Do Product Market Reforms Raise Innovation? Evidence from Micro-data Across 12 Countries

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Abstract

How does policy affect innovation and the digital economy? We revisit how product market regulation affects innovation and develop a novel framework for thinking about digital regulation. Using new company-level micro-data across 12 countries between 1998 and 2012, this paper first estimates the effect of competition policy on innovation. We find that a standard deviation rise in standardized index of product market regulation is associated with a 1.03% decline in innovation activities. These declines are a result of product market regulation on the incentives to invest in in-house R&D and make the appropriate capital acquisitions, as well as of the effects of regulation on the cost of innovation activities. We then theorize on the effect of digital regulation on innovation and we empirically explore it on a sub-sample of the years in our analysis. We find that "protective regulation", i.e., regulation that creates predictability and scope for markets to work, confers a positive effect on innovation, while "restrictive regulation", i.e., regulation that endeavors to spell out negative behaviors, confers a negative effect on innovation. We also find that the digital regulation results are more sensitive to the content of regulation. We attribute this ambiguity to the fact that markers require an enhanced level of trust to be operative.

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1 Introduction

"Under what circumstances will the participation in global value chains contribute to learning and upgrading at the level of the company, at the level of a sector and to economic and social development at the national level? Such an analysis would be helpful in defining strategies for 'managing the openness of national systems of innovation'." – (Lundvall, 2016)

Research and development (R&D) has been widely acknowledged as an important determinant of productivity growth and innovation (Griliches, 1986), which is integral for understanding cross-country differences in economic welfare and standards of living. There is also an increasing recognition that institutions matter for economic development (Acemoglu and Robinson, 2012). While the prevailing consensus is that policies fostering competition, particularly around the digital economy, are important for economic growth, an open question remains over the effects of such policies on learning and innovation at the level of individual companies (Lundvall, 2016). This question has become even more important in an era defined by rising concerns about monopoly power in the technology sector.

The evidence in the empirical literature on the effects of standard Product Market Regulation (PMR) is quite extensive, but inconclusive. Prior papers generally fall short of answering our research questions in at least one of three ways: (a) they lack causality because of a reliance on aggregate (e.g., country-level) data that is contaminated by a range of time-varying fluctuations in economic activity, (b) they are cross-sectional and do not allow for comparisons of companies in the same country subject to different regulatory frameworks over time, and (c) they do not measure innovation activities within the company directly, or they are missing concrete measures of policy relating to digital regulation, etc. For instance, some papers suggest that competition can generate positive effects for innovation (see e.g., Griffith et al. (2010), on EU Single Market Programme's (SMP) reforms of the 1990s and Hu et al. (2020) on the implications of China's carbon emission trading system on the quality and quantity of innovation), while other report the presence of an inverted-U relationship between competition and innovation (Aghion et al., 2005). However, the effects of these regulations ultimately depend on their characteristics and implementation. Moreover, empirical approaches in the literature are diverse, ranging from company-level data (Aghion et al., 2005) to industry-country panel (Barbosa and Faria, 2011).

The first aim of our research paper is to address these issues by employing company-level data, controlling for time-varying country, industry and company-level characteristics to pro-

vide a clear prediction as to the impact of PMR on innovation. To this end we first revisit the role of one specific type of national institutions, namely national policy that promotes competition, and its effects on the incentive to invest in R&D and innovate at a company-level.

Second, using the same rich company-level dataset, we extend the literature by shedding light on the effects of digital policies on innovation, a topic that is yet largely unexplored (Guellec and Paunov, 2018; OECD, 2016). Guellec and Paunov (2018) argue that the digital transformation affects the economics of information and knowledge and more specifically pricing and allocation. Their report develops a theoretical framework of how the digital transformation has an impact on innovation processes and outcomes. According to a recent report by OECD (2016), three out of four inhabitants in the OECD area have a subscription to a mobile wireless broadband service, which they use daily, and up to 95% of all businesses are now connected to the Internet, with three quarters having an online presence and almost half using this platform to do e-commerce. The report concludes that the use of ICT fosters productivity, green and inclusive growth through digital innovation. Our approach contributes to these timely conversations by quantifying how the emerging class of new regulatory policies on the digital economy are related with innovation outcomes at the company-level.

In the first part of our analysis we estimate the effects of product market regulation (PMR) on innovation activities within companies, which we measure using total investment in innovation, in house and external R&D, acquiring new assets, and acquiring new human capital. Our statistical strategy exploits the fact that reforms to product markets were introduced at different times and to different degrees across countries, allowing us to compare observationally equivalent companies exposed to varying degrees of deregulation of product markets. Our results suggest that a standard deviation rise in PMR is associated with a 1.03% decline in innovation activities, especially in-house R&D and the acquisition of new capital.

In the second part of our analysis, we provide suggestive evidence on the effects of digital regulation on the incentives to innovate using a limited part of our company-level dataset. We find that some regulations, such as restrictions on e-commerce transactions, domestic services, physical goods, right to return and protection of personal data confer a positive and statistically significant effect, yet companies in countries with restrictions on search engine content and restrictions on e-commerce sales have lower innovation spending.

Our results contribute directly to an ongoing policy debate about product market reg-

ulation and competition in the digital economy. Early initiatives, like the Lisbon Agenda and Europe 2020, were promulgated on the basis that liberalization would raise competition and, as a result, stimulate more innovation. However, Europe's more recent General Data Protection Regulation (GDPR) introduced new regulations for companies that use or process personal data, raising concerns about their competitive effects, particularly for small technology companies (Koerner, 2018). Our paper introduces previously underutilized micro-data to study the quantitative effects of national competition and digital policy on innovation outcomes within companies.

The structure of the paper is as follows. Section 2 introduces our theoretical framework for relating competition policy with innovation within a company as well as the impact of digital regulation on innovation. Section 3 discusses our data and measurement strategy with a few summary statistics. Section 4 presents for both the standard regulation and the digital regulation cases, our empirical specification, main results, robustness, heterogeneity and investigates the mechanism behind our results. Section 5 concludes and briefly discusses policy implications.

2 Theoretical Background and Research Questions

2.1 Product Market Regulation

Overall, the aim of our paper is to establish a link between product market regulation (PMR) and innovation, with an extension to internet regulation. It is essential to note that an underlying mechanism through which such a link can exist is the effect of regulation on product market competition (PMC). According to Amable et al. (2016) a brief way to connect the two terms is that PMC is the theoretical concept and PMR is the applied policy counterpart.

> In order to better understand the policy debate on these issues, as well as our own critical contribution, it is worth making a selective synthesis of the main arguments analysing the link between market structure and technological performances. We begin by focusing the discussion on PMC as a theoretical concept and introduce PMR as the applied policy counterpart. It should be kept in mind, however, that the link between both remains far from trivial (Amable et al., 2016).

The PMR indicator of OECD is a comprehensive and internationally-comparable set of indicators that measure the degree to which policies promote or inhibit competition in areas

of the product market where competition is viable (Conway et al., 2005; OECD, 2021). Since PMR is the applied aspect of competition theory, we are thus interested in the impact of PMR on innovation.

2.1.1 Competition and Innovation: The Theoretical Literature

The interplay between competition and innovation is theoretically ambiguous, dating back to early models of Schumpeterian competition and Arrow (1962), arguing that under the assumption of perfect competition, intellectual property rights raises the incentive to innovate in a competitive market. The importance of product market competition (PMC) as an engine of growth has been highlighted in several theoretical papers (Aghion et al., 1997, 2005, 2014). They emphasize the role of product market competition in inducing innovation. These theories suggest the presence of a non-linear relationship between product market regulation and innovation (as well as competition) based on two opposing forces.

The first force is the *pure competition effect* as predicted in the standard Schumpeterian theory (Schumpeter, 1911, 1942). In this case, monopoly rents are necessary for a company to innovate. These rents are easier to obtain in less regulated markets, i.e., in market with low product market regulation. The second force, also brought up in Arrow (1962), is the existence of greater incentives in a competitive market. Aghion et al. (2015) introduces the escape competition effect, i.e., increases in competition can raise innovation by encouraging companies to innovate as a way of escaping competition. This effect works in sectors which are neck-neck (i.e., a leader and a company catching up). In more heavily regulated markets, and unless the companies collude, competition is higher and thus companies have more incentives to innovate in order to get higher share of market profits and to stay close to the leader.

On aggregate, the combined effect (composition effect) of these two forces is a U-shaped relationship between competition (partly as a result of regulation) and innovation. As mentioned in Aghion et al. (2005) "the peak of this curve is 'larger and occurs at a higher degree of competition in more neck-and-neck industries'" . Thus competition (e.g., driven by lower regulation) may foster innovation when companies are near the frontier. Which of these effects is larger and under what circumstances? While policy makers have been debating about it, theoretical and empirical evidence is mixed[1].

[1]As Alexander Italianer, Director-General of DG Competition declared in 2010: "Effective competition pushes companies to innovate. They have to come up with new and better products to retain existing

The basic growth theory framework predicts that what is critical for which effect will dominate is the initial level of competition as partly determined by regulation. Competition can also affect the innovation activity of one company by forcing the companies to improve their structure. According to Caves (1980), competition leads to companies' employment of more efficient decision-making structures. Boone (2001) has generalized the analysis to show that the value of innovation higher on competition and as a result non-linearities may occur. More recent studies have further elaborated on these arguments. Amable et al. (2009) highlight the role of the market leader in raising the difficultly of the followers to innovate. Bourlès et al. (2013) illustrate the effect of regulation in upstream industries on the economic performance of downstream companies and industries that use regulated intermediate factors such as service inputs.

2.1.2 PMR, Competition and Innovation: The Empirical Literature

The theoretical concept of competition, can be quantified using the set of indices that comprise the PMR index. On the empirical front there are several macro-level studies that explore the aggregate effect. As in the theoretical literature, evidence is again mixed. Aghion et al. (2005) support the presence of an inverted-U relationship between competition and innovation, while Aghion et al. (2009) illustrate that higher competition fosters innovation in frontier companies and the opposite effect in companies further from the frontier.

Griffith et al. (2010) argue that following the EU Single Market Programme's (SMP) reforms of the 1990s, the drop in barriers to competition raised incentive to carry out R&D as a means to counter lower profitability. Correa and Ornaghi (2014) also establish a positive correlation between competition and innovation. Blind (2012), in a panel of 12 countries between 1999-2004, suggests that PMR may not be correlated to patenting when additional dimensions of regulation policies are accounted for such as competition legislation or price control. Franco et al. (2016) estimate a knowledge production function in a panel of OECD industries and find that upstream product market regulation has an adverse effect on R&D efficiency in the manufacturing sector. Moreover, they illustrate that the marginal impact of PMR is higher in less regulated markets.

customers and gain new ones. . . . Competition encourages companies to allocate their resources in the most efficient way, leading companies to offer more choice and better quality at lower prices. As a result, competition boosts productivity, growth and job creation.' (Competition Policy in support of the EU 2020 policy objectives. Speech at the Vienna Competition Conference 2010 'Industry vs. Competition?')

Barbosa and Faria (2011) use a sample of 10 EU countries and manufacturing industries for the period 2002–2004. Their findings suggest a weak negative effect of regulation on the proportion of innovative companies within an industry. The constant arrival of competing products is a permanent threat which makes the companies to increase their innovation activities like R&D (Tang, 2006). According to Tang (2006) the quick obsolescence of products enhances R&D. In addition, policies in one area may attract investments from foreign companies and to increase competitiveness (Fabrizio et al., 2017). Amable et al. (2016) study the innovation-productivity nexus, in a sample of OECD manufacturing countries. They find that liberalizing policies are not systematically associated with innovation-boosting effects at the leading edge.

2.2 Research Questions

Motivated by the conflicting results derived from the comparison of macro and the micro literature, as well as within each literature, on the implications of PMR on innovation outcomes we try to reach a conclusive answer relying on our detailed dataset. In doing so, we focus on PMR, as the applied counterpart of competition and test its impact on innovation. We can thus formulate our first research question.

RQ 1.a: *Does product market regulation have a reinforcing or an adverse effect on the return to investing in innovation activities?*

In the attempt to answer the first research question, our paper exploits variation in PMR within and across countries over time and how companies in different sectors might be heterogeneously exposed. Moreover, our approach differs from the above-mentioned studies in several dimensions. First, we use a micro-level sample of companies which allows as to exploit within-country variation across companies and sectors. Second, we use alternative type of data about innovation such as spending and activities and last, we employ a broader measure of regulation, i.e., the PMR index, which reflects variation in the economy as a whole, not deregulation in a particular sector.

Closer to our study are micro-level studies. A seminal contribution to the field is that of Nickell (1996) who explores the interplay between changes in competition, productivity and growth rates in a sample of UK companies. He proxies competition using different measures such as monopoly rents, number of competitors, concentration and more. His findings suggest that higher competition has a positive effect on both the level and the growth of

productivity. His results are further confirmed for a broader set of UK companies (Disney et al., 2003). Klette (2003) uses Norwegian plant level data and establishes that the plants that have the highest market power tend to be more productive. Bottasso and Sembenelli (2001) employ Italian company level data and argue that the EU Single Market Program has led to an increase in productivity of companies that were expected, ex-ante, to be more sensitive to the abolition of external barriers. Aghion et al. (2005) explore the effect of foreign company entry, instrumented with policy variables, on TFP growth and the number of patents using UK company level data. Other related papers focus on particular sectors, e.g., Olley and Pakes (1996) on the US telecommunication industry following deregulation or Arnold et al. (2016) using company level data in the service sectors in India.

Additional questions that can be addressed by the richness of our data are:

RQ 1.b: *Are the effects of PMR on innovation activities larger or smaller among companies that are more exposed to product market regulation and smaller companies that have less incumbency advantage?*

Following the discussion above and to the extent that liberalization of product markets has positive effects on innovation, what specifically do these reforms change within a company? Our company level data further allows us to explore this effect. This debate leads us to exploring the following two research questions:

RQ 2.a: *Does product market regulation reduce or reinforce the incentive for companies to conduct in house R&D and to make acquisitions of relevant tangible or intangible capital?*

RQ 2.b: *Are these effects driven by the costs associated with conducting innovative activities?*

We conduct our analysis at the intersection of these literatures, using a multi-level analysis where we explore the effect of country-level policies concerning product market regulation and its impact on company-level spending on innovation activities. Exploiting the differences in the scale of operation of these companies, we elaborate on the opposing forces behind competition and innovation.

