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Abstract

This paper assesses the short-term impact of product market deregulation in upstream sectors on the productivity growth of firms in downstream sectors (i.e. those firms using the output of the reformed sectors as inputs in their production process). Relying on a firm level database for the period 2004-2014 covering all Portuguese firms, we show that the most productive firms - those at the sectoral technological frontier - grasp short-run benefits from these reforms, which are then spread to the other existing firms via spillover mechanisms. In addition, reforms potentiate the exit of the least productive firms, improving the resource allocation in the economy. Finally, we show that the adoption of product market reforms in upstream sectors leads to a more resilient economy, better equipped to face adverse shocks.

JEL Classification: D04, D22, L43, L51

Keywords: Product Market Reforms, Total Factor Productivity, Growth, Exit Rates, Resource Allocation, Resilience

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1. Introduction

In recent years, Portugal implemented a large number of structural policies aimed at increasing productivity and improving resilience to shocks. Reforms covered many areas, such as the labour market, education and skills, the judicial and fiscal systems and several product market frameworks.

Product market reforms were a key area, given the dimension of the pre-existing challenges and the expected payoffs.[2] In 2008, Portugal ranked 26th out of 34th countries in the OECD Product Market Regulation index.[3] In this context, the product market reform agenda covered a large number of measures, aimed at fostering competition and reducing the excessive rents of sheltered sectors (see Box 1 for an overview of the main measures). As a consequence, between 2008 and 2013, Portugal climbed 14 places in the OECD's Product Market Regulation ranking, reaching the 12th position.

Box 1 – Examples of the main product market reforms implemented in Portugal during the economic adjustment programme (2011-2013)

Liberalization of gas and electricity markets, with the phasing out of regulated tariffs;

Negotiations with energy producers to reduce rents and eliminate the tariff debt;

Creation of a transports regulator; the reduction of ports operating costs;

New telecommunications regulatory framework, including the reduction of termination rates and lower restrictions on customers' mobility;

Competition enhancing framework in the postal sector;

Several steps in the direction of the liberalisation of 19 regulated professions;

Revision of the competition law and improved enforcement (e.g. with the creation of specialized courts);

Elimination of State special rights in private companies.

By using firm-level data from 2004 to 2014 and the OECD's PMR indicators, we assess the impact of the liberalization of product markets in Portugal on firms' productivity, reallocation of resources and resilience to shocks. In particular, we consider the effect of deregulation of product market sectors in downstream industries, i.e. on firms using these markets' output as input in their production process. This is possible due to a newly available OECD dataset relying on input-output matrices (Égert and Wanner, 2016).

Given that the reforms are recent and our available firm-level time series are relatively short, we focus mainly on short-run effects. This is particularly relevant for the political economy of the reform process, as its potential short-term costs, if not well communicated and properly addressed, may undermine support and create reform fatigue. In fact, while long-term gains of product market reforms are well established (see e.g. IMF, 2015 and OECD, 2015), they may take some years to materialize and even be negative in the short-run. For instance, lower rents lead to the exit of incumbent firms (while firm entry occurs only in the medium-term), thus contracting aggregate supply and increasing unemployment, which in turn reduces aggregate

[2] Several studies show that product market reforms produce the largest economic gains when compared to other reforms (see, for instance Égert and Gal, 2016 and Barnes, Bouis, Briard, Dougherty and Eris, 2013).

[3] The country ranked 1st being the more flexible in terms of product market regulations. The index is a *de jure* measure, thus not assessing outcomes.

demand. In addition, innovating firms have immediate costs but only longer-term (uncertain) gains. Aggregate demand may also contract in the short-run if reforms increase agents' uncertainty, leading them to higher savings and less consumption.

