure; (ii) the share of firms that have engaged in product innovation, for R&D firms and non-R&D firms; and (iii) the average growth of firms' turnover, for firms that have engaged in product innovation or not. We observe significant heterogeneity across countries for the three variables. In particular, Hungary and Slovakia have the lowest shares of R&D firms and product innovators. However, if we focus only on R&D firms, the share of product innovators in these two countries is comparable to the other countries. In fact, we observe strong links between the three variables: (i) most R&D firms engage in product innovation, while non-R&D firms hardly do so; and (ii) the turnover growth of firms that are product innovators is significantly higher than that of non-product innovators, regardless of the country.

Table 1 – Descriptive analysis of the innovation process

	Share of R&D firms	Share of product innovators			Turnover growth		
		All firms	R&D firms	Non-R&D firms	All firms	Product innovators	Non-Product innovators
Czech Rep.	17%	31%	87%	20%	18%	20%	18%
Spain	17%	22%	69%	12%	11%	14%	10%
Hungary	7%	17%	82%	12%	14%	18%	13%
Portugal	13%	35%	85%	27%	11%	15%	9%
Slovakia	7%	16%	80%	11%	19%	24%	19%
Average	12%	24%	81%	16%	15%	18%	14%

Our estimated equations use also other firm level variables: the number of employees (in three classes), group membership, sales market (local, national or international), market share, innovation cooperation between firms, public financial support for innovation from central governments or European Union. See Appendix A for a more detailed descriptive analysis of the CIS variables.

<u>European Union Labor Force Survey</u>

The European Union Labour Force Survey (LFS) database provides harmonised information for people aged 15 and over in all European countries up to 2017.[5] Our analysis uses the employment status of the person and the following individual characteristics: age, education, gender, sector and region. We distinguish 10 age groups, and education is divided into three levels: (i) high, with at least some tertiary education; (ii) medium, with upper secondary education; and (iii) low. These three educational levels correspond respectively to 15.4%, 45.5% and 39.1% of the estimation sample. Chart 2 shows the overtime employment rates of the country sample. There is strong heterogeneity in the level and dynamics of the employment rate, especially after the 2008 financial crisis. On average, the

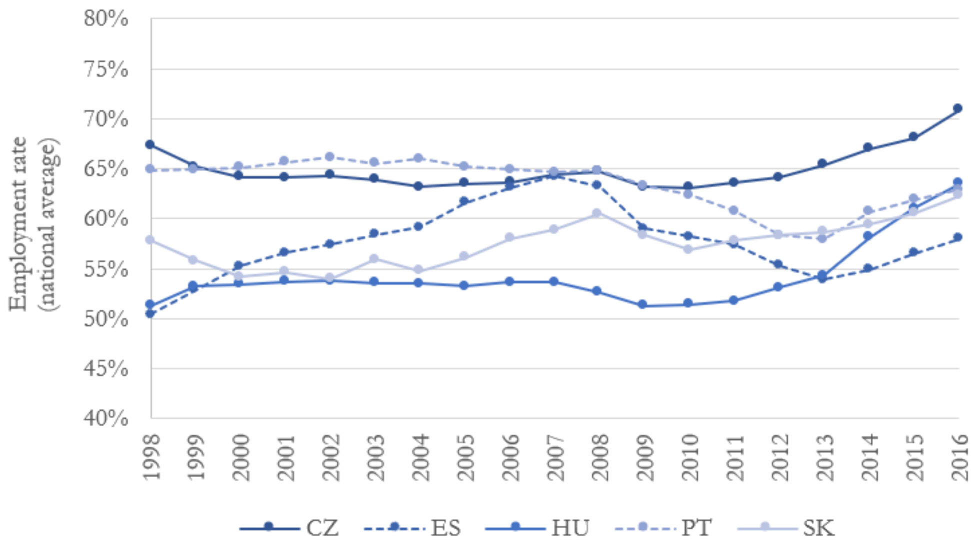
[3] R&D expenditure is measured in the last year of the wave, while turnover is measured in the first and last years. To compute the R&D ratio, we use the first year's turnover to avoid endogeneity due to simultaneity.