2.3 Digital Regulation

The issue of digital regulation is a rather new topic that is largely unexplored. While there is much anecdotal discussion on the topic, no formal theory yet exists that addresses the

particularities of the digital market.

We assume that digital services, like other markets, are subject to similar market forces, i.e., the pure competition effect and the incentives to innovate in a competitive market. We skip the analysis of these two forces in the context of digital markets since they are identical to the analysis in the previous subsection on standard product market regulation.

We focus instead on two additional and opposing forces that are more prominently present in the case of digital markets. The first element, is that digital markets are markets that require an increased level of trust in order to be able to operate when compared to traditional markets. The absence of physical contact, the need for a more elaborate set of skills, the severity of cyber-crime and the huge financial losses that can be associated with it make the presence of trust (a trait necessary for every commercial transaction) even more indispensable. To this end, digital regulation is a prerequisite for the development and the growth of the digital markets, which is a precondition for their decision to innovate.

On the other hand, digital markets, compared to standard markets, can more easily avoid regulation by redirecting their activities to countries that are less heavily regulated. While capital has always been fairly mobile, and labor has been stick, digital services are inherently mobile because many of the labor inputs can function. As such, countries that need to decide the extend of regulation need to balance their desire for consumer protection with how easily they can deter this type of economic activity. We therefore anticipate that the impact of digital regulation on innovation can have an ambiguous effect, driven by these two additional forces that need to be considered.

We exploit cross-country variation in internet regulation to study how regulation in the digital economy affects innovation activities. Next, we form our research question.

RQ 3: *Which is the effect of "Protective Internet Regulation", i.e., regulation that creates predictability and scope for markets to work, may be associated with a positive impact on innovation and "Restrictive Internet Regulation", i.e., regulation that endeavors to spell out negative behaviors, on innovation activity?*

3 Data and Measurement

3.1 Company Level Data

Our primary dataset is the Community Innovation Survey obtained from the European Commission. The data can be accessed via CD-ROMs (scientific-use files) as well as via the Safe Centre (SC) at Eurostat's premises in Luxembourg (Eurostat, 2012). We include in our analysis five CIS waves over the period 1998-2012.[2] Our panel is unbalanced and the full sample contains 414,277 companies from eighteen countries. All our indicators have been harmonized. Tables A.1 and A.2 in Appendix A illustrate the distribution of companies in our CIS sample across countries and across industries (based on NACE classification). Not all countries are represented in our sample with the main ones absent being Germany (that did not release this data) and France (whose data are accessible only via the safe center). Noticeably, Spain has the biggest number of reported companies and the vast majority of companies operate in the manufacturing sector.

The CIS data is unique since it provides micro-level variation on the expenditures on innovation activities, which are the main dependent variables, as well as additional indicators of the reasons why a company does not undertake innovation activities. Our main dependent variable, used in the benchmark analysis, is the total innovation activities harmonized in US dollars, constant 2010 prices. In addition, we use other variables as robustness such as in-house R&D (current expenditures, labour costs and capital expenditures on buildings and equipment specifically for R&D), acquisition of existing knowledge from other enterprises or organizations (expenditures on acquisition of existing knowledge from other enterprises or organizations), acquisition of machinery, equipment, software and buildings, and external R&D (expenditures on acquisition of machinery, equipment, software and buildings). All these variables are in dollars (constant 2010 prices) and the also come from the CIS.

Furthermore, the data includes additional company-level characteristics, including the turnover, the NACE code, information on marketing and organizing, and extent of operations. Table A2 in Appendix A illustrates the summary statistics for our main variables of interest. While there exist companies that choose not to innovate, there are a large number of

[2]The first wave is in 2000 covering the period 1998-2000. Next, the second wave is in 2004 for the period 2002-2004, third in 2006 for the period 2004-2006 and the last two waves in 2010 and 2012 covering the period 2008-2012. EUROSTAT does not provide a unique identifier of the companies and neither the names of the companies. It is possible for one company to exist multiple times in our panel. The second wave in 2004 has similar names for the indicators with the wave in 2006. The same with the waves in 2010 and 2012 but there was no similarity in the names between the periods 2000, 2006 and 2010.

companies that direct resources to innovation activities. Interestingly most companies view as the high cost of innovation as the most deterring factor, while information and IT shortage are the least important reasons for not picking, suggesting that capital constraints are unlikely culprits. Companies are quite diversified as to whether they sell internationally, regionally or locally an element crucial for our identification strategy. The names of the indicators and more details about the construction of the dataset can be tracked in Appendix B. Tables A.1, A.2 and A.3 in the appendix illustrate the distribution of companies across countries, across NACE categories and company-level data summary statistics correspondingly.

3.2 Product Market Regulation Index

We now turn towards a discussion of our measurement of product market regulation, which we draw on from the foundational work in Koske et al. (2015).[3] The data covers all OECD countries and 21 non-OECD countries and is updated every five years, specifically 1998, 2003, 2008, and 2013. However, some countries have missing values for the index in some years. The index is generated based on the responses to 1400 questions on economy-wide or industry-specific regulatory provisions. Despite the wide array of questions, over 90% of them are answered, on average, although differences exist across countries (e.g., below 70% in India and 100% for the Czech Republic). While we refer readers to Koske et al. (2015) for the full discussion, Figure 1 below provides a diagram of the range of topics covered by the questions, ranging from the degree of state control to barriers to trade and investment.

The data that are being collected are categorized under 18 low-level indicators that are subsequently aggregated to three high-level indicators and then summed up into the PMR index. The three high-level indicators are "state control", "Barriers to entrepreneurship" and "Barriers to trade and investment". Importantly as mentioned in Koske et al. (2015) *"The indicators are based on 'objective' data about laws and regulations as opposed to 'subjective' assessments by market participants in opinion surveys. Hence, they capture the 'de jure' policy settings. While this makes the indicators more comparable across countries by insulating them from context-specific assessments, it also entails a number of limitations. For instance, informal regulatory practices such as administrative guidelines or self-disciplinary measures by professional associations are only captured to a very limited extent by the indicators. Also*

[3]Quoting Koske et al. (2015) "To measure a country's regulatory stance and track reform progress over time the OECD developed an economy-wide indicator of product market regulation (PMR) in 1998 (Nicoletti et al., 2000), which was then updated in 2003 and 2008 (Woelf et al., 2009). The economy-wide product market regulation indicator is complemented by a set of indicators that measure regulation at the sector level. These indicators of non-manufacturing regulation (NMR) cover seven network sectors and five services sectors." Koske et al. (2015) undertake the 2013 update of the OECD Index on Product Market Regulation.

the way in which regulations are applied by authorities is hardly reflected in the indicators, even though enforcement can have a considerable impact on the level of competition."

In addition to the limitations discussed by Koske et al. (2015), we now discuss some additional particularities of the index. First, that different regulations evolve at different rates in different sectors, therefore the variation in the index is not instantaneously capturing changes. Second, the index comprises elements that are slow moving and are the results of the overall economic change and elements that are fast moving. The slow-moving part renders the index more exogenous. An example of slow-moving parts of the index could be e.g., state control. Last, withing the elements of the index in on e particular country some regulations may foster and some may mitigate competition. These features of the index, namely that it is not constructed based on contemporaneous economic conditions, encourages us that our identifying within-country variation is plausibly exogenous with respect to our outcome variables.

We work with a standardized (z-score) measure of the product market regulatory stringency obtained by rescaling our Product Market Regulation index to have a mean of zero and a standard deviation of one. Table A.4 reports the summary statistics of the regulation indices. The regulation measures are reported at the company-level.

[INSERT FIGURE 1 HERE]

Figure 1 illustrates the time series variation associated with these reforms. Consider Spain and Hungary. Although both countries began a new wave of reforms at similar times in 2004, they began at different levels and declined at different rates. For example, whereas Hungary exhibited greater regulation in 2000 than Spain, by 2012 its product market regulation stringency was marginally below that of Spain.

[INSERT FIGURE 2 HERE]

Figure 2 plots the distribution of product market regulation across countries. We see, for example, that there are two main mass points at the lower and higher ends of the distribution. While 31% of the variation is cross-sectional (obtained from a fixed effects regression), the bulk of it is driven by within-country variation, as evidenced by Figure 1 above. Figure 3 plots the kernel density distribution of product market regulation across countries in our sample between 2000-2012.

[INSERT FIGURE 3 HERE]

3.3 Digital Regulation Measures

We use several measures of internet regulation derived by Koske et al. (2014). The first is an indicator derived from the question "Are there any domestic legal protections that specifically cover e-commerce transactions (e.g. purchases made online or via mobile platforms) and that go beyond general consumer protection rules?" The second is derived from the question "Does the level of domestic legal protection provided to consumers who buy or subscribe to e-commerce services differ from the level of protection provided when the services are bought or subscribed to by other means?" The third question is "Does the level of domestic legal protection provided to consumers who buy physical goods via e-commerce differ from the protection provided when the goods are bought elsewhere (e.g. by mail or at a retail store)?" The fourth question is "Do consumers have a statutory right to return physical goods purchased through e-commerce under certain conditions, for a full or partial refund?" The fifth question is "Does a law specify the maximum time period for which personal data can be stored by Internet service and application providers?". We document these five indicators as "protective regulation indices" as they appear to be primarily intended to protect consumers via enforcing the online retailers to provide better quality of services.

The sixth question is "Are there any restrictions on the types of goods and services that can be sold online?" The seventh question is "Is there any regulation that forces search engine providers to edit content provided in the results in order to filter out certain material such as links to sites?" From each question we construct a binary indicator that takes the value 0 in the absence of regulation and the value of 1 in the presence of regulation. We document these two indicators as "restrictive regulation indices" as they appear to be primarily intended to restrict the activity of the companies.

Our benchmark analysis illustrates the results for each indicator separately. We then construct two composite indices, one being the sum of all the "protective regulation" indices and one being the sum of all the "restrictive regulation" indices. Figure 4 illustrates the map of all countries in our sample using the two composite indices for digital regulation.

[INSERT FIGURE 4 HERE]

One limitation of the internet regulation data is that we only have overlap with our

company-level data for 2013, meaning that we are restricted to cross-sectional variation. Moreover, we are restricted to using only the last wave of our company-level data (i.e., the year 2012) as it is the year nearest to the regulation data. This significantly reduces our sample to approximately 42,000 observations.

3.4 Country Controls

Our time-varying country level controls come from the World Bank´s World Development Indicators (The World Bank, 2018). Our main controls are "Days to register properties", "Gross enrollment ratio for tertiary education", "Labor force with tertiary education", "Researchers per million", "Research and development expenditure as a percentage of GDP"and "Population density." Tables A.4 and A.5 illustrate the summary statistics for the country-level data and a correlation table between PMR and the internet regulation measures.

4 Product Market Regulation: Empirical Model and Main Results

This section introduces our statistical methodology. We explain the factors that are likely to contribute to statistical bias and the rationale for our approach in overcoming them. We also present our main results on the effects of competitive policy on innovation outcomes, together with robustness and heterogeneity exercises for further insight.

4.1 Empirical Model

To understand the relationship between innovation outcomes and product market reforms, we begin with the following baseline specification:

$$y_{ict} = \gamma PMR_{ct} + \beta X_{it} + \xi D_{ct} + \phi_c + \lambda_c + \epsilon_{ict} \tag{1}$$

where y denotes the company-level innovation outcome, PMR denotes a standardized z-score of the product market regulatory stringency. To obtain the standardized z-score we rescaled our Product Market Regulation index to have a mean of zero and a standard deviation of one. This facilitates the interpretation of our results in terms of the standard deviation. X denotes a vector of company controls, D denotes a vector of country demographic controls, and ϕ and λ denote fixed effects on country and year, respectively. We cluster standard errors at the country-level (Bertrand et al., 2004).

Our empirical model contains several important features. First, our inclusion of country and year fixed effects removes time-invariant heterogeneity across countries that could be correlated with innovation. For example, cultural differences in the propensity to share and disseminate knowledge have been linked with innovation (Gorodnichenko and Roland, 2011). Moreover, differences in labor market institutions could explain differences in innovation outcomes since they affect employment and wages (Ljungqvist and Sargent, 1998, 2008).

We exploit detailed micro-data to compare different types of companies exposed to different regulatory regimes over time. For example, we can examine how an observationally equivalent company responds to changes in regulation over the course of a decade. We can also explore how different types of companies respond to regulatory changes. In particular, one way we exploit heterogeneity across companies is by drawing on information on whether the company produces and sells goods in other countries. We use this to implement a difference-in-difference that compares innovation outcomes among companies that are less exposed to product market regulation before versus after, specifically:

$$y_{ict} = \gamma PMR_{ct} + \eta MULTI_{ict} + \psi(MULTI_{ict} \times PMR_{ct}) + \beta X_{it} + \xi D_{ct} + \phi_c + \lambda_c + \epsilon_{ict} \qquad (2)$$

where $MULTI$ is an indicator denoting whether the company sells multinationally. Now, the treatment effect for multinationals is $\gamma + \psi$ where we expect $\psi > 0$ since they are less exposed to national regulation and should, be less effected by national policy in absolute value.

4.2 Main Results

We begin by presenting the results associated with our main estimating equation in Table 1. In this table we will start with the simplest research question and we will continue extending our set of controls in each column so as to follow the evolution of the coefficient and the standard errors. Column 1 begins with a simple least squares estimator that simply relates product market regulation with innovation activities in the cross-section.

Inconsistent with our theoretical framework, we find a positive correlation: greater product market regulation raises innovation. However, such a comparison is statistically biased if countries with greater product market regulation have more innovative activity. For example, more innovative countries might also have more complicated political economy regimes such

that policymakers pass regulation in response to rent seeking. There are many reasons that could otherwise explain the correlation, including other historical factors that may have led to different systems of governance, for example. This means that the unconditional correlation bundles unobservables, thereby generating the positive correlation.

Turning to column 2, we now include both country and year fixed effects, which removes time-invariant heterogeneity that could be correlated with both product market regulation and innovation. Moreover, once we add country controls to the specification in column 3, the results become more statistically precise, although they decline in magnitude. Not surprisingly, we see a positive association between the number of researchers in a country and innovation. However, we see a negative association between tertiary education and innovation, which is surprising since a larger supply of educated workers tends to be positively correlated with innovation. We also see a similar negative association between population density and innovation activities, which could reflect the fact that greater density leads to greater social interaction, which allows for just as much innovation without as many funds being devoted towards these activities.