We provide the following contributions. Firstly, we analyse the short-term impact of reforms on productivity, showing that deregulation in upstream sectors increases productivity growth for the most productive downstream firms (those at the technological frontier), but not for the others (the laggards). However, laggard firms benefit from second round effects, as we also show that there are spillovers from those at the frontier, both via diffusion and catching-up mechanisms. In addition, we show that the short-run effects of reforms are heterogeneous across sectors, possibly due to different competitiveness structures and the position over the cycle.[4]

Secondly, we assess how the reforms affect firms' exit. Using a probit model, we show that less productive firms are more prone to exiting the market under a more flexible regulatory setting, which highlights the relevance of reforms to promote a more efficient resource allocation.

Finally, we assess the effects of reforms on firms' resilience to shocks. Relying on a difference-in-differences estimation and comparing two groups of firms – one more affected by the reforms and the other not as much – we show that previously enacted reforms allow firms to better manage the 2011 crisis, with a lower reduction in productivity.

This empirical contribution, by highlighting the existence of short-run costs allows for fine-tuning existing reforms and improving the design of future reforms; moreover, the evidence on the benefits of already enacted reforms is key in promoting ownership. This is particularly important in product markets, where vested interests are in general a strong impediment to reforms (as costs are concentrated on a small number of stakeholders, while gains are diffuse).

The paper proceeds as follows: Section 2 explores the most relevant literature and Section 3 presents the methodology. Section 4 introduces the database and the variables used and Section 5 provides the empirical results. Finally, Section 6 concludes.

2. Literature Review

The long-run positive impact of product market reforms on productivity and growth is a well-established result, both in model-based simulations (e.g. Arpaia, Alfonso, Roeger, Varga and Veld, 2007; Everaert and Schule, 2008; Andrés, Arce and Thomas, 2014; IMF, 2016) and in applied econometric research, using aggregate, sectoral and firm-level data (e.g. Égert and Gal, 2016; Arnold and Barbosa, 2015; Barnes, Bouis, Briard, Dougherty and Eris, 2013; Bouis and Duval, 2011; Bouis, Causa, Demmou, Duval and Zdzienicka, 2012; IMF, 2015; and OECD, 2015).[5]

However, these longer-run effects take time to materialize and may even be negative in the short-run – for instance, lower mark-ups may force incumbents to leave the market, implying, in the short-run, physical and human capital scrapping, contracting aggregate supply; the increased unemployment due to the exit of the least productive firms increases unemployment, potentiating also a reduction in short-term aggregate demand; agents' possible perception of

[4] For instance, the impact on hotels and restaurants is overall positive, which may be due to the competitive pressures that were introduced in the sector. Higher output-price elasticity implies that price reductions translate into higher output. Conversely, in the construction sector the effects are overall negative, since, as described in the literature, short-term costs of reforms are amplified during downturns (that particularly affected the construction sector).

[5] See Table A in the Annex for a schematic view of the papers covered in this literature review.

increased income insecurity may increase precautionary savings, further reducing aggregate demand.

The results in the model-based literature indeed point to the presence of these short-term costs for small open economies (Cacciatore, Duval, Fiori and Ghironi, 2015), for economies at the zero lower bound (Eggertsson, Ferrero and Raffo, 2013) and during downturns (IMF, 2016). The evidence on applied econometric literature does indicate that short-term gains are not granted. For instance, while Cacciatore and Fiore (2015) and Bouis, Causa, Demmou, Duval and Zdzienicka (2012), using aggregate data for a set of OECD countries, find evidence of short-term costs, Gal and Hijzen (2016), using firm-level data for 18 advanced economies, and Barone and Cingano (2011), using industry-level data for a set of OECD countries, find that product market reforms produce gains already in the short-run. Firm-level national studies, such as Forlani (2012) for France and Lanau and Topalova (2016) for Italy, also provide evidence of short-term gains.