[4] The literature often uses labour productivity to measure firm performance, but we have neither a measure of value added for the five countries in our sample nor the number of employees as a continuous variable.

[5] As with the CIS, the EU-LFS research database provided by Eurostat is anonymised. As a result: (i) we are not able to follow individuals over time; (ii) some variables are excluded; and (iii) the values of others are aggregated at a higher level. In particular, localisation is only at NUTS2 level, which corresponds to administrative regions.

employment rate increased by 11.3% over the period (equivalent to an increase of 5 percentage points) despite the financial crisis.

Chart 2 – Employment rate, country*year sample averages



III. Model and estimation method

In this section, we first present our model of the innovation process based on firm data. We then introduce the OECD network regulation indicator into this model. Next, we present the equation used to investigate the employment effects of regulation on individual data. Finally, we present our estimation methods.

The innovation process

To estimate the innovation process, we use the model from Vernerey (2024), inspired by Crépon, Duguet and Mairesse (1998) but adapted to our data. We explain first the firms' decision of R&D expenses, then the innovation intensity and finally the firm performance in term of turnover growth, according to the following equations:

$$ln\left(\frac{RD_f}{Turn_f}\right) = \sum_k \left[x_f^{1,k} b^{1,k}\right] + \phi_{cw}^1 + \phi_{sw}^1 + \phi_{cs}^1 + u_f^1$$

$$ln(I_f) = ln\left(\frac{RD_f}{Turn_f}\right) \times b^{RD} + \sum_k \left[x_f^{2,k} b^{2,k}\right] + \phi_{cw}^2 + \phi_{sw}^2 + \phi_{cs}^2 + u_f^2$$

$$Turn_f^g = ln(I_f) \times b^I + \sum_k \left[x_f^{3,k} b^{3,k}\right] + \phi_{cw}^3 + \phi_{sw}^3 + \phi_{cs}^3 + u_f^3$$

Where the dependent variables are: RD_f the amount of R&D expenses of firm f; *Turn* firm's turnover; I the intensity of product innovation (the share of new product in turnover); and $Turn^g$ turnover growth over the wave, calculated as the log difference between the turnover last and first years of the wave. For equation i, $x^{i,k}$ is the set of covariates, $b^{i,k}$ the estimated parameters, ϕ_{cw}^i, ϕ_{sw}^i and ϕ_{cs}^i country*waves, sector*waves and country*sector fixed effects, and u^i the residuals. In each equation the set of covariate includes the number of employees (in three classes) and a dummy for group membership. The R&D equation includes also the firm's market share (in log) and dummies for the public financial support for innovation from central governments or from European Union.

Introduction of the network regulation indicator

A lack of competition may impact directly firms' sales, but it may also reduce the incentives to innovate according to the endogenous growth models (see Aghion and Howitt, 2008, for a review). Therefore, we must introduce the OECD anticompetitive network regulation indictors in all the step of the innovation process for the network sectors. Moreover, the empirical literature also finds a strong effect of anticompetitive regulation on the sectors using intermediate inputs produced by the regulated sectors (see for instance Barone and Cingano, 2011). Indeed, the lack of competition allows producers of intermediate inputs to capture part of the rent created in the sectors using these inputs, thus reducing incentives to innovates. It could also reduce the competition in these last sectors (see Cette, Lopez and Mairesse, 2016 and 2019). The network sectors are important producers of intermediate inputs, so the effect on the other sectors could be strong.