We subsequently add company controls in column 4. We see that larger companies with over 50 employees have 82% more innovation, as do those that sell their goods nationally. Turnover growth is also positively associated with innovative activities, reflecting the fact that greater churn is a sign of healthy reallocation in a labor market.

To address the potential for structural transformation (i.e., changes in industrial composition) that might be driven by technological change, column 5 adds two-digit industry-by-year fixed effects, which generates similar results. In sum, our preferred specification in column 5 suggests that a standard deviation rise in PMR is associated with a 1.03% decline in innovation activities. Economically, this means that a 0.38 increase in the non-standardized regulation index (that takes values from 1.37 to 2.75) is associated with an average of 32,000 US dollars, constant 2010 prices reduction in money allocated to innovation. The mean amount of money allocated to innovation activities is 3,066,305 US dollars. Especially since our results are concentrated among smaller and domestic companies that invest less in innovation overall, our estimated effect is economically meaningful. From this point onwards, we always refer to the specification employed in Column 5 as our benchmark specification a it includes the full set of controls. We employ this specification in all subsequent tables.

Finally, column 6 reports the results associated with our difference-in-difference estimator.

Again, consistent with theory, we see a positive coefficient on the interaction between PMR and the multinational indicator since companies that sell internationally are less exposed to national product market regulation. In particular, we find that, for these companies, the treatment effect is -1.13% (versus -1.03% for the average companies in column 5). The fact that the treatment effect, even for these companies, is still negative suggests that our results are not confounded by other time-varying factors.

[INSERT TABLE 1 HERE]

4.3 Robustness

We now turn to a series of robustness checks.

First, we test alternative measures of innovation in Table 2 to explore the potential factors behind the adverse association documented above. We begin by replicating our baseline coefficient using logged funds allocated to innovation activities in column 1. Like we explained earlier, we use the full set of controls, as in the benchmark specification (i.e., Column 5 in Table 1). We subsequently turn towards four alternative measures: the logged funds allocated to in house R&D activities, logged funds allocated to the acquisition of existing knowledge from other organizations or enterprises, logged funds allocated towards the acquisition of capital (i.e., machinery, equipment, software, and buildings), and logged funds allocated towards external R&D activities.

We see that the bulk of the negative association is driven by in house R&D activities and the acquisition of capital, rather than the acquisition of knowledge from outside sources or external R&D. These results are important because they illustrate that product market regulation does not simply lead to a reallocation of innovation activities to outside sources, but rather a decline in an company's own activities. The fact that both of these activities, however, respond less elastically to changes in product market regulation than overall innovation suggests that there are other unobserved determinants (e.g., intangible capital) that are responding more elastically.

[INSERT TABLE 2 HERE]

Second, we conduct an additional robustness check where we estimate a mixed multilevel model. We combine the measure of the PMR index varying at the country and time level,

with company level data. This approach indeed allows us to better identify the individual response of a company, despite the fact that all companies in the same country are faced with the same PMR. Results are reported in Table 3 and are in line with those obtained from the benchmark specification. Column 1 introduces a random intercepts model, i.e., we make the underlying assumption that each country has a different initial endowment of money allocated to innovation activities and a differential initial endowment across sectors. However, the slope, i.e,. the rate of increase is implicitly assumed to be constant across countries and sectors. Column 2 of Table 3 introduces random slopes, i.e., we implicitly assume that the increase in the money allocated to innovation differs across countries and sectors. Last, column 3 embeds both these assumptions by allowing both the slope and the intercept to vary across sectors and countries, which is a rather plausible underlying assumption. Reassuringly, our results remain qualitatively the same in all three columns, i.e., there is a negative and statistically significant effect across specifications and quantitatively very close to the benchmark specification.

[INSERT TABLE 3 HERE]

Third, we establish the robustness of our analysis to the exclusion of countries which represent only a small fraction of the companies in our sample. In each column of Table 4 we replicate the benchmark analysis excluding first Greece (Column 1), then Estonia (Column 2), Slovenia (Column 3) and all these countries in Column (4). Our results are very stable both in terms of significance and magnitude.

[INSERT TABLE 4 HERE]

Last, we establish the robustness of our results to the exclusion/inclusion of dominating sectors. Analytically, each column of Table 5 replicates the benchmark analysis for a broader sector classification, i.e., we moved from two digit categories to one digit categories (Column 1), excluding the manufacturing sector which accounts for 45% of the sample (Column 2) and including only the manufacturing sector (Column 3). In line with our main findings our result remain very stable and the magnitude of the coefficient varies slightly.

[INSERT TABLE 5 HERE]

4.4 Heterogeneity Analysis

In addition to our earlier results on the effects of PMR on companies that sell locally versus internationally, we now explore several additional dimensions of heterogeneity. First, motivated by our theoretical model, we examine whether smaller companies are more adversely

affected. Indeed, we find that a standard deviation rise in PMR is associated with a 1.12% decline in innovation activities for companies with less than 50 employees, but only a 0.22% decline in companies with over 50 employees (significant at the 1% level).

The fact that smaller companies are more adversely affected suggests that larger companies are more able to cope with the heightened compliance costs and/or more able to solidify their incumbency advantage. Moreover, larger companies might be able to benefit from regulations that discourage entry.

In Figure 5, we subsequently allow for heterogeneity in the treatment effects across industries to explore whether our results are driven by predominantly one sector over others. While we see a strong negative association between innovation and PMR in accommodation and food services, we more generally see a similar negative association across all sectors. Electricity, gas, and air conditioning and professional, scientific, and technical services rank as the second most adversely affected sectors.

One reason could arise from the fact that professional services, for example, attracts many high skilled workers, so competitive policy that prevents workers from matching into the right job in these knowledge services jobs will have an especially large effect on a company's ability to innovate. Similarly, although electricity, gas, and air is a more capital intensive sector, it has been predominantly a concentrated sector, so lack of competition may be one reason behind its relatively slower innovation of new energy and efficiency technologies.[4]

[INSERT FIGURE 5 HERE]

4.5 Understanding the Mechanism

We now explore the potential mechanisms behind the decline in innovation activities resulting from product market regulation. We focus on five specific factors: high costs associated with innovation, a lack of skilled workers ("skills gap"), a shortage of information technology (IT), lack of information about market access, and low demand for innovations in the market. Each of these measurements are scaled on an index of zero to three where zero denotes that the company does not have experience with the issue, one denotes that it is of low important,

[4]Unfortunately, we cannot estimate treatment effects precisely for every industry because of sample size and cross-country representativeness limitations. Future work should obtain more comprehensive samples that ensure comparability across countries.

two denotes that it is of some importance, and three denotes that it is very important. We define new variables that are equal to one if the company reports that the issue is somewhat or very important, zero otherwise. In this sense, since PMR has a negative effect on innovation, we should see a positive association between PMR and the prospective factor.

Table 6 documents our results under our baseline specification. In each column, the dependent variable is now each of the factors mentioned above and the explanatory variable is always the PMR. We find that a standard deviation rise in PMR is associated with a strong 0.87 percentage point rise in the probability that the company reports that the costs associated with innovation are the primary culprit behind low innovation. While these costs could be high due to company-level inefficiency, the fact that we include company controls suggests that the costs could be high due to, for example, regulatory and compliance distortions in the system. We also find that PMR is associated with a 0.28 increase in the probability that companies report that finding talented workers is a problem, although our estimate is only significant at the 10% level. This could be due to, for example, low competition in the labor market that discourages reallocation and human capital accumulation over the long run.

We do not, however, find evidence that the declines in innovation activities are due to a shortage of information technology, a lack of information about market access, or low demand, although we cannot rule out the probability that there is a slight positive association between these factors and product market regulation. The fact that PMR is associated most heavily with higher costs is consistent with the view that less competition leads to higher prices and lower quality, suggesting that national policies aimed at raising awareness or subsidizing information and communication technology (ICT) capital are likely to be ineffective.

5 The Digital Economy

5.1 Empirical Model

What do our data and existing results say about the broader privacy and internet regulation debate, which have been subject to significant investigation in both the United States and Europe? For example, the passage of the General Data Protection Regulation (GDPR) has resulted in criticism that the regulation more adversely affects smaller companies, relative to larger and incumbent companies, thereby eroding competition (Koerner, 2018). Moreover, because of anticipated adverse effects on the accessibility of credit and sales revenues, Deloitte (2013) estimates that there could lead to a 173 billion euro reduction of GDP and a

2.8 million job loss.

We now draw on data measuring the stringency of internet regulations across countries. We specifically focus on the seven binary indicators of internet regulation described in the data section. The indicators take the value of 1 if the regulation is present and zero otherwise. We also construct two composite indices that sum across the inputs in each of the protective and restrictive indices.

Based primarily on the way each variable is phrased we define two broad categories of digital regulation, i.e., "protective" and "restrictive" regulation. Our main line of thinking is that every market needs some amount of regulation to define the scope and boundaries. For example, given that uncertainty adversely affects investment (see e.g. Bloom (2009)); guidelines are one way of creating certainty in a marketplace. We thus define protective regulation as those regulations that create predictability and scope for markets to work, whereas we define as restrictive regulations those that endeavor to spell out negative behaviours.

Our categorization is based on two criteria. The first criterion is formulated based on the exact way the variables are phrased and formulated in Koske et al. (2014). All the five variables that are included in the protective regulation index are phrased in such a way that they explicitly or implicitly refer to the protection of the consumers. Similarly, the variables that are included in the restrictive regulation index all refer to restrictions and controls on behavior.

The second criterion is data driven. In Tables 7 and 8 where we provide the results for our analysis, we do not present only the aggregate index for protective and restrictive regulation respectively but also, we provide the results for each variable individually that is contained in each index. In line with our prior, the variables that hinted toward protective (restrictive) regulation conferred a positive (negative) effect on innovation outcomes. The combination of these two criteria helped us shape the two categories.

As they are available only for the year 2013 we examine cross-sectional comparisons between countries with versus without these types of internet regulation, conditional on company and country controls. To understand the relationship between innovation outcomes and digital regulation, we begin with the following baseline specification:

$$y_{ic} = \gamma DR_c + \beta X_i + \xi D_c + \epsilon_{ic} \tag{3}$$

where y denotes the company-level innovation outcome, DR denotes each of the seven digital regulation indicators as well as the composite indices, X denotes a vector of company controls and D denotes a vector of country demographic controls. We cluster standard errors at the country-level (Bertrand et al., 2004).

5.2 Main Results

Table 7 documents the coefficients associated with these regressions. Although we are unable to include company and time fixed effects since we only have access to cross-sectional variation, all columns include the full set of controls available for the digital regulation analysis as discussed in the previous section. Column 1 presents the composite index of all the "protective regulation" indices. The results suggest that a 1 unit increase in the index is associated with a 0.31% increase in the money allocated to innovative activities. Columns 2-6 report the same results but for each indicator separately. The results are qualitatively the same and even stronger quantitatively, due to the fact that the composite index has much larger variation while the separate indices suggest the transition from no regulation to the presence of regulation.

[INSERT TABLE 7 HERE]

These results are consistent with models where trust plays an important role in the provision of digital goods and services. Many of the internet intermediaries have created revenue streams based on the sale of consumer data for the construction of targeted ads. Regulations that improve privacy, protection, or even public confidence can create greater predictability and trust within the digital infrastructure, thereby leading to greater returns in innovation activities that build upon the infrastructure (Goldfarb and Tucker, 2019).

Table 8 reports the results of the "restrictive regulation" indices. As above, Column 1 reports the effect of the aggregate index, i.e., the sum of the two restrictive measures, while Columns 2 and 3 report each index separately, i.e., the type of activity and search engine content. In both these cases the result to innovation is negative, i.e., more restrictive regulation is associated with lower expenses directed to innovation. The magnitude of the effect is highly significant and negative, suggesting that an 1-unit increase in the index (see Column 1) is associated with a 0.541% reduction in money allocated to innovation activities. Economically, this means that is about half of the product market regulation effect. We can thus suspect that regulations that overstretch and restrict freedom are harmful to innovation.

[INSERT TABLE 8 HERE]

5.3 Robustness

Following the same approach as in Table 2, Tables 9 and 10 explore the robustness of our results with respect to the measures of money allocated to innovation. We turn to the same four alternative measures, i.e., the logged funds allocated to in house R&D activities, logged funds allocated to the acquisition of existing knowledge from other organizations or enterprises, logged funds allocated towards the acquisition of capital (i.e., machinery, equipment, software, and buildings), and logged funds allocated towards external R&D activities. In Table 9 we replicate the analysis for the index of "protective" regulation while in Table 10 we replicate the analysis for the measure of "restrictive" regulation. Reassuringly, our results are statistically significant and qualitatively in line with the benchmark findings for all the four alternative measures.

[INSERT TABLES 9 AND 10 HERE]

5.4 Heterogeneity Analysis

We further explore whether the results vary across sector, to figure out whether our results are driven by predominantly one sector over others. The results are illustrated graphically in Figure 6 (Protective Regulation) and Figure 7 (Restrictive Regulation).[5]

There are two main findings. First, in both cases, the sectoral results are consistent with the overall effect of the index, meaning that the sectoral results go to the same direction (positive effect for the protective regulation index and vice versa) and are statistically significant for all sectors. This could relate to the fact that while different sectors rely to a differing degree on the internet (e.g., the Information and Communication sector is affected more by regulation as compared to other sectors, a results that seems to be totally reasonable), yet nowadays digital markets have become prevalent and are crucial for all sectors. We thus observe that the effect is significant across all sectors.

The second striking finding is that two sectors are affected in a different way compared to

[5]Unlike our earlier heterogeneous treatment effects by industry, we do not have any variation across the accommodation and food services sectors, so they are omitted from our results here.

all the rest. The "electricity, gas and air" sector, and the "water and waste" sector. Interestingly this finding holds for both cases, i.e., the effect of protective regulation is negative for these two sectors and positive for the case of the restrictive regulation. We speculate that the intuition behind this result is that both sectors are associated with energy and resources, in which case they do not rely that much on the digital dissemination and second the provision of services is in some sense irreversible.

[INSERT FIGURES 6 AND 7 HERE]

6 Conclusion

The recent introduction of the General Data Protection Regulation (GDPR) has reignited the debate about the effects of policy on competition and innovation activities. This paper revisits the effects of national innovation policy on company outcomes using better data.