It is thus important to understand what is driving these short-run effects, as different contexts may lead to different results. The empirical literature points to effects such as the role of (i) the economic cycle, (ii) technological spillovers, (iii) sectoral differences and (iv) initial conditions and interactions with other reforms. Indeed, a number of papers, using aggregate (e.g. Adhikari, Duval, Hu and Loungami, 2016), sectoral (e.g. Dabla-Norris, Guo, Haksar, Kim, Kochhar, Wiseman and Zdzienicka, 2015) and firm-level data (IMF, 2016), argue that the macroeconomic conditions influence the impact of structural reforms, with downturns reducing the expected gains. Bourles, Cette, Lopez, Mairesse and Nicolleti (2013), using industry-level data for a set of OECD countries, show that the effects of product market reforms are different for different firms, as increased competition may increase the returns to innovation for the most productive firms but reduce the incentives to innovate for the least productive. Nicoletti and Scarpeta (2003), also relying on sectoral level data, argue that product market regulation slows down technological catching-up. Santos, Gouveia and Gonçalves (2017), using firm level data for Portuguese firms for the period 2006-2014, show that while the effects of product market reforms are positive in the short-run for frontier firms (and, for some product market reforms, also for laggards), they negatively impact spillovers, in particular by curbing the pass-through from technological frontier firms to laggards. Dabla-Norris, Guo, Haksar, Kim, Kochhar, Wiseman and Zdzienicka (2015) and Gal and Hijzen (2016), using, respectively sectoral and firm-level data, show that the impact of product market reforms differs across sectors, due to different levels of competition and regulation before the implementation of such reforms. By comparing the effect of upstream regulation on manufacturers and services, Gal and Hijzen (2016) show that, while the effect is positive for both, it is more visible for manufacturers, which is, in general, more competitive (and thus have more to gain in terms of increase output from potential price reductions made possible for lower priced inputs). By further exploring the direct effects on the reformed sectors, the authors argue that higher initial regulation may bring higher short-term costs (but also larger long-term gains). Finally, Égert and Gal (2016) and Bouis, Causa, Demmou, Duval and Zdzienicka (2012), using aggregate data, also show that short-term costs are not independent of the initial conditions nor of other reforms.[6]

[6] The studies presented above evaluate the impact of product market reforms from two angles: their direct effect on regulated sectors (which are usually upstream sectors, such as electricity or gas) and their effects on the economy at large, by their impact on downstream sectors (which use the output of upstream sectors as inputs in the production process). For instance, while Gal and Hijzen (2016) and Lanau and Topalova (2016) focus mainly on upstream effects, Barone and Cingano (2011), Forlani (2012) and Bourles, Cette, Lopez, Mairesse and Nicolleti (2013) study the impact of reforms on downstream industries. The latter are based on sectoral or firm-level intensities of upstream inputs usages.

In a nutshell, the existing empirical literature shows that liberalized product markets foster productivity growth in the long-run but their short-run effects depend on the conditions under which they occur. Overall, gains are grasped due to a more competitive environment, which decreases mark-ups and increases churn-rates. The first effect was already studied for the Portuguese economy (Amador and Soares, 2013 and Folque, 2017), showing the important role of reforms, while highlighting the significant sectoral differences. For churn rates, existing literature shows that product market reforms potentiate firm entry and exit (European Commission, 2005; Schiantarelli, 2005; and Lanau and Topalova,2016, Gal and Hijzen, 2016).

The reduction in mark-ups and the increased churn rates improve the allocation of resources within the economy, fostering productivity growth. Indeed, the link between a more efficient resource allocation and higher productivity is widely explored in the literature.[7]

In addition to higher productivity growth, product market reforms are also expected to improve the economy's shock resilience, a result corroborated by Duval, Elmeskov and Vogel (2007), using industry-level data for a cross-country panel of OECD countries. Ernst, Gong and Semmler (2007), relying on a similar dataset, also conclude that these reforms reduce consumption volatility in the economy. Pelkmans, Montoya and Maravalle (2008), using sectoral data for euro area countries, show that product market reforms lubricate shock adjustments, price stickiness and inflation persistence. Finally, Cacciatori and Fiori (2016), relying on firm-level data for euro area countries, prove that business cycle fluctuations and economic volatility decreases with the implementation of product market reforms.