In order to take into account of the network regulation effects on the other sectors, we calculate the following variable:

$$NR_{scw}^{up} = \sum_{j} int_{sj} \times NR_{cw}^{j} \tag{a}$$

Where NR^{up}_{scw} is our measure of the importance of the knock-on effect or burden of the network sectors regulation on the sector s in the country c and wave w. This effect depends on NR^j the regulation in the network sector j (energy, transport or communication) and of int_{sj} the intensity of utilization by the sector s of intermediate goods produced by the sector j. The regulation indicators are available yearly, but not the CIS data, therefore we use the indicator value of the first year of the wave. To calculate intensity of utilization, we use the ratio of intermediate input consumption from sector j over the production of the sector s, using the USA 1997 Input-Output Table. We use this table rather than country*wave specific values because regulations may also have an effect on the intensity of utilization of intermediate goods, thus making more difficult to interpret the NR^{up} changes. As there is a strong persistence in the Input-Output tables over time and across countries, the USA 1997 table is a good proxy of country*year specific tables.

Finally, we estimate the following equations:

$$ln\left(\frac{RD_f}{Turn_f}\right) = d_f^{net} \times \overline{NR}_{cw} \times b^{NR,1} + NR_{kcw}^{up} \times b^{NR^{up},1} + \sum_{k}\left[x_f^{1,k} b^{1,k}\right] + \phi_{cw}^1 + \phi_{sw}^1 + \phi_{cs}^1 + u_f^1 \tag{1}$$

$$\begin{aligned} ln(I_f) = {} & d_f^{net} \times \overline{NR}_{cw} \times b^{NR,2} + NR_{kcw}^{up} \times b^{NR^{up},2} + ln\left(\frac{RD_f}{Turn_f}\right) \times b^{RD} + \sum_{k}\left[x_f^{2,k} b^{2,k}\right] + \phi_{cw}^2 \\ & + \phi_{sw}^2 + \phi_{cs}^2 + u_f^2 \end{aligned} \tag{2}$$

$$\begin{aligned} Turn_f^g = {} & d_f^{net} \times \overline{NR}_{cw} \times b^{NR,3} + NR_{kcw}^{up} \times b^{NR^{up},3} + ln(I_f) \times b^I + \sum_{k}\left[x_f^{3,k} b^{3,k}\right] + \phi_{cw}^3 + \phi_{sw}^3 \\ & + \phi_{cs}^3 + u_f^3 \end{aligned} \tag{3}$$

Where d_f^{net} is a dummy equal to one for a firm in the network sector and $\overline{NR}_{cw}$ the country*year average value of the three network sectors regulation indicators.[6] b^{NR} is the impact of the network regulations within this sector, while b^{NRup} allows testing whether the effect on the other sectors is growing with the intensity of use of the intermediate inputs from the regulated sector.

<u>Network regulation impact on employment</u>

As anticompetitive regulations are implemented at the sectoral level, most studies investigating their effects use cross-country-sector panel data. However, workers are mobile between sectors, so we could miss the full effect of regulation if we use sector data. Vernerey and Lopez (2024) argues that the preferred level of analysis for the impact on employment would be local labor markets, i.e., geographical areas within which most workers reside and work, and in which establishments can find most of the labor force needed to fill the jobs offered.

The anonymized EU-LFS database provided by Eurostat is available only at the NUTS2 level, which is more aggregated than local labor markets. It induces a reduction of data variability, but this localization level is still useful because our identification strategy requires only the lack of workers' mobility between the geographical units and a very small share of the workers in our sample were in another region the previous year: 0.6% in Czech Republic and Hungary, 0.3% in Estonia, 1.2% in Portugal (this information is not available for Slovakia).

Our identification assumption is that the impact of a sector regulation on a regional labor market grows with the size of this sector in the region, measured by the share of workers in this industry among the whole set of workers in this region. Therefore, to estimate the impact of network regulation on employment, we calculate the following variable:

$$NR_{rct}^{emp} = \sum_{j} \omega_{rj} \times NR_{ct}^{j} \tag{b}$$

Where NR^{emp}_{rct} is our measure of the importance of the network regulation burden for employment on the region r, in country c and year t. This effect depends on NR^j the regulation in the network sector j (energy, transport or communication) and of ω_{rj} the share of region r workers engaged in the regulated sector j. As for the intensity of use of regulated intermediate inputs, we use in this formula regional workers share that are fixed over time in order to interpret changes in NR^{emp} as changes in network regulations only. We use shares computed over the first five years available in the LFS database for each country. These shares are good approximations of the yearly in-sample shares because of the persistence of regional specialization in regulated industries. Indeed, using yearly in-sample shares we find that regional fixed effects explain 70% of the variability of these shares.