Using company-level data between 1998 and 2012, this paper finds that a standard deviation rise of product market regulations leads to a 1.03% decline in innovation activities. These effects are concentrated in companies that sell locally and companies with less than 50 employees. Moreover, these effects are driven by the effect of regulation on innovation costs and the ability to find talented workers. We also find that these effects are concentrated among larger companies and those that sell abroad, consistent with the macroeconomic literature on distortions based on company size and the industrial organization literature on locational choice.

We subsequently examine the role of internet-based regulation, finding some evidence of similar adverse effects on innovation activities and the digital economy but also of positive effects as well, being driven by opposing forces. Our results inform the class of policies that can advance global value chains in the digital economy. Future research should employ more comprehensive data that allows for longitudinal comparisons of companies before versus after the adoption of internet regulation. Moreover, future research should investigate how companies cope with the introduction of regulation, potentially by shifting markets or changing their organizational strategy.

We view our results as important and contributing to the existing literature in two major ways. First, given the richness of the data, we can account for a large number of unob-

servables and thus come to conclude a negative relationship between PMR and innovation. The value added of our study lies in the use of a micro-level sample that allows us to exploit within country variation not only across companies but also sectors. It also allows us to use a variety of innovation related outcomes, beyond the standard innovation measures, such as spending and activities, thus nailing down the robustness of our analysis. Last, it allows us to nail down explicitly potentially associated mechanisms. Second, we are the first to empirically explore and establish the interplay between internet regulation and innovation. Importantly, we empirically establish the novel results the actual sign of the correlation, depends on the nature of the regulation, i.e., whether it is restrictive or protective regulation.

Some form of digital regulation can be important for protecting consumers particularly given the propensity for monopolistic competition in online markets due to economies of scale and network externalities. Consumer protections can in some cases help foster entrepreneurship since these endeavors can be easily squashed by large barriers to entry and/or a lack of trust among actors. In particular, especially since actors do not meet directly in person, market participants need to have sufficient confidence in the platform.

And yet, digital regulation can also generate countervailing effects if it is primarily restrictive—that is, imposing excessive restrictions on commercial activity. If, for example, policymakers make ad hoc decisions about protected versus unprotected speech, then uncertainty about how that definition may evolve can stifle innovation and reduce confidence in the system at large. Given that digital services are highly mobile, the adverse effects of such policies in one country can lead to rapid substitution and/or regulatory arbitrage. Consider, for instance, introduction of the General Data Protection Regulation (GDPR).

Balancing between the protective and restrictive forces for digital regulation will require quantitatively evaluating the costs and benefits of regulation on innovation activity. Policies aimed at creating a predictable and stable foundation for the free and open use of the internet will enable continued growth for the digital economy, whereas policies that restrict content may risk setting arbitrary definitions that deter innovation and growth.

References

Acemoglu, Daron and James Robinson, *Why Nations Fail: The Origins of Power, Prosperity and Poverty*, New York: Crown, 2012.

Aghion, Philippe, Christopher Harris, and John Vickers, "Competition and growth with step-by-step innovation: An example," *European Economic Review*, 1997, *41* (3-5), 771–782.

_ , Nicholas Bloom, Richard Blundell, Rachel Griffith, and Peter Howitt, "Competition and Innovation: an Inverted-U Relationship," *The Quarterly Journal of Economics*, 2005, *120* (2), 701–728.

_ , Richard Blundell, Rachel Griffith, Peter Howitt, and Susanne Prantl, "The effects of entry on incumbent innovation and productivity," *Review of Economics and Statistics*, 2009, *91* (1), 20–32.

_ , Ufuk Akcigit, and Peter Howitt, "What Do We Learn From Schumpeterian Growth Theory?," in "Handbook of Economic Growth," Vol. 2, Elsevier B.V., 2014, pp. 515–563.

_ , _ , and _ , "The Schumpeterian Growth Paradigm," *Annual Review of Economics*, 2015, *7* (1), 557–575.

Amable, Bruno, Ivan Ledezma, and Stéphane Robin, "Product market regulation, innovation, and productivity," *Research Policy*, 2016, *45* (10), 2087–2104.

_ , Lilas Demmou, and Ivan Ledezma, "Product market regulation, innovation, and distance to frontier," *Industrial and Corporate Change*, 2009, *19* (1), 117–159.

Arnold, Jens Matthias, Beata Javorcik, Molly Lipscomb, and Aaditya Mattoo, "Services Reform and Manufacturing Performance: Evidence from India," *Economic Journal*, 2016, *126* (590), 1–39.

Arrow, Kenneth J., "Economic Welfare and the Allocation of Resources for Invention," in "The Rate and Direction of Inventive Activity: Economic and Social Factors," National Bureau of Economic Research, Inc, 1962, pp. 609–626.

Barbosa, Natália and Ana Paula Faria, "Innovation across Europe: How important are institutional differences?," *Research Policy*, 2011, *40* (9), 1157–1169.

Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan, "How much should we trust differences-in-differences estimates?," *Quarterly Journal of Economics*, 2004, *119* (1), 249–275.

Blind, Knut, "The influence of regulations on innovation: A quantitative assessment for OECD countries," *Research Policy*, 2012, *41* (2), 391–400.

Bloom, Nicholas, "The Impact of Uncertainty Shocks," *Econometrica*, 2009, *77* (3), 623–685.

Boone, Jan, "Intensity of competition and the incentive to innovate," *International Journal of Industrial Organization*, 2001, *19* (5), 705–726.

Bottasso, Anna and Alessandro Sembenelli, "Market power, productivity and the EU Single Market Program: Evidence from a panel of Italian firms," *European Economic Review*, 2001, *45* (1), 167–186.

Bourlès, Renaud, Gilbert Cette, Jimmy Lopez, Jacques Mairesse, and Giuseppe Nicoletti, "Do productmarket regulations in upstreamsectors curb productivity growth? Panel data evidence for oecd Countries," *Review of Economics and Statistics*, 2013, *95* (5), 1750–1768.

Caves, Richard E., "Industrial organization, corporate strategy and structure," in "Readings in Accounting for Management Control," Springer US, 1980, pp. 335–370.

Conway, Paul, Véronique Janod, and Giuseppe Nicoletti, "Product Market Regulation in OECD Countries: 1998 to 2003," *OECD Economics Department Working Papers*, 2005, *419.*

Correa, Juan A. and Carmine Ornaghi, "Competition & innovation: Evidence from u.s. patent and productivity data," *Journal of Industrial Economics*, 2014, *62* (2), 258–285.

Deloitte, "Economic impact assessment of the proposed European General Data Protection Regulation Final Report," Technical Report 2013.

Disney, Richard, Jonathan Haskel, and Ylva Heden, "Restructuring and productivity growth in UK manufacturing," *Economic Journal*, 2003, *113* (489), 666–694.

Eurostat, "Community Innovation Survey," 2012.

Fabrizio, Kira R., Sharon Poczter, and Bennet A. Zelner, "Does innovation policy attract international competition? Evidence from energy storage," *Research Policy*, 2017, *46* (6), 1106–1117.

Franco, Chiara, Fabio Pieri, and Francesco Venturini, "Product market regulation and innovation efficiency," *Journal of Productivity Analysis*, 2016, *45* (3), 299–315.

Goldfarb, Avi and Catherine Tucker, "Digital economics," *Journal of Economic Literature*, 2019, *57* (1), 3–43.

Gorodnichenko, Yuriy and Gerard Roland, "Individualism, innovation, and long-run growth," *Proceedings of the National Academy of Sciences of the United States of America*, 2011, *108* (SUPPL. 4), 21316–21319.

Griffith, Rachel, Rupert Harrison, and Helen Simpson, "Product market reform and innovation in the EU," *Scandinavian Journal of Economics*, 2010, *112* (2), 389–415.

Griliches, Zvi, "Productivity, R&D, and Basic Research at the Firm Level in the 1970's," *American Economic Review*, 1986, *76* (1), 141–154.

Guellec, D. and C. Paunov, "Innovation policies in the digital age," *OECD Science, Technology and Industry Policy Papers*, 2018, (59).

Hu, Jiangfeng, Xinxin Pan, and Qinghua Huang, "Quantity or quality? The impacts of environmental regulation on firms' innovation–Quasi-natural experiment based on China's carbon emissions trading pilot," *Technological Forecasting and Social Change*, 2020, *158*, 120–122.

Klette, Tor Jakob, "Market Power, Scale Economies and Productivity: Estimates from a Panel of Establishment Data," *The Journal of Industrial Economics*, 2003, *47* (4), 451–476.

Koerner, K, "GDPR – boosting or choking Europe's data economy?," 2018.

Koske, Isabell, Isabelle Wanner, Rosamaria Bitetti, and Omar Barbiero, "The 2013 update of the OECD's database on product market regulation: Policy insights for OECD and non-OECD countries," *Documents de Travail du Département des Affaires Économiques*, 2015, *1200.*

_ , Rosamaria Bitetti, Isabelle Wanner, and Ewan Sutherland, "The Internet Economy - Regulatory Challenges and Practices," *OECD Economic Department Working Papers*, 2014, (1171), 0_1–34.

Ljungqvist, Lars and Thomas J. Sargent, "The European unemployment dilemma," *Journal of Political Economy*, jun 1998, *106* (3), 514–550.

_ and _ , "Two questions about European unemployment," *Econometrica*, 2008, *76* (1), 1–29.

Lundvall, Bengt-Ake, *The learning economy and the economics of hope*, Anthem Press, 2016.

Nickell, Stephen J., "Competition and corporate performance," *Journal of Political Economy*, 1996, *104* (4), 724–746.

Nicoletti, G., S. Scarpetta, and O. Boylaud, "Summary Indicators of Product Market Regulation with an Extension to Employment Protection Legislation," *OECD Economics Department Working Papers*, 2000, *226.*

OECD, "Stimulating digital innovation for growth and inclusiveness: The role of policies for the successful diffusion of ICT," *OECD Digital Economy Papers*, 2016, *256.*

_ , "OECD regulatory databases and indicators," *Retrieved from http://www.oecd.org/regreform/regulatory-databases-and-indicators.htm. Accessed March 3, 2021.*, 2021.

Olley, G. Steven and Ariel Pakes, "The Dynamics of Productivity in the Telecommunications Equipment Industry," *Econometrica*, 1996, *64* (6), 1263.

Schumpeter, Joseph A, *The theory of economic development. Harvard economic studies, vol. XLVI*, Vol. 46, Harvard University Press, Cambridge, MA, 1911.

_ , *Capitalism, Socialism and Democracy*, New York: Harper & Brothers, 1942.

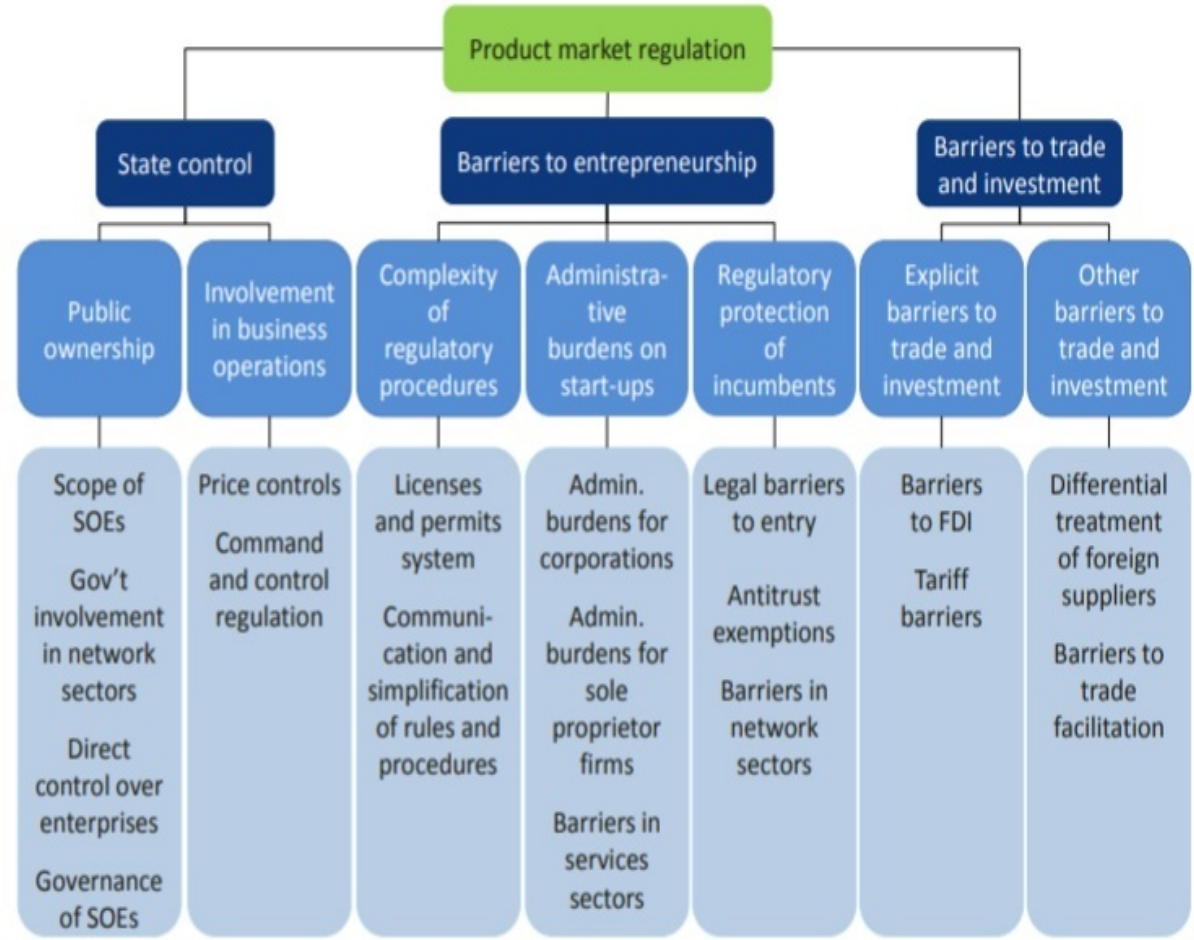
Tang, Jianmin, "Competition and innovation behaviour," *Research Policy*, 2006, *35* (1), 68–82.

The World Bank, "World Bank Group - International Development, Poverty, & Sustainability," 2018.