Following this literature, we investigate the impact of the deregulation of upstream sectors which occurred in Portugal in recent years. In particular, we assess the short-run effects on downstream firms' productivity, taking special attention to sectoral differences and to different initial productivity levels. Additionally, we assess if reforms are fostering a more efficient reallocation of resources, by potentiating the exit of the least productive firms. Finally, we investigate if reforms improve the resilience to adverse shocks.

3. Methodology

This section outlines the methodology of each part of the paper.

Firstly, we investigate the relationship between product market regulation in upstream sectors and firms' performance in downstream ones. Our baseline equation is as follows:

$$\Delta \mathrm{TFP}_{\mathrm{i,k,t}} = \beta_0 + \beta_1 \Delta \mathrm{Frontier}_{\mathrm{k,t}} + \beta_2\, \mathrm{DTF}_{\mathrm{i,k,t-1}} + +\beta_3\, \mathrm{Regimpact}_{\mathrm{k,t-1}} + \sum_{\mathrm{s=1}}^{4} \psi_{\mathrm{i}} \mathrm{D}_{\mathrm{i}} + \alpha_{\mathrm{k}} + \alpha_{\mathrm{t}} + \alpha_{\mathrm{r}} + \varepsilon_{\mathrm{i,k,t}} \quad [2]$$

Where $\Delta TFP_{i,k,t}$ is the growth of total factor productivity for firm i in sector k at year t.[8] $\Delta Frontier_{k,t}$ stands for the productivity growth of the sectoral technological frontier within the sector k at time t and $DTF_{i,k,t-1}$ denotes the distance of each firm to its sectoral frontier; these terms are included to control for spillovers from firms at the frontier, i.e., to assess whether more productive firms are spreading innovative features across the economy through so-called diffusion (or pass-through) mechanisms and catching-up. $Regimpact_{k,t-1}$, our regulatory variable, is an index that ranges from 0 (low impact of regulation in downstream sectors) to 1

[7] For instance, Foster, Haltiwanger, and Krizan (2001) and Restuccia and Rogerson (2007), both using firm-level data for the United States, conclude that a better resource allocation leads to productivity improvements.
[8] For more detailed information on how this variable is constructed, please refer to Section 4.2.

(high impact).[9] Hence, we expect a negative coefficient for this variable. Additionally, sectoral, time and region fixed effects are included (α_k , α_t , α_r, respectively) to control for characteristics that are specific to the sector, year and region. Firm size controls are also included ($\sum_{s=1}^{4} \psi_i D_i$). All regressions use robust standard errors to control for heteroskedasticity.

To assess the potential heterogeneous effects across firm productivity levels and sectors, we extend [2] by interacting the reform variable with a dummy, $Dfront$ (which is one for firms at the sectoral technological frontier and 0 otherwise), and separately for each sector (with and without the interaction variable).

The impact on productivity may be driven by changes in the intensive margin (i.e. changes in the TFP of firms in the market) or in the extensive margin (i.e. exit of firms with lower TFP). We investigate this second mechanism through the probit equation [3]:

$$\mathrm{Exit_{i,k,t}} = \beta_0 + \beta_1 \mathrm{Regimpact}_{k,t-1} * \mathrm{TFP_{i,k,t-1}} + \beta_2 \mathrm{Regimpact_{k,t-1}} + \beta_3 TFP_{i,k,t-1} + \varepsilon_{i,k,t} \quad [3]$$

Where $Exit_{i,k,t}$ is equal to 1 when a firm exits the market and 0 otherwise, $TFP_{i,k,t-1}$ stands for the level of productivity and $Regimpact_{i,k,t-1}$ is defined as in [2]. If reforms potentiate the exit of low productivity firms, the coefficient of the interaction term should be negative. The coefficient of $Regimpact_{i,k,t-1}$ is also expected to be negative, as a higher value represents a higher impact of regulation in upstream sectors. $TFP_{i,k,t-1}$ should also have a negative coefficient, because more productive firms are more likely to survive. We cluster standard errors at the sector level.