As already mentioned, we may expect that network regulation may have an impact on firm performance, which may influence employment. To estimate this effect, we use the same formula as above but applied on firm's turnover growth:

$$Turn_{rct}^{g,emp} = \sum_{s} \omega_{rs} \times Turn_{ct}^{g,s} \tag{c}$$

Where $Turn^{gs}_{ct}$ is the turnover growth average over industry s, country c and year t.

[6] We have chosen to use the averages over the three network sectors for consistency with the analysis of the impact on employment, as these three sectors are not separated in the LFS database.

Finally, the estimated equation for the network regulation impact on employment is the following:

$$EMP_i = NR_{rct}^{emp} \times b^{NR^{emp}} + Turn_{rct}^{g,emp} \times b^{Turn^{g,emp}} + \sum_k \left[x_f^{4,k} b^{4,k}\right] + \phi_{ct} + \phi_r + u_i^4 \tag{4}$$

Where EMP_i is a dummy variable equal to one if individual *i* works; ϕ_{ct} and ϕ_r are respectively country*year and regional fixed effects.

To study the relationship between employment and network regulation in depth, we also investigate effects on people's activity and unemployment status. Moreover, we estimate the effects of the network regulation and firm turnover for the whole sample and then the specific effects for the most vulnerable sub-samples: the low educated, youngest and older workers.

<u>Estimation methods</u>

There are several potential endogeneity sources we must take into account when estimating equations (1) to (4). One is the selection bias in equation (1) and (2). Indeed, the logarithm of R&D expenses is measured only for firms investing in R&D and the innovation intensity only for firms innovating in products.[7] To deal with this issue, we use the Tobit type II estimation method to estimate simultaneously the equations (1) and (2) with the following corresponding selection equations:

$$d_f^{RD} = \sum_k \left[x_f^{1\prime,k} b^{1\prime,k}\right] + \phi_{cw}^{1\prime} + \phi_{sw}^{1\prime} + \phi_{cs}^{1\prime} + u_f^{1\prime} \tag{1'}$$

$$d_f^{I} = d_f^{RD} b^{dRD} + \sum_k \left[x_f^{2\prime,k} b^{2\prime,k}\right] + \phi_{cw}^{2\prime} + \phi_{sw}^{2\prime} + \phi_{cs}^{2\prime} + u_f^{2\prime} \tag{2'}$$

Where $d^{RD}{}_f$ is a dummy equal to 1 if firm *f* report R&D expenses and d^I is a dummy equal to one if the firm have introduced a new product during the period of the wave. As for equation (1) to (3), the set of covariates in these equations include the number of employees (in three classes) and a dummy for group membership. Dummies for the sales market (local, national, international) are introduced specifically in the R&D selection equation (1'), as in the seminal CDM, and a dummy for innovation cooperation between firms is introduced in the product innovation selection equation (2').[8]

There are still two other endogeneity potential sources in the innovation process: (i) a possible simultaneity between R&D expenses, innovation intensity and firm performance; and (ii) the difficulty to measure innovation input and output. To deal with these issues, we use the Full Information Maximum Likelihood (FIML) estimator to estimate simultaneously the system of equation, thus maximizing the likelihood function of the system.[9]

[7] Appendix A shows strong differences between firms investing or not in R&D, as well as between firms innovating in product or not. It suggests that there is also strong differences on the unobservable variable, so the endogeneity bias du to selection could be significant when using the OLS estimator.
[8] The Tobit type II estimator could be consistent even if there is no variable specific to the selection equation, but the identification of parameters would then be based only on the assumption of normality of the residuals.
[9] In other words, the likelihood function of the R&D step is introduced in the function of the innovation step and the result is introduced in the function of the performance step. It results to a single likelihood function that we maximize. For more information on the estimation methods of the innovation process and find various robustness tests, see Vernerey (2024).