Woelf, A., I. Wanner, T. Kozluk, and G. Nicoletti, "Ten Years of Product Market Reform in OECD Countries: Insights from a Revised PMR Indicator," *OECD Economics Department Working Papers*, 2009, *695.*

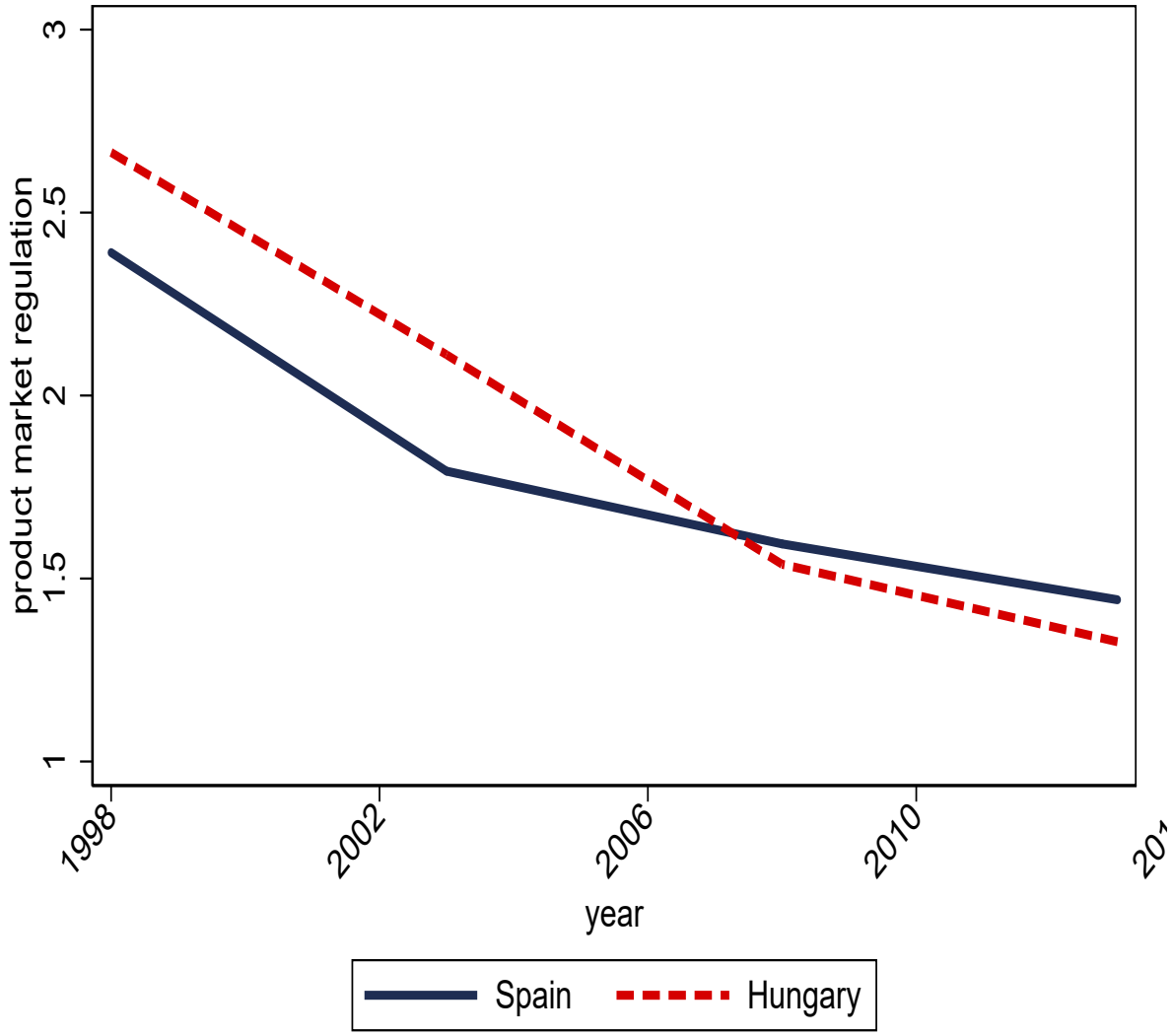
7 Figures and Tables

Figure 1: Conceptual Diagram of Product Market Regulation Index Development



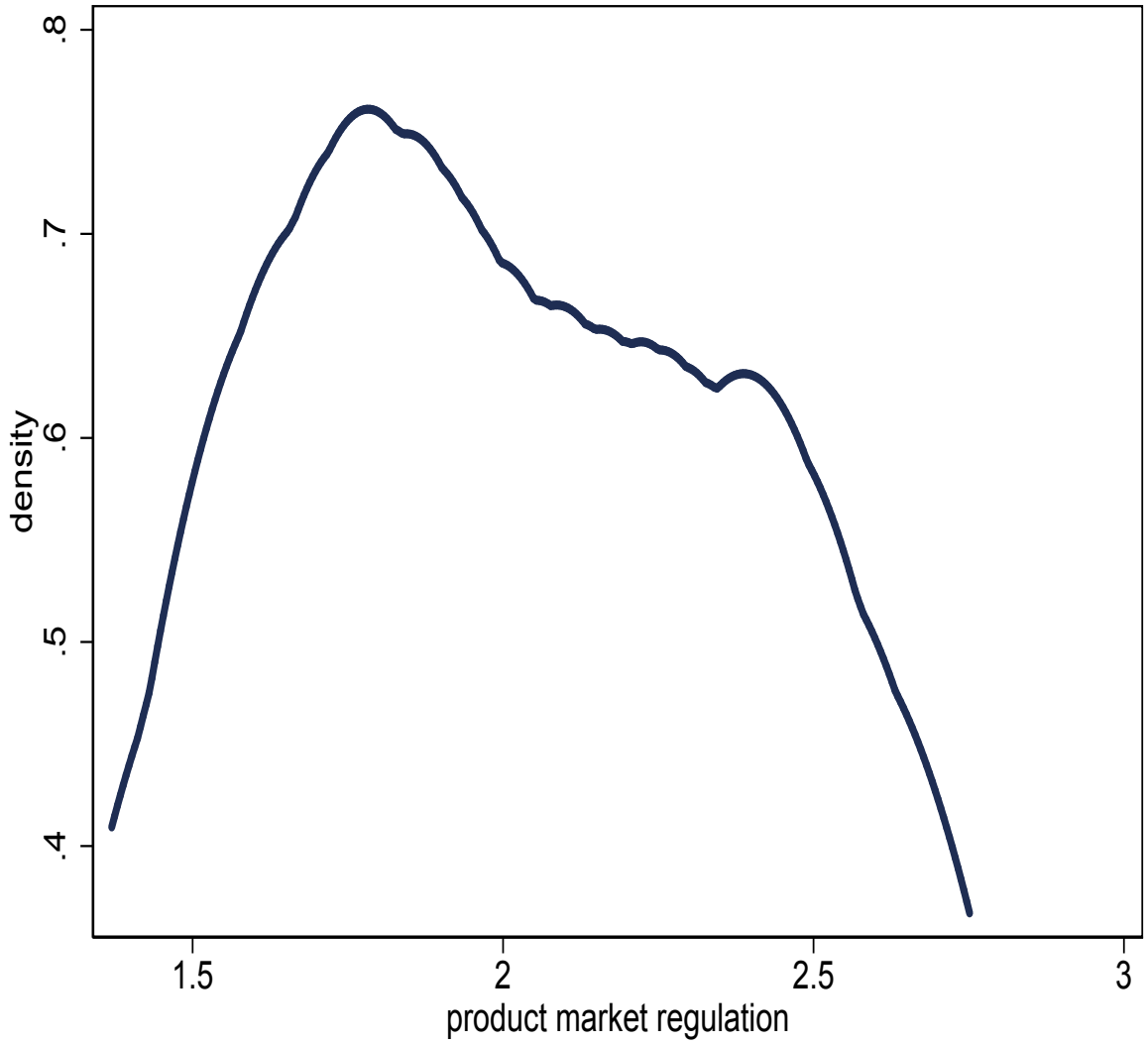
Notes.–Sources: Koske et al. (2015). The figure depicts the range of topics that are surveyed over in constructing the product market regulation index for countries over time.

Figure 2: Time Series of Product Market Regulation Restrictions



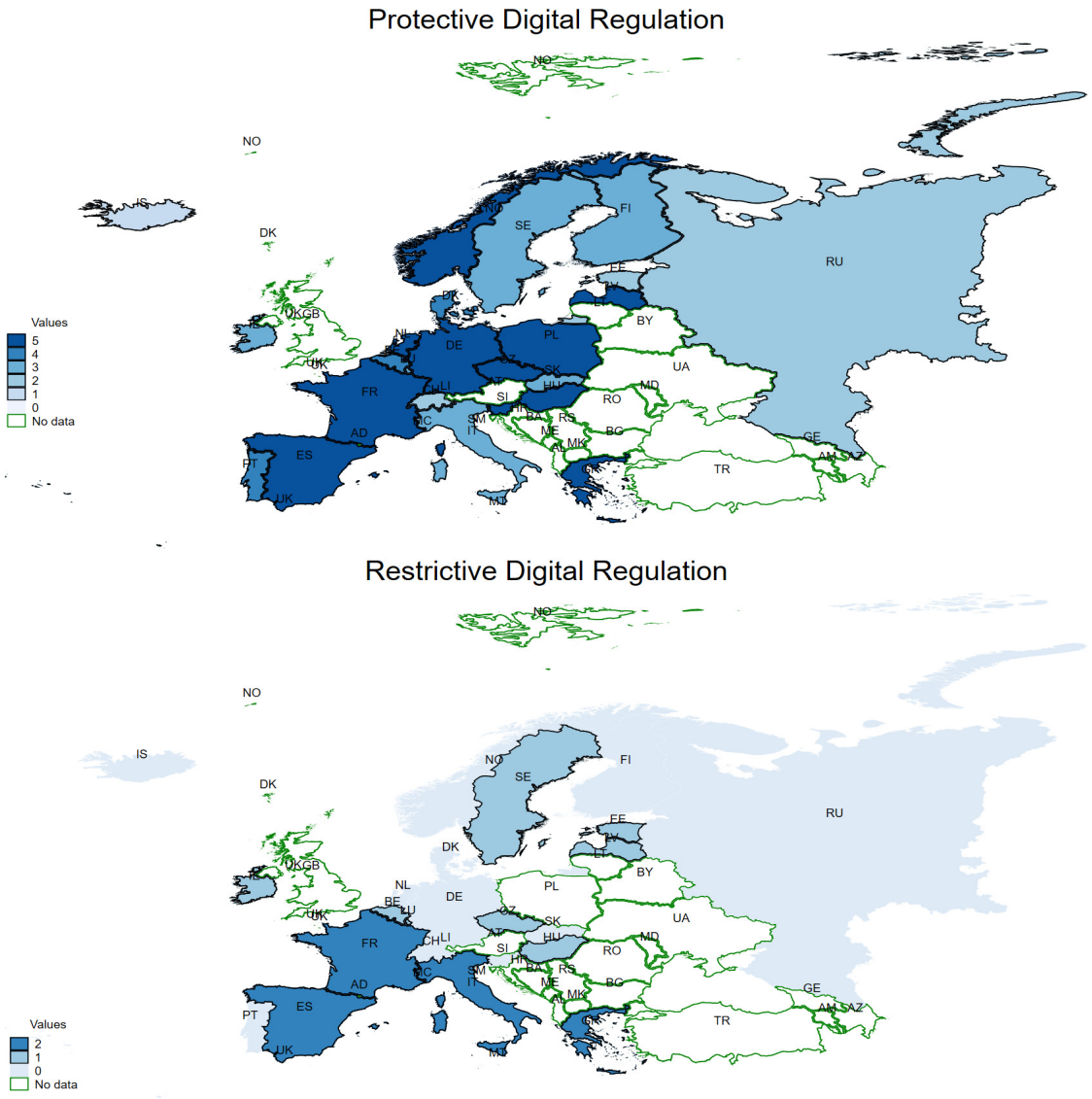
Notes.–Sources: The figure plots the average index of product market regulation stringency for Spain and Hungary as an illustrative example of the within-country variation.

Figure 3: Distribution of Product Market Regulation Restrictions



Notes.–Sources: The figure plots the kernel density distribution of product market regulation across the countries in the sample between 2000-2012.

Figure 4: Digital Regulation Indices Across our Sample



Notes.–Sources: The figure plots a spatial representation of the countries in our sample with internet regulation in 2013.