Finally, we apply a difference in differences (*DiD*) approach to evaluate whether firms in the downstream sectors that benefit the most from reforms (*treated* group) are more resilient to crisis. We expect their productivity levels to be less affected by the 2011 crisis, as compared to the *control* group (firms which are less affected by reforms).

Given that, up to 2011, the most important reforms tackled electricity and gas (Figure 1), we focus on these two upstream sectors to create the *treated* and *control* groups. The treated sectors use electricity and gas more intensively, i.e. belong to the 70th sectoral percentile, while the control sectors use them less intensely (30th sectoral percentile of gas and electricity usage).[10] To build the sectoral intensities, we use the OECD input-output matrix for the Portuguese economy. Importantly, we define the *treated* and *control* at the sectoral level, but we then implement a firm-level analysis.[11]

We thus estimate the following equation:

$$\mathrm{TFP_{i,k,t}} = \alpha_0 + \alpha_1 \mathrm{T_k} + \alpha_2 \mathrm{S_t} + \alpha_3 \mathrm{T_k} * \mathrm{S_t} + \varepsilon_{\mathrm{i,k,t}} \quad [3]$$

The dependent variable is the level of total factor productivity; T_k is the treatment dummy, i.e., it indicates firms in *treated* sectors; S_t is a time dummy that turns one from 2011 onwards,

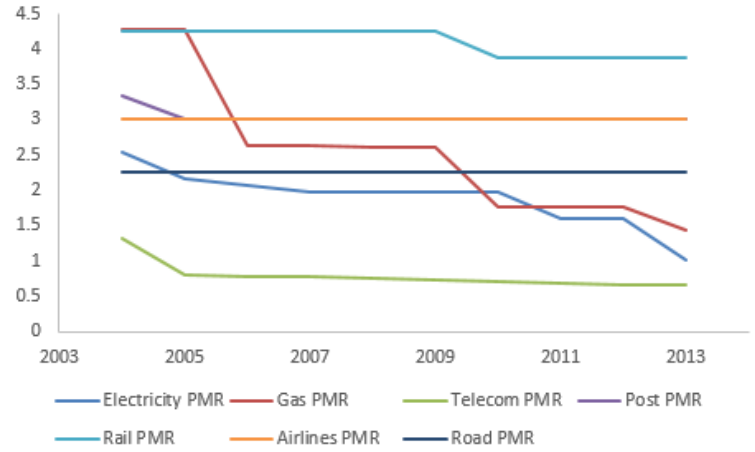
[9] The index may increase because the downstream sector relies more heavily on regulated upstream sectors or because upstream regulation is tightened.

[10] *Treated* group sectors (70th percentile): Electricity, gas and water supply; Other non-metallic mineral products; Mining and quarrying; Basic metals; Hotels and Restaurants; Agriculture, hunting, forestry and fishing; Pulp, paper, paper products, printing and publishing and Rubber and plastics products; *control* group sectors (30th percentile): Post and telecommunications; Electrical machinery and apparatus, nec; R&D and other business activities; Construction; Motor vehicles, trailers and semi-trailers; Computer, Electronic and optical equipment; Renting of machinery and equipment and Coke, refined petroleum products and nuclear fuel.

[11] Ideally, one would prefer to use firm-level intensities, but this information is not available in our firm-level database.

while $T_k * S_t$ is the *DiD* term, that we expect to have a positive coefficient, implying that the *treated* group reacts better to a negative shock, registering a lower decrease in TFP as compared to the *control* group.

Figure 1 – Product market regulation in network industries in Portugal



Source: OECD, Product Market Regulation Database. These indicators vary between 0 and 6 with 6 standing for maximum regulation.