There is maybe also simultaneity between employment and turnover growth in equation (4). To deal with this issue, we calculate the predicted values of turnover growth according to equation (1) to (3) estimates, then we use these predicted values to compute the variable $Turn^{g,emp}$ from formula (c) and the result is included in equation (4).[10]

A last issue should be taken into account. Equations (1) to (3) are estimated on firm data, but our main explanatory variables on regulation are calculated at the industry level. In the same way, equation (4) is estimated on individual data, but our main explanatory variables on regulation burden are calculated at the regional level. Strong clustering issues may be expected, leading to the precision of the estimations being overstated. Therefore, we present in the next section "clustered" standard errors, i.e., standard errors corrected according to the « Moulton factor » taking into account the within-industry/region correlations of the residuals and explanatory variables.

IV. Main estimates and simulations

This section presents first the estimated effects of the main explanatory variables in equation (1) to (4). The values of the estimated coefficients of the network regulation indicators are difficult to interpret directly, so we interpret only the sign and statistical significance of the results when commenting the regulation coefficients of the estimation tables, then we provide a simulation that give some economic significance to these results.

Main estimates

Table 2 presents the estimated marginal effects calculated from the FIML estimation results of the system of equations (1) to (3). We find a positive and significant effect on R&D intensity of public financial support for innovation from central governments as well as from European Union. On the contrary, firms with an important market share on the first year of a wave have a smaller R&D intensity. It suggests that an important market share reduces the incentives to innovate. Concerning our dependent variables, we find that a 100% increase of R&D expenses would lead to a 18% increase of innovation intensity (i.e., the share of new product in the turnover), then to a 0.36% higher turnover growth. There is a negative effect on firm's R&D, innovation and turnover growth of network regulation within sector ($\overline{NR}$) and on the other sectors (NR^{up}). The within sector effect is also always statistically significant and the effect on the other sector is statistically significant for firm's turnover growth, but our estimates of the effect on R&D and innovation intensities on the other sectors lack of precision.

[10] The innovation intensity and turnover growth predictions are calculated for the CIS waves. We use the interpolation method to calculate year values.

Table 2 – Estimated marginal effects of the innovation process

Estimation method: FIML estimation of the system of equation, using the Tobit type II model for the R&D and innovation equations

	R&D intensity (log)	Innov. intensity (log)	Turnover growth
Market power (log)	-0.359*** [0.011]		
Public financial support – Central Government	0.434*** [0.017]		
Public financial support – European union	0.335*** [0.033]		
R&D intensity (log)		0.183*** [0.017]	
Innov. intensity (log)			0.020*** [0.002]
Network regulation indicator	-0.309* [0.164]	-0.381** [0.183]	-0.104** [0.042]
Network regulation burden indicator	-3.297 [2.871]	-0.772 [3.018]	-3.423*** [0.807]
Observations		330,604	

*** p<0.01, ** p<0.05, * p<0.1; Clustered standard errors in brackets; Cluster: Country*sector*wave; Included fixed effects: country*wave, sector*wave and country*sector.
Other control variables included: number of employees in three classes and group membership for each equation

Table 3 presents the estimated marginal effects on employment, activity and unemployment of network regulation and firm performance. This last variable is calculated according to Table 1 estimation results and formula (c). It allows calculating the effect of network regulation which passe through firm performance. The results are shown when estimated on the whole sample or on the most vulnerable sub-sample: the low educated people or youngest or oldest.

The estimated effects of the control variables are presented in Appendix B.[11] We find that well-educated middle-aged men have the highest activity and employment probability. Highly educated men are also less likely to be unemployed than women and poorly or averagely educated workers. The unemployment probability is the lowest for older workers, for whom the propensity to leave the labor market is probably high when they lose their jobs.

On the whole sample, we find a significant negative impact of the regulation burden on the activity probability but not on unemployment, leading to a negative impact on employment probability. On the contrary, the firm performance has a significant negative impact on unemployment probability but no significant impact on activity, leading to a positive impact on employment probability. These results suggests that the network regulation affect unemployment probability through firm performance but activity probability through a different channel.