Table 1: The Effects of Product Market Regulation on Innovation Outcomes Across Companies

Dep. var. =	ln(Investment in Innovation)					
	(1)	(2)	(3)	(4)	(5)	(6)
product market regulation, z-score	1.13**	-0.86	-0.53**	-0.68***	-1.03***	-1.13***
	[0.43]	[0.64]	[0.17]	[0.14]	[0.11]	[0.19]
sells internationally						0.78***
						[0.24]
× sells internationally						0.98**
						[0.33]
ln(days to register properties)			0.41***	0.28***	0.25**	0.26***
			[0.09]	[0.08]	[0.08]	[0.07]
gross enrollment ratio for tertiary			-3.18**	-3.17***	-4.85***	-3.71***
			[1.28]	[0.69]	[0.76]	[0.63]
labor force with tertiary education			4.10	-25.68**	-18.77**	-19.60**
			[13.91]	[8.27]	[6.81]	[7.60]
ln(researchers per million)			-0.36	-0.12	-0.54**	-1.05***
			[0.41]	[0.17]	[0.20]	[0.27]
ln(population density)			-25.86***	-15.03***	-13.44***	-19.23***
			[4.16]	[2.10]	[2.23]	[2.01]
research and development expenditure			0.57	0.44	0.30	0.61
			[0.57]	[0.41]	[0.39]	[0.36]
turnover growth			8.79***	10.84***	9.72***	11.88***
			[1.90]	[1.73]	[1.53]	[1.93]
R-squared	0.07	0.20	0.20	0.25	0.31	0.26
Sample Size	191092	191092	191092	191092	191092	191092
Country FE	No	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes	Yes	Yes
Country Controls	No	No	Yes	Yes	Yes	Yes
Firm Controls	No	No	No	Yes	Yes	Yes
hasindt	No	No	No	No	Yes	No

Notes: Sources: Community Innovation Survey, OECD, World Bank 2000-2012. The table reports the coefficients associated with regressions of logged money allocated to innovation activities within a company on a standardized z-score of product market regulation, conditional on country controls (the logged number of days it takes to register properties, the gross enrollment ratio for tertiary education as a percent, the labor force with a tertiary education as a percent, the logged number of researchers in R&D activities per million people, and logged population density) and company controls (an indicator for whether there are over 50 employees, an indicator for whether they sell goods locally/regionally, an indicator for whether they sell goods nationally, and turnover growth in their employment). OLS model with robust standard errors, clustered at the country level, are reported in parenthesis. *** denotes statistical significance at 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Table 2: Product Market Regulation and Alternative Measures of Innovation Outcomes

Dep. var. =	baseline innovation	in house R&D	acquiring knowledge	acquiring capital	external R&D
	(1)	(2)	(3)	(4)	(5)
product market regulation, z-score	-1.03***	-.46*	-.20	-.54**	-.25**
	[.11]	[.23]	[.15]	[.18]	[.10]
R-squared	.31	.17	.04	.12	.09
Sample Size	191092	195573	194501	195553	193684
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Country Controls	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes

Notes: Sources: Community Innovation Survey, OECD, World Bank 2000-2012. Outcome variables: in house R&D is the money allocated to house RD (Current expenditures, labour costs and capital expenditures on buildings and equipment specifically for RD), acquiring knowledge is money allocated to acquiring knowledge (Expenditures on acquisition of existing knowledge from other enterprises or organizations), acquiring capital is money allocated to acquiring capital (Expenditures on acquisition of machinery, equipment, software and buildings, exclude expenditures on these items that are for RD), external RD is money allocated to external RD (Expenditures on external RD). The table reports the coefficients associated with regressions of innovation outcomes on a standardized z-score of product market regulation, conditional on country controls (the logged number of days it takes to register properties, the gross enrollment ratio for tertiary education as a percent, the labor force with a tertiary education as a percent, the logged number of researchers in R&D activities per million people, and logged population density) and company controls (an indicator for whether there are over 50 employees, an indicator for whether they sell goods locally/regionally, an indicator for whether they sell goods nationally, and turnover growth in their employment). OLS model with robust standard errors, clustered at the country level, are reported in parenthesis. *** denotes statistical significance at 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Table 3: Baseline results robustness - Mixed multilevel model

Dep. var. =	ln(money allocated to innovation activities)		
	(1)	(2)	(3)
product market regulation, z-score	-0.823***	-1.371***	-1.299***
	[0.068]	[0.208]	[0.223]
ln(days to register properties)	0.204***	0.242***	0.243***
	[0.026]	[0.060]	[0.063]
gross enrollment ratio for tertiary	-4.479***	-4.807***	-4.678***
	[0.360]	[0.541]	[0.581]
labor force with tertiary education	-33.000***	-17.486***	-16.720***
	[2.820]	[3.988]	[3.942]
turnover growth	10.004***	10.393***	10.371***
	[1.041]	[1.034]	[1.034]
ln(researchers per million)	0.078	-0.842**	-0.904***
	[0.196]	[0.340]	[0.339]
ln(population density)	-10.475***	-2.023**	-1.889**
	[1.219]	[1.026]	[0.917]
research and development expenditure	0.223	0.266	0.314
	[0.195]	[0.202]	[0.204]
Sample Size	191092	191092	191092
LR chi2(2)	5450.67	8389.68	8506.91
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Over 50 Employees FE	Yes	Yes	Yes
Sells Internationally FE	Yes	Yes	Yes
Sells Locally/Regionally FE	Yes	Yes	Yes
Sells Nationally FE	Yes	Yes	Yes
Sells Other Countries FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes

Notes: Sources: Community Innovation Survey, OECD, World Bank 2000-2012. The table reports the coefficients associated with regressions of logged money allocated to innovation activities within a company on a standardized z-score of product market regulation, conditional on country controls (the logged number of days it takes to register properties, the gross enrollment ratio for tertiary education as a percent, the labor force with a tertiary education as a percent, the logged number of researchers in R&D activities per million people, and logged population density) and company controls (an indicator for whether there are over 50 employees, an indicator for whether they sell goods locally/regionally, an indicator for whether they sell goods nationally, and turnover growth in their employment). Multilevel mixed-effects linear regression model with random intercepts is reported in column 1, multilevel mixed-effects linear regression model with random slopes for PMR is reported in column 2 and multilevel mixed-effects linear regression model with random intercepts and slopes is reported in column 3. Standard errors are reported in parenthesis. *** denotes statistical significance at 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Table 4: Baseline results robustness on sample selection

Dep. var. =	ln(money allocated to innovation activities)			
	(1)	(2)	(3)	(4)
product market regulation, z-score	-1.027***	-1.030***	-1.029***	-1.028***
	[0.116]	[0.115]	[0.115]	[0.118]
ln(days to register properties)	0.248**	0.246**	0.246**	0.248**
	[0.077]	[0.077]	[0.077]	[0.079]
gross enrollment ratio for tertiary	-4.842***	-4.852***	-4.852***	-4.842***
	[0.767]	[0.762]	[0.761]	[0.780]
labor force with tertiary education	-18.529**	-18.797**	-18.830**	-18.620**
	[6.966]	[6.851]	[6.832]	[7.074]
turnover growth	9.676***	9.737***	9.720***	9.700***
	[1.557]	[1.549]	[1.547]	[1.592]
ln(researchers per million)	-0.535**	-0.535**	-0.535**	-0.535**
	[0.202]	[0.201]	[0.201]	[0.206]
ln(population density)	-13.516***	-13.422***	-13.418***	-13.479***
	[2.236]	[2.247]	[2.248]	[2.280]
research and development expenditure	0.306	0.304	0.301	0.309
	[0.392]	[0.389]	[0.389]	[0.398]
R-squared	0.31	0.31	0.31	0.31
Sample Size	190602	190334	190485	189237
Sample	Excluding Greece	Excluding Estonia	Excluding Slovenia	Excluding all
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Over 50 Employees FE	Yes	Yes	Yes	Yes
Sells Internationally FE	Yes	Yes	Yes	Yes
Sells Locally/Regionally FE	Yes	Yes	Yes	Yes
Sells Nationally FE	Yes	Yes	Yes	Yes
Sells Other Countries FE	Yes	Yes	Yes	Yes
Industry X Year FE	Yes	Yes	Yes	Yes

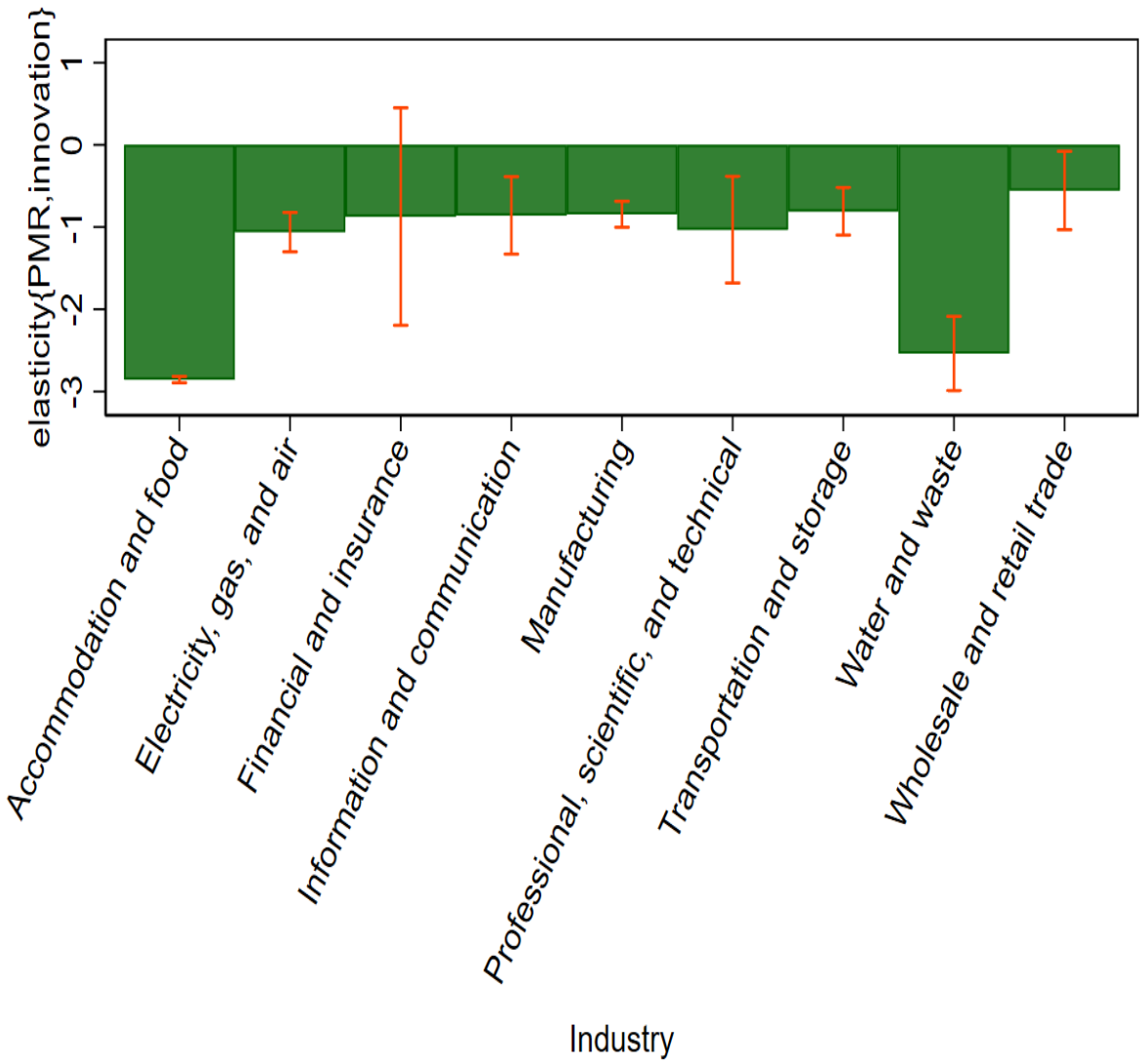
Notes: Sources: Community Innovation Survey, OECD, World Bank 2000-2012. The table reports the coefficients associated with regressions of logged money allocated to innovation activities within a company on a standardized z-score of product market regulation, conditional on country controls (the logged number of days it takes to register properties, the gross enrollment ratio for tertiary education as a percent, the labor force with a tertiary education as a percent, the logged number of researchers in R&D activities per million people, and logged population density) and company controls (an indicator for whether there are over 50 employees, an indicator for whether they sell goods locally/regionally, an indicator for whether they sell goods nationally, and turnover growth in their employment). In the first column we exclude Greece, in the second column we exclude Estonia, in the third column we exclude Slovenia and in the final column we exclude all of them. OLS model with robust standard errors, clustered at the country level, are reported in parenthesis. *** denotes statistical significance at 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Table 5: Baseline results with robustness on industry classification

Dep. var. =	ln(money allocated to innovation activities)		
	(1)	(2)	(3)
product market regulation, z-score	-0.874***	-1.103***	-0.917***
	[0.130]	[0.092]	[0.166]
ln(days to register properties)	0.228**	0.101	0.358***
	[0.077]	[0.069]	[0.092]
gross enrollment ratio for tertiary	-4.051***	-5.968***	-3.375***
	[0.745]	[0.716]	[0.861]
labor force with tertiary education	-21.680**	-21.261**	-14.733
	[7.813]	[7.520]	[8.215]
turnover growth	10.768***	10.650***	9.689***
	[1.380]	[1.988]	[1.935]
ln(researchers per million)	-0.382*	-0.941***	-0.316
	[0.171]	[0.195]	[0.192]
ln(population density)	-14.741***	-15.306***	-10.787***
	[2.289]	[2.393]	[2.479]
research and development expenditure	0.387	0.363	0.262
	[0.388]	[0.370]	[0.461]
R-squared	0.28	0.35	0.24
Sample Size	191092	83851	107241
Nace	Broader Definition Nace	Only Manufacturing Sector	Not Manufacturing Sector
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Over 50 Employees FE	Yes	Yes	Yes
Sells Internationally FE	Yes	Yes	Yes
Sells Locally/Regionally FE	Yes	Yes	Yes
Sells Nationally FE	Yes	Yes	Yes
Sells Other Countries FE	Yes	Yes	Yes
Industry X Year FE	Yes	Yes	Yes

Notes: Sources: Community Innovation Survey, OECD, World Bank 2000-2012. The table reports the coefficients associated with regressions of logged money allocated to innovation activities within a company on a standardized z-score of product market regulation, conditional on country controls (the logged number of days it takes to register properties, the gross enrollment ratio for tertiary education as a percent, the labor force with a tertiary education as a percent, the logged number of researchers in R&D activities per million people, and logged population density) and company controls (an indicator for whether there are over 50 employees, an indicator for whether they sell goods locally/regionally, an indicator for whether they sell goods nationally, and turnover growth in their employment). In the first column we use a broader definition of industries, in the second column we use only manufacturing sector and in the last column we remove from the sample the companies in manufacturing sector. OLS model with robust standard errors, clustered at the country level, are reported in parenthesis. *** denotes statistical significance at 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Figure 5: Heterogeneity in Treatment Effects across Industries



Notes.–Sources: Community Innovation Survey, OECD, World Bank 2000-2012. The table reports the coefficients associated with regressions of logged money allocated to innovation activities within a company on a standardized z-score of product market regulation, conditional on country controls (the logged number of days it takes to register properties, the gross enrollment ratio for tertiary education as a percent, the labor force with a tertiary education as a percent, the logged number of researchers in R&D activities per million people, and logged population density) and company controls (an indicator for whether there are over 50 employees, an indicator for whether they sell goods locally/regionally, an indicator for whether they sell goods nationally, and turnover growth in their employment) separately for each major industry.Standard errors are clustered at the country-level.