4. Data

4.1 The dataset

We use the IES database - *Informação Empresarial Simplificada* (Simplified Corporate Information) provided by INE - *Instituto Nacional de Estatística* (Statistics Portugal), which includes the annual accounts (income statements and balance sheet) of all Portuguese firms, as reported simultaneously to the Ministry of Finance, the Ministry of Justice, Bank of Portugal and Statistics Portugal. Data are available from 2004 onwards.

The initial dataset covered 3,916,315 observations for the period 2004-2014.[12] To ensure consistency and robustness of our results, we focus on firms with positive values of assets, turnover, external supplies and services and with non-negative personnel expenses and number of employees. In addition, using the 3-digit level NACE Rev. 3, we exclude specific sectors, namely financial activities and insurance services, health care, entertainment, domestic staff and international organizations, given the specificities of their business models. With these exclusions, we reach a dataset of 3,199,118 observations. Moreover, due to lack of underlying data, we are not able to compute total factor productivity (TFP) for around 300,000 firms, leaving us with a total of 2,892,449 firms.[13]

4.2 Variables

This section describes the variables used in the study. The main performance variable is TFP, although we also compute Labour Productivity (LP) (output per worker), for robustness checks. TFP was computed using the Levinsohn and Petrin (2003) estimation method, which addresses the endogeneity problem arising from methods such as OLS or fixed-effects estimators.[14] The

[12] We focus solely on companies and we have thus excluded individual entrepreneurs (*empresários em nome individual*).

[13] Please refer to Section 4.2. for detailed information about our estimation of total factor productivity (TFP).

[14] As the authors argue, when estimating production functions, one must account for the correlation between input levels and productivity, as otherwise one gets inconsistent estimates of the parameters of the production function. Therefore, they develop an estimator using intermediate inputs to proxy for the unobservable productivity term. To compute the TFP, we rely on the STATA code developed by Petrin, Poi and Levinsohn (2004), using external supplies and services as a proxy for intermediate inputs.

technological frontier was defined as the firms in the 90th percentile for the estimated TFP, by year and sector. Firms outside the technological frontier are labelled as laggards. The distance to frontier is the productivity gap between laggards and frontier firms, and is computed for each laggard firm as the difference between its TFP level and the lower bound value of the productivity at the frontier, for each year and sector.

Sectoral fixed effects are constructed using the 3-digit level NACE Rev 3.[15] Region fixed effects are obtained with the NUT 2 Portuguese region division.[16] Additionally, firm size controls are included. Following Statistics Portugal methodology, we construct each firm-size bracket according to the conditions presented in Table 1.

Table 2 presents the descriptive statistics. The firms in our sample have an average of 10 workers, 1.2 million € of output and 1.6 million € of assets. Concerning firm size, 82% are micro firms, 15% are small, 2% are medium and 0.4% are large. Operational costs and cost of employees account for, on average, 0.3 and 0.2 million €, respectively. Frontier firms are, on average, larger – they have a much higher output, their assets are more than the double of those of laggards and their number of workers is also higher. The average annual TFP growth is negative for laggards (-0.05%) but positive for firms at the frontier (+0.24%).[17]

Table 1 – Firm size - criteria

Type of Firm	Number of Workers		Output
Micro	<10	and	<2 Million
Small	>10 and <50	and	>2 Million and <10 Million
Medium	>50 and <250	and	>10 Million and <50 Million
Large	>250	or	>50 Million

Source: Statistics Portugal

Table 2 – Descriptive Statistics – firm level data

Variables	*Unit*	Mean	Std Dev	Min.	Max.	Mean frontier	Mean laggards
Output	*10 ³ €*	1,218	26,700	0	10,300,000	5,214	774
Operational Costs	*10 ³ €*	288	5,621	0	1,820,000	735	238
Cost of employees	*10 ³ €*	174	2,114	0	5,030,00	252	152
Assets	*10 ³ €*	1,586	53,500	0	21,200,000	3,051	1,423
Number of workers	*unit*	10	89	1	22,734	13	9
Micro Firms	*unit*	0.82	0.38	0	1	0.72	0.83
Small Firms	*unit*	0.15	0.36	0	1	0.2	0.14
Medium Firms	*unit*	0.02	0.15	0	1	0.06	0.02
Large Firms	*unit*	0	0.07	0	1	0.01	0
TFP growth [ΔTFP]	*%*	-0.02	0.54	-10.8	12.2	0.24	-0.05
TFP growth of frontier [ΔFrontier]	*%*	0	0.02	-0.6	0.53	-	-
Distance to Frontier [DTF]	*p.p.*	0.86	0.75	0	13.45	0	0.96

Source: Authors' own calculations based on IES.