The network regulation effect on employment probability is strongly higher for the low educated workers and the oldest, through a high negative effect on activity and even a positive slightly significant impact on unemployment for the low educated. For these two sub-samples the firm performance effects are quite close to the effects on the whole sample. For the youngest, we find no direct effect

[11] Appendix B shows also estimation results taking into account of innovation intensity. When introduced simultaneously with firm performance, the innovation intensity effect is sometimes statistically significant but very small.

of network regulation, but the firm performance effects are stronger, with even a positive significant effect on activity probability, meaning that all the regulation effects go through firm performance and that this effect may be high. We need simulation to give more economic significance to these results.

Table 3 – Estimated marginal effect of network regulation

Note: for the unemployment equation the sample is reduced to the active population, while it is the working age population for employment and activity equations.

Dep. var.	Employment		Activity		Unemployment	
	Network regulation burden	Firm performance burden	Network regulation burden	Firm performance burden	Network regulation burden	Firm performance burden
	(1)		(2)		(3)	
Whole sample	-0.094*	0.398***	-0.146***	0.094	-0.058	-0.405***
	(0.052)	(0.083)	(0.038)	(0.058)	(0.056)	(0.094)
Observations	8,594,055		8,594,055		5,664,706	
	(4)		(5)		(6)	
Low education	-0.441***	0.404***	-0.437***	0.145**	0.093*	-.545***
	(0.060)	*(0.095)*	*(.039)*	*(.058)*	*(.053)*	*(.110)*
Observations	8,594,055		8,594,055		5,664,706	
	(7)		(8)		(9)	
Age 17 to 26	0.082	0.670***	0.026	0.291***	-0.064	-0.538***
	(0.058)	*(0.093)*	*(0.046)*	*(0.070)*	*(0.056)*	*(0.095)*
Age 57 to 66	-0.745***	0.283***	-0.727***	0.065	-0.068	-0.341***
	(0.059)	*(0.087)*	*(0.047)*	*(0.064)*	*(0.058)*	*(0.094)*
Observations	8,594,055		8,594,055		5,664,706	

Fixed effects: Country, region, year and country*year; Control variables: age, education and gender
Clustered standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Simulations

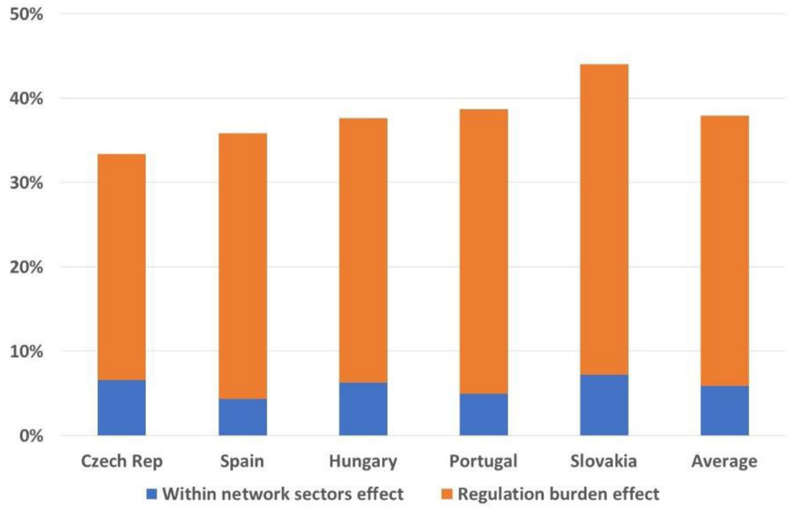
To give economic significance to the effects of network regulations, we calculate for each country the long-term effects of reforms implemented on the 1998-2016 period, using the changes observed in the OECD network sectors regulation indicators. As shown in Chart 1, these reforms were important for all the countries in our sample. We first calculate the turnover growth effects, then the effects on employment.