Table 6: Understanding the Mechanisms Behind the Adverse Effects of Product Market Regulation

Dep. var. =	costs too high	skills gap	IT shortage	low information	low demand
	(1)	(2)	(3)	(4)	(5)
product market regulation, z-score	0.155***	0.503	0.455	0.310	1.294***
	[0.024]	[0.344]	[0.439]	[0.477]	[0.018]
Sample Size	155127	155049	155025	155008	154344
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Over 50 Employees FE	Yes	Yes	Yes	Yes	Yes
Sells Internationally FE	Yes	Yes	Yes	Yes	Yes
Sells Locally/Regionally FE	Yes	Yes	Yes	Yes	Yes
Sells Nationally FE	Yes	Yes	Yes	Yes	Yes
Sells Other Countries FE	Yes	Yes	Yes	Yes	Yes

Notes: Sources: Community Innovation Survey, OECD, World Bank 2000-2012. The table reports the coefficients associated with logit regressions of indicators for different factors behind the failure to innovate on on a standardized z-score of product market regulation, conditional on country controls (the logged number of days it takes to register properties, the gross enrollment ratio for tertiary education as a percent, the labor force with a tertiary education as a percent, the logged number of researchers in R&D activities per million people, and logged population density) and company controls (an indicator for whether there are over 50 employees, an indicator for whether they sell goods locally/regionally, an indicator for whether they sell goods nationally, and turnover growth in their employment). The outcome variable indicators are over four measures: high costs associated with innovation, a lack of skilled workers ("skills gap"), a shortage of information technology (IT), lack of information about market access, and low demand for innovations in the market. Logit model with robust standard errors, clustered at the country level, are reported in parenthesis. *** denotes statistical significance at 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Table 7: The Effects of Protective Digital Regulation on Innovation Outcomes Across Companies

Dep. var. =	ln(money allocated to innovation activities)					
	(1)	(2)	(3)	(4)	(5)	(6)
protective regulation index	0.031***					
	[0.000]					
personal data		0.193***				
		[0.003]				
domestic e-commerce transactions			0.144***			
			[0.002]			
domestic services				0.126***		
				[0.002]		
domestic physical goods					0.144***	
					[0.002]	
statutory right to return						0.193***
						[0.003]
ln(days to register properties)	-0.016***	0.037***	-0.028***	-0.064***	-0.028***	0.037***
	[0.000]	[0.001]	[0.000]	[0.001]	[0.000]	[0.001]
gross enrollment ratio for tertiary	-4.849***	-5.111***	-4.416***	-5.262***	-4.416***	-5.111***
	[0.029]	[0.032]	[0.023]	[0.034]	[0.023]	[0.032]
labor force with tertiary education	10.349***	10.834***	9.421***	11.338***	9.421***	10.834***
	[0.069]	[0.074]	[0.059]	[0.081]	[0.059]	[0.074]
turnover growth	1.423***	1.423***	1.423***	1.423***	1.423***	1.423***
	[0.209]	[0.209]	[0.209]	[0.209]	[0.209]	[0.209]
ln(researchers per million)	1.488***	1.836***	1.192***	1.552***	1.192***	1.836***
	[0.012]	[0.016]	[0.009]	[0.012]	[0.009]	[0.016]
ln(population density)	0.998***	1.077***	0.874***	1.113***	0.874***	1.077***
	[0.007]	[0.008]	[0.006]	[0.009]	[0.006]	[0.008]
research and development expenditure	-0.029***	-0.215***	0.056***	0.063***	0.056***	-0.215***
	[0.001]	[0.003]	[0.001]	[0.001]	[0.001]	[0.003]
R-squared	0.03	0.03	0.03	0.03	0.03	0.03
Sample Size	41630	41630	41630	41630	41630	41630
Over 50 Employees FE	Yes	Yes	Yes	Yes	Yes	Yes
Sells Internationally FE	Yes	Yes	Yes	Yes	Yes	Yes
Sells Locally/Regionally FE	Yes	Yes	Yes	Yes	Yes	Yes
Sells Nationally FE	Yes	Yes	Yes	Yes	Yes	Yes
Sells Other Countries FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: (i) The variable protective regulation index is the combined sum of all the other internet indexes in this Table, (ii) personal data refers to a law which specifies the maximum time period for which personal data can be stored by Internet service and application providers, (iii) e-commerce transactions refers to any domestic legal protections that specifically cover e-commerce transactions (e.g. purchases made online or via mobile platforms) and that go beyond general consumer protection rules, (iv) domestic services refers to the level of domestic legal protection provided to consumers who buy or subscribe to e-commerce services differ from the level of protection provided when the services are bought or subscribed to by other means, (v) domestic physical goods refers to the level of domestic legal protection provided to consumers who buy physical goods via e-commerce differ from the protection provided when the goods are bought elsewhere (e.g. by mail or at a retail store) and (vi) the variable statutory right to return refers to consumers that have a statutory right to return physical goods purchased through e-commerce under certain conditions, for a full or partial refund. OLS model with robust standard errors, clustered at the country level, are reported in parenthesis. *** denotes statistical significance at 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Table 8: The Effects of Restrictive Digital Regulation on Innovation Outcomes Across Companies

Dep. var. =	ln(money allocated to innovation activities)		
	(1)	(2)	(3)
restrictive regulation index	-0.541***		
	[0.008]		
restrictions on e-commerce sales		-2.037***	
		[0.028]	
restrictions on search engine content			-0.736***
			[0.010]
ln(days to register properties)	-0.110***	-0.365***	-0.018***
	[0.001]	[0.005]	[0.000]
gross enrollment ratio for tertiary	13.450***	39.827***	3.923***
	[0.228]	[0.594]	[0.095]
labor force with tertiary education	-25.734***	-88.871***	-2.930***
	[0.446]	[1.323]	[0.133]
turnover growth	1.423***	1.423***	1.423***
	[0.209]	[0.209]	[0.209]
ln(researchers per million)	-6.538***	-21.292***	-1.209***
	[0.102]	[0.307]	[0.028]
ln(population density)	-2.836***	-9.665***	-0.370***
	[0.048]	[0.142]	[0.014]
research and development expenditure	0.556***	2.734***	-0.231***
	[0.008]	[0.038]	[0.004]
R-squared	0.03	0.03	0.03
Sample Size	41630	41630	41630
Over 50 Employees FE	Yes	Yes	Yes
Sells Internationally FE	Yes	Yes	Yes
Sells Locally/Regionally FE	Yes	Yes	Yes
Sells Nationally FE	Yes	Yes	Yes
Sells Other Countries FE	Yes	Yes	Yes

Notes: (i) The variable restrictive regulation index is the combined sum of the other two indexes in this Table, (ii) restrictions on e-commerce sales refers to the restrictions on the types of goods and services that can be sold online and (iii) restrictions on search engine content refers to any regulation that forces search engine providers to edit content provided in the results in order to filter out certain material such as links to sites inappropriate for children or intended to defraud consumers. OLS model with robust standard errors, clustered at the country level, are reported in parenthesis. *** denotes statistical significance at 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Table 9: Protective Regulation Index and Alternative Measures of Innovation Outcomes

Dep. var. =	baseline innovation	in house R&D	acquiring knowledge	acquiring capital	external R&D
	(1)	(2)	(3)	(4)	(5)
protective regulation index	0.031***	0.039***	0.007***	0.025***	0.014***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
R-squared	0.03	0.02	0.01	0.05	0.01
Sample Size	41630	40549	39659	40594	39328
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Over 50 Employees FE	Yes	Yes	Yes	Yes	Yes
Sells Internationally FE	Yes	Yes	Yes	Yes	Yes
Sells Locally/Regionally FE	Yes	Yes	Yes	Yes	Yes
Sells Nationally FE	Yes	Yes	Yes	Yes	Yes
Sells Other Countries FE	Yes	Yes	Yes	Yes	Yes

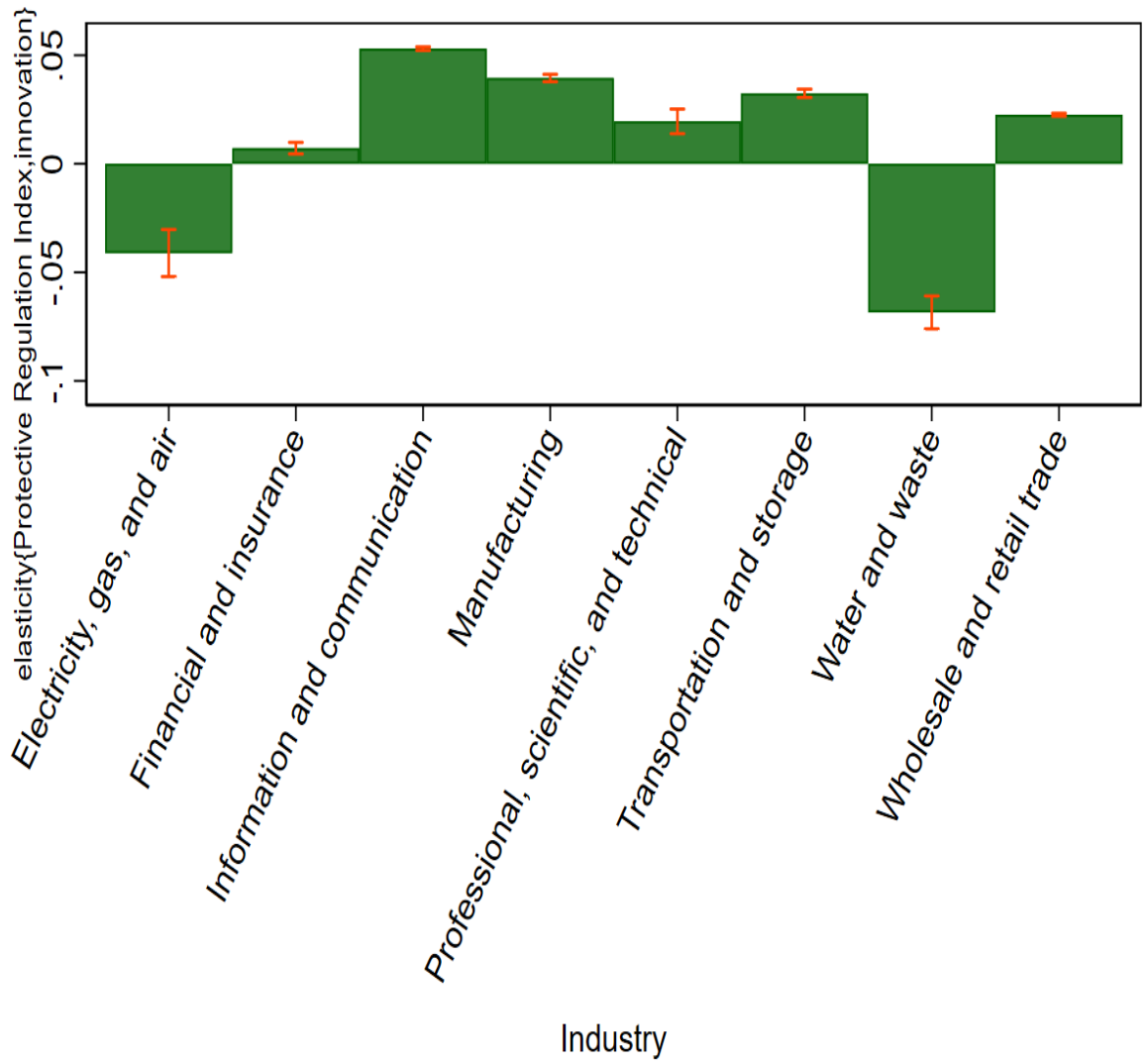
Notes: The table reports the coefficients associated with regressions of innovation outcomes on protective regulation index. The variable protective regulation index is the combined sum of the internet indexes: personal data, e-commerce transactions, domestic services, domestic physical goods and the variable statutory right to return. OLS model with robust standard errors, clustered at the country level, are reported in parenthesis. *** denotes statistical significance at 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Table 10: Restrictive Regulation Index and Alternative Measures of Innovation Outcomes

Dep. var. =	baseline innovation	in house R&D	acquiring knowledge	acquiring capital	external R&D
	(1)	(2)	(3)	(4)	(5)
restrictive regulation index	-0.541***	-0.680***	-0.128***	-0.430***	-0.239***
	[0.008]	[0.007]	[0.000]	[0.007]	[0.002]
R-squared	0.03	0.02	0.01	0.05	0.01
Sample Size	41630	40549	39659	40594	39328
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Over 50 Employees FE	Yes	Yes	Yes	Yes	Yes
Sells Internationally FE	Yes	Yes	Yes	Yes	Yes
Sells Locally/Regionally FE	Yes	Yes	Yes	Yes	Yes
Sells Nationally FE	Yes	Yes	Yes	Yes	Yes
Sells Other Countries FE	Yes	Yes	Yes	Yes	Yes

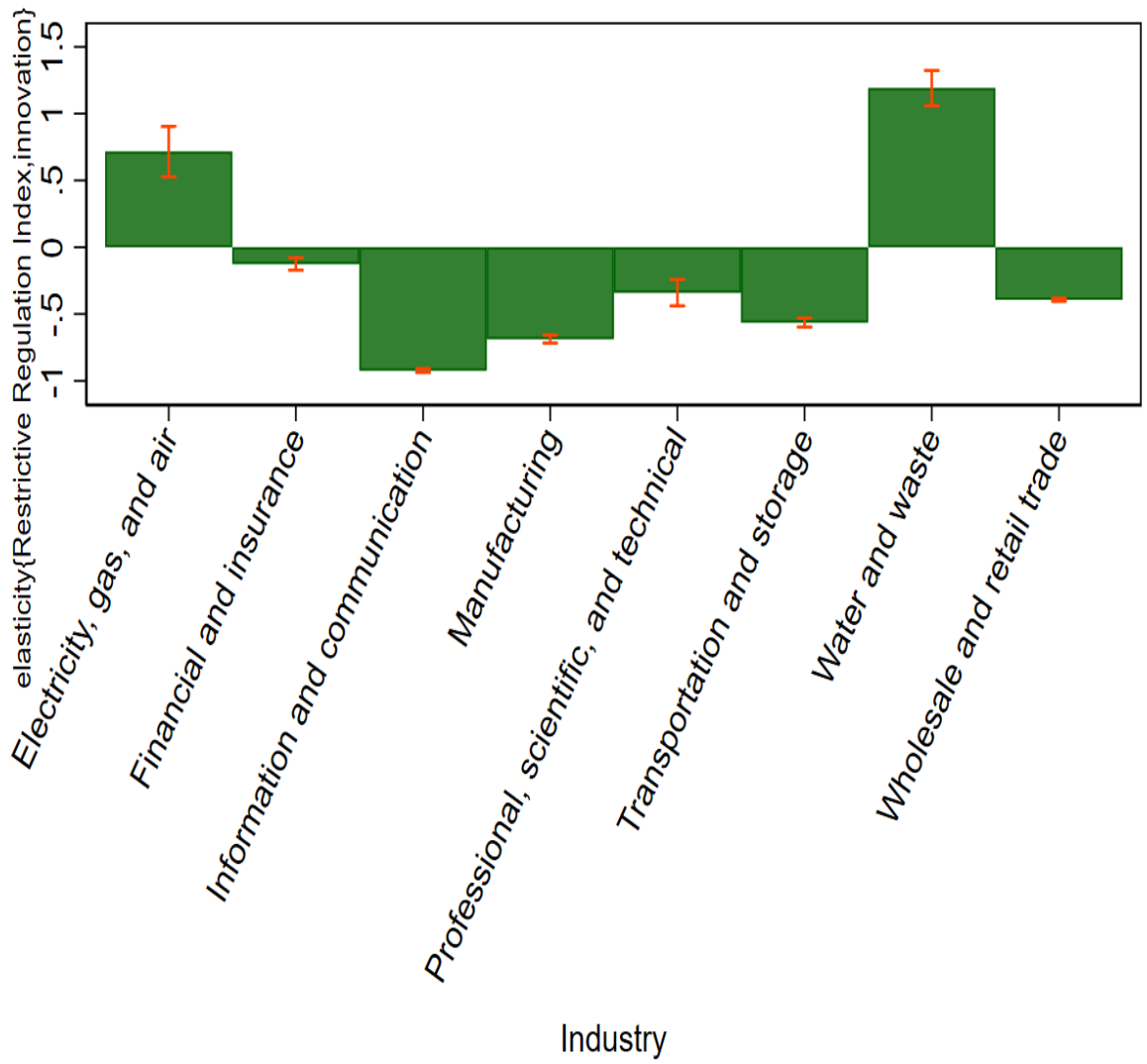
Notes: The table reports the coefficients associated with regressions of innovation outcomes on restrictive regulation index. The variable restrictive regulation index is the combined sum of the internet indexes: restrictions on e-commerce sales and restrictions on search engine content. OLS model with robust standard errors, clustered at the country level, are reported in parenthesis. *** denotes statistical significance at 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Figure 6: Protective Digital Regulation: Heterogeneity in Treatment Effects across Industries