The turnover growth effect is calculated according to Table 2 estimates and taking into account of the knock-on effect on the other sectors thanks to formula (a). It gives us sector effects that we weight by the number of firms by sectors to calculate average effects for each country.[12] Chart 3 shows these simulated effects of reforms on turnover growth. The differences between countries come from the size of the reform in each country but also, to a lesser extent, to the relative importance of the different sectors in the sample. The total impact of the reforms on the long-run would be an increase of the turnover growth of 38% on average. As the average turnover growth in our sample is of about 15%, the reform effect corresponds to a 5.7 percentage point increase. The within network sectors effect account for 16% of the total effect, so an increase of 5.9% (0.9 percentage points) of the average turnover growth, while the network sectors represent 19% of the firms in our sample. The within network sectors effect shown in Chart 3 includes the regulation effects through R&D and then

[12] These average effects may differ from country effects as our sample exclude the agricultural and non-market sectors.

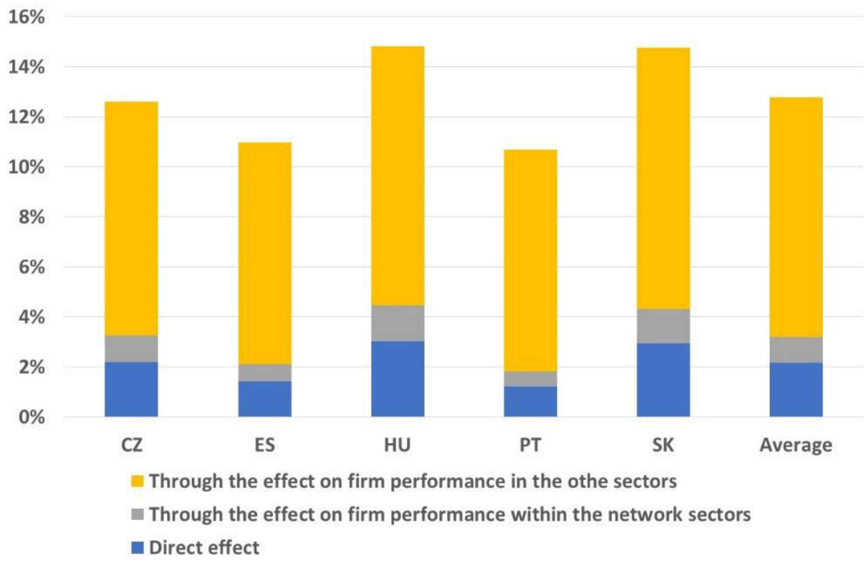
innovation intensity, but this channel account for only 7% of the within sector effect on turnover growth.

Chart 3 – Average impact of the 1998-2016 network regulation reforms on firm turnover growth



The employment effect of reforms is calculated according to Table 3 estimates, formula (b) for the 'direct' effects of regulation and formula (c) to take into account of the reform effects on firm performance already calculated. We get results at the regional level, that we aggregate at the national level using the number of working age people of each region. Chart 4 presents the simulated effects of the network reforms on employment through the different channels. The total impact of the reforms would be of 12.8% on the long-run. This is a huge effect, that should be looked at in the context of very important reforms implemented in countries with relatively low employment rate but that have experienced a 11.3% increase of the employment probability on the sample period despite the 2008 financial crisis. Most of this total impact come from the regulation effect on firm performance. The effect which is not explained by firm performance, called the 'direct' effect in Chart 4, would leads to a 2.2% increase of the employment rate on the long run. Consistent with Chart 3 results, the employment impact through the within network sectors effect on firm performance is relatively small, 1%. The most important employment impact is explained through the effect of network regulation on the sectors using the network intermediate inputs: it should lead to a 10.6% increase on the long run.

Chart 4 – Average impact of the 1998-2016 network regulation reforms on employment probability



Finally, we run the same calculation of the employment effects of implemented reforms, but for the most vulnerable sub-samples. The average effect on employment probability is always higher than for the whole sample. The most important impact is for the oldest, with an increase of 25% of the employment probability, followed by the low educated and the youngest, with a 21% and 16% increase respectively.

V. Conclusions

This paper is the first to investigate the impact of network regulations on both the innovation process and the labor market in a consistent framework. We find that network regulations have a significant negative impact on employment, which is almost entirely explained by their effects on firm performance. It was not obvious: the creative destruction effects induced by an increase in firms' innovation and performance could also have led to job creation and destruction and thus to more congestion in the labour market. However, this strong estimated effect should be put into perspective: it corresponds to effects in countries that have experienced impressive reforms in the network sectors.

These results should be complemented in at least two ways. First, by using data from other countries. This would make it possible to check whether or not the results are comparable across countries, but also to study the retail and professional services regulation effects. The data variability of the OECD indicators for these two sectors was too small in our sample of five countries to be able to identify their effects. The lack of countries in our sample is due to the availability of data in Eurostat's CIS database. However, the CIS is implemented in every Member State of the European Union. Therefore, it may be possible to include more countries in the same database in the near future.

Second, in this paper we use the OECD sector-level regulatory indicators, which are based on the average of hundreds of sub-indicators. This aggregation limits our policy recommendations on regulatory design. The econometric tools are not useful to identify the effects of these sub-indicators separately, while machine learning methods could provide interesting insights into the relationships between these sub-indicators, firm performance and employment probability.

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Appendix A: CIS Data descriptive analyses

This section further elaborates on the descriptive analysis of our data from the Community Innovation Survey (CIS). Table A shows the average values of all variables of the estimated model from the CIS database for four subsamples of our estimation sample: product innovators/non-product innovators, R&D firms/non-R&D firms. It shows strong sample differences for the exogenous variables: the shares of group members, sellers on international markets and large firms as well as the market share are much higher for product innovators and for R&D firms. This is also the case for the shares of innovation cooperation and financial support, but obviously non-innovative firms can't cooperate or get financial support. We also see that there is a strong relationship between investment in R&D and product innovation. Finally, we also observe that turnover growth is higher for product innovators and R&D firms.

Table A: CIS database variable sub-sample averages

	R&D firms	Non-R&D firms	Product innovators	Non- product innovators
Exogeneous dummy variables				
Group membership	47,90%	27,01%	42,85%	26,05%
Sales market: only local	3,88%	22,86%	6,97%	24,21%
Sales market: only local or national	18,54%	32,45%	22,32%	32,96%
Sales market: local, national and international	77,57%	44,56%	70,69%	42,69%
Innovation cooperation	50,31%	7,44%	40,38%	5,32%
Government financial support for innovation	36,15%	3,20%	23,76%	3,09%
European Union financial support for innovation	13,02%	1,63%	9,83%	1,24%
<50 employees	41,94%	61,66%	46,82%	62,53%
[50 ; 250] employees	35,57%	27,82%	33,84%	27,41%
>250 employees	22,23%	9,74%	19,11%	9,20%
Exogeneous continuous variables				
Market share[(a)]	48,23%	14,74%	42,32%	12,50%
Selection variables				
R&D firms	100,0%	0,00%	45,91%	4,91%
Product innovators	74,86%	15,35%	100,0%	0,00%
Endogeneous variables				
R&D intensity	8,13	0,00	3,71	0,41
Innovation intensity	27,68	5,06	34,82	0,00
Turnover growth	115,31	110,96	114,89	110,56

(a): The market share variable is calculated using CIS data only and is therefore a poor proxy for the market power of firms.

Appendix B: Estimated effects of control variables

While Table 3 in Section IV "Main estimates and simulations" shows the estimated impact of regulation, this appendix shows the marginal effects of the control variables estimated from the same equation. These control variables are taken from the European Union Labour Force Survey database. As already mentioned in section IV, we find that well-educated middle-aged men have the highest activity and employment probability. Highly educated men are also less likely to be unemployed than women and low or medium educated workers. The probability of unemployment is lowest for older workers, who are likely to have a high propensity to leave the labour market if they lose their job.

Chart B: Marginal estimated effects of the LFS explanatory variables