Notes.–Sources: OECD, World Bank 2000-2012. The table reports the coefficients associated with regressions of logged money allocated to innovation activities within a company on an index of protective digital regulation, conditional on country controls (the logged number of days it takes to register properties, the gross enrollment ratio for tertiary education as a percent, the labor force with a tertiary education as a percent, the logged number of researchers in R&D activities per million people, and logged population density) and company controls (an indicator for whether there are over 50 employees, an indicator for whether they sell goods locally/regionally, an indicator for whether they sell goods nationally, and turnover growth in their employment) separately for each major industry.Standard errors are clustered at the country-level.

Figure 7: Restrictive Digital Regulation: Heterogeneity in Treatment Effects across Industries



Notes.–Sources: OECD, World Bank 2000-2012. The table reports the coefficients associated with regressions of logged money allocated to innovation activities within an company on an index of restrictive digital regulation, conditional on country controls (the logged number of days it takes to register properties, the gross enrollment ratio for tertiary education as a percent, the labor force with a tertiary education as a percent, the logged number of researchers in R&D activities per million people, and logged population density) and company controls (an indicator for whether there are over 50 employees, an indicator for whether they sell goods locally/regionally, an indicator for whether they sell goods nationally, and turnover growth in their employment) separately for each major industry.Standard errors are clustered at the country-level.

Table A.1: Distribution of Companies across Countries

country	firms	percent
Belgium	4595	1.66
Czech Republic	29077	10.5
Estonia	9513	3.43
Greece	1029	0.37
Hungary	19638	7.09
Iceland	680	0.25
Italy	21854	7.89
Norway	15052	5.43
Portugal	24340	8.79
Slovakia	11867	4.28
Slovenia	9450	3.41
Spain	129954	46.91

Notes: This table contains the distribution of companies across countries in our sample and their share from 1998-2012.

Table A.2: Distribution of Companies across NACE Categories

section	name	firms	percent
SECTION A	AGRICULTURE FORESTRY AND FISHING	1819	0.68
SECTION B	MINING AND QUARRYING	1559	0.58
SECTION C	MANUFACTURING	120891	45.04
SECTION D	ELECTRICITY GAS STEAM AND AIR CONDITIONING SUPPLY	4430	1.65
SECTION E	WATER SUPPLY SEWERAGE WASTE MANAGEMENT AND REMEDIATION	8372	3.12
SECTION F	CONSTRUCTION	6222	2.32
SECTION G	WHOLESALE RETAIL TRADE AND REPAIR	27862	10.38
SECTION H	TRANSPORTATION AND STORAGE	27807	10.36
SECTION I	ACCOMMODATION AND FOOD SERVICE ACTIVITIES	6386	2.39
SECTION J	INFORMATION AND COMMUNICATION	17749	6.61
SECTION K	FINANCIAL AND INSURANCE ACTIVITIES	8810	3.28
SECTION L	REAL ESTATE ACTIVITIES	289	0.11
SECTION M	PROFESSIONAL SCIENTIFIC AND TECHNICAL ACTIVITIES	27669	10.31
SECTION N	ADMINISTRATIVE AND SUPPORT SERVICE	3706	1.38
SECTION P	EDUCATION	266	0.1
SECTION Q	HUMAN HEALTH AND SOCIAL WORK ACTIVITIES	3299	1.23
SECTION R	ARTS ENTERTAINMENT AND RECREATION	844	0.31
SECTION S	OTHER SERVICE ACTIVITIES	449	0.17

Notes: This table contains the distribution of companies across NACE categories over the period 1998-2012.

Table A.3: Company Level Data-Summary Statistics

variables	obs	mean	stddev	min	max
		.	.	.	.
Innovation Outcomes		.	.	.	.
Money allocated to innovation activities	191092	161406	4373620	0	797000000
Money allocated to house Research and Development	232638	1152609	131000000	0	30800000000
Money allocated to acquiring knowledge	231190	135441	17900000	0	3800000000
Money allocated to acquiring capital	232754	1546528	139000000	0	28400000000
Money allocated to external Research and Development	230241	247425	27600000	0	5670000000
		.	.	.	.
Reasons not to Innovate Outcomes		.	.	.	.
Costs too high	148285	0.4	0.498	0	1
Skill gap	148997	1.08	1.05	0	3
IT shortage	148973	0.96	0.98	0	3
Low information	148956	0.93	0.97	0	3
Low demand	148292	1.09	1.12	0	3
		.	.	.	.
Other Controls: Firm Level		.	.	.	.
Sells internationally	191092	0.25	0.43	0	1
Sell goods locally/regionally	191092	0.83	0.377	0	1
Sell goods nationally	191092	0.7	0.457	0	1
Sell goods to other countries	191092	0.4	0.49	0	1
Over 50 employees	191092	0.49	0.5	0	1
Turnover growth	191092	32400000	364000000	0	38500000000

Notes: Summary statistics for all the variables in the dataset over the period 1998-2012.

Table A.4: Country Level Data - Summary statistics

variables	obs	mean	stddev	min	max
Product Market Regulation					
Product market regulation (non-standardized)	191092	-0.11	0.96	-1.52	1.86
Internet Regulation					
Domestic e-commerce transactions	42683	0.98	0.13	0	1
Domestic services	42683	0.9	0.3	0	1
Domestic physical goods	42683	0.98	0.13	0	1
Statutory right to return	42683	0.99	0.11	0	1
Personal data	42683	0.99	0.11	0	1
Restrictions on e-commerce sales	42683	0.85	0.34	0	1
Restrictions on search engine content	42683	0.75	0.43	0	1
Protective regulation index	42683	4.84	0.52	2	5
Restrictive regulation index	42683	1.6	0.73	0	2
Other Controls: Country Level					
Days to register properties	191092	28.68	32.24	1	124
Gross enrollment ratio for tertiary	191092	0.69	0.11	0.44	0.91
Labor force with tertiary education	191092	0.27	0.09	0.13	0.38
Researchers per million	191092	2550.36	789.96	1234.18	5547.82
Population density	191092	107.62	37.54	12.57	196.12
Research and development expenditure (perc of GDP)	191092	1.2	0.23	0.47	2.58

Notes: Summary statistics for all the variables in the dataset over the period 1998-2012.

Table A.5: Correlation of Internet Measures and PMR

	PMR	Dom trans	Dom serv	Dom phys	Stat return	Pers data	Restr sales	Restr engine
Product Market Regulation	1							
Dom e-commerce transactions	-0.20	1						
Dom services	-0.20	1	1					
Dom physical goods	0.51	0.42	0.42	1				
Statutory right to return	-0.05	-0.04	-0.04	-0.016	1			
Personal data	-0.05	-0.04	-0.04	-0.02	1	1		
Restrictions on e-commerce sales	-0.47	0.612	0.612	-0.056	0.28	0.28	1	
Restrictions on search engine content	0.01	0.57	0.57	0.24	0.2	0.2	0.72	1

Notes: Correlation between measures of internet and PMR for the year 2012.

H Appendix Data Sources

This section describes the main variables used in our analysis.

H.1 Company Level Data

H.1.1 Innovation Outcomes

All the variables in this section are in US dollars, constant prices, 2010.We take the log of these variables.

Money allocated to innovation activities: This index counts the total expenditures in innovation activities. Source: CIS.

Money allocated to house R&D: Current expenditures, labour costs and capital expenditures on buildings and equipment specifically for R&D. Source: CIS.

Money allocated to acquiring knowledge: Expenditures on acquisition of existing knowledge from other enterprises or organizations. Source: CIS.

Money allocated to acquiring capital: Expenditures on acquisition of machinery, equipment, software and buildings. (Exclude expenditures on these items that are for R&D. Source: CIS.

Money allocated to external R&D: Expenditures on external R&D. Source: CIS.

H.1.2 Reasons not to Innovate Outcomes

All the variables in this section are dummy variables. They receive the value three if it is high and the value zero if the factor is not experienced.

Costs too high: Innovation cost is too high. Source: CIS.

Skill gap: Lack of qualified personnel. Source: CIS.

IT shortage: Lack of information on technology. Source: CIS.

Low information: Lack of information on markets. Source: CIS.

Low demand: Low demand for innovations in your market. Source: CIS.

H.1.3 Company Characteristics

Sells internationally: It is a dummy variable that takes the value one if the company sells products to other members of European Union or associated countries. Source: CIS.

Sell goods locally/regionally: It is a dummy variable that takes the value one if the company sells products to the local market. Source: CIS.

Sell goods nationally: It is a dummy variable that takes the value one if the company sells products nationally. Source: CIS.

Sell to all other countries: It is a dummy variable that takes the value one if the company sells products to all other countries. Source: CIS.

Over 50 employees: It is a dummy variable which has the value one if the company has more than fifty employees and zero otherwise. Source: CIS.

Turnover growth: Turnover is defined as the market sales of goods and services. Turnover growth is the growth in the company´s turnover. Source: CIS.

Nace: It reports the main activity of every company.Source: CIS.

H.2 Country Level Data

H.2.1 Product Market Regulation

Product market regulation, z-score: Index of product market regulation. It contains regulations about state control, barriers to entrepreneurship, and barriers to trade and investment. It has been standardized and rescaled to have a mean of zero and a standard deviation of one. Source: Koske et al., 2015.

H.2.2 Internet Regulation

Domestic e-commerce transactions: This is a dummy variable which takes the value one if it is “Yes” and the value zero if it is “No”. The question is: Are there any domestic legal protections that specifically cover e-commerce transactions (e.g. purchases made online or via mobile platforms) and that go beyond general consumer protection rules? Source: Koske et al., 2014.

Domestic services: The question is: This is a dummy variable which takes the value one if "protection is generally higher if the good is bought via e-commerce" and zero if it is "protection is the same, irrespective of how the service is bought". Does the level of domestic legal protection provided to consumers who buy or subscribe to e-commerce services differ from the level of protection provided when the services are bought or subscribed to by other means? Source: Koske et al., 2014.

Domestic physical goods: This is a dummy variable which takes the value one if "protection is generally higher if the good is bought via e-commerce" and zero if it is "protection is the same, irrespective of how the service is bought". The question is: Does the level of domestic legal protection provided to consumers who buy physical goods via e-commerce differ from the protection provided when the goods are bought elsewhere (e.g. by mail or at a retail store)? Source: Koske et al., 2014.

Statutory right to return: This is a dummy variable which takes the value one if it is “Yes” and the value zero if it is “No”. The question is: Do consumers have a statutory right to return physical goods purchased through e-commerce under certain conditions, for a full or partial refund? Source: Koske et al., 2014.

Personal data: The question is: This is a dummy variable which takes the value one if it is “Yes” and the value zero if it is “No”. Does a law specify the maximum time period for which personal data can be stored by Internet service and application providers? Source: Koske et al., 2014.

Protective regulation index: It is the combined sum of the internet measures: domestic e-commerce transactions, domestic services, domestic physical goods, statutory right to return and personal data.

Restrictions on e-commerce sales: This is a dummy variable which takes the value one if it

is “Yes” and the value zero if it is “No”. The question is: Are there any restrictions on the types of goods and services that can be sold online? Source: Koske et al., 2014.

Restrictions on search engine content: This is a dummy variable which takes the value one if it is “Yes” and the value zero if it is “No”. The question is: Is there any regulation that forces search engine providers to edit content provided in the results in order to filter out certain material such as links to sites inappropriate for children or intended to defraud consumers? Source: Koske et al., 2014.

Restrictive regulation index: It is the combined sum of the internet measures: restrictions on e-commerce sales and restrictions on search engine content.

H.2.3 Country Controls

Days to register properties (in log): The time required to register property. Source: World Bank´s World Development Indicators.

Gross enrollment ratio for tertiary: The gross enrolment ratio for tertiary education for both sexes. Source: World Bank´s World Development Indicators.
Labor force with tertiary education: The percentage of total labor force with tertiary education. Source: World Bank´s World Development Indicators.

Researchers per million (in log): The number of researchers for every country. Source: World Bank´s World Development Indicators.

Population density (in log): Population density (people per square km of land area). Source: World Bank´s World Development Indicators.

Research and development expenditure (% of GDP): The research and development expenditure as a percentage of GDP for every country. Source: World Bank´s World Development Indicators.

Exchange rate: The exchange rate for every country in the dataset. It converts the national currency to US dollars. Source: OECD, 2012. CPI: The consumer price index of 2010. Source: World Bank´s World Development Indicators.