[15] The included sectors are Agriculture, hunting, forestry and fishing; Mining and quarrying; Food products, beverages and tobacco; Wood and products of wood and cork; Pulp, paper, paper products, printing and publishing; Coke, refined petroleum products and nuclear fuel; Chemicals and chemical products; Rubber and plastics products; Other non-metallic mineral products; Textiles, textile products, leather and footwear; Basic Metals; Fabricated metal products except machinery and equipment; Machinery and equipment n.e.c; Motor vehicles, trailers and semi-trailers; Other transport equipment; Electricity, gas and water supply; Construction; Transport and storage; Post and telecommunications; Real estate activities; Office, accounting and computing machinery; Electrical machinery and apparatus n.e.c; Radio, television and communication equipment; Medical, precision and optical instruments; Manufacturing n.e.c and recycling; Wholesale and retail trade, repairs; Hotels & Restaurants; Renting of machinery and equipment; Computer and related activities; Other Business Activities; Research and Development.

[16] This division includes 7 regions, covering Mainland Portugal and Islands.

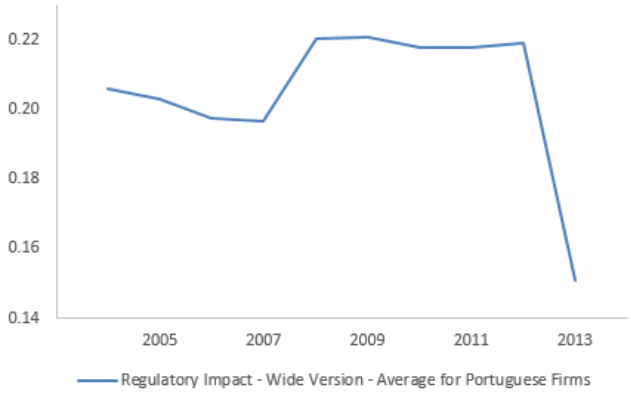
[17] The average growth of the technological frontier is different from this value (0.00%) because we have an unbalanced sample.

The Regulatory Impact variable (*Regimpact*) is an OECD index of the potential costs of the anti-competitive regulation in network sectors, retail distribution and professional services on 37 sectors of the economy that uses the output of these sectors as intermediate inputs (see Égert and Wanner, 2016, for more information). This variable is computed by the OECD by weighing the degree of regulation in the non-manufacturing sectors (Regnmi) by the input-output coefficient (w) of sector k from the non-manufacturing sector j:

$$Regimpact_{k,t} = \sum_{j=1}^{n} Regnmi_{j,t} * w_{j,k} \qquad [1]$$

We rely on the wide version of the indicator, which includes network sectors, retail distribution and professional services as upstream sectors, and use the narrow version, which only considers regulation in network sectors, for robustness purposes.[18] Figure 2 shows the evolution of the wide indicator for Portuguese firms between 2004 and 2013.[19]

Figure 2 – Regulatory Impact indicator 2004–2013



Source: Authors' own computations based on OECD, Product Market Regulation Database and IES.

Table 3 – Descriptive statistics –firm level data - *DiD* estimation

Variable	Unit	Treated	Control	t[a]
Output	10^3 €	1,120	1,289	-2.48
		(28)	(70)	
Operational Costs	10^3 €	164	434	-32.81
		(3)	(10)	
Cost of Employees	10^3 €	118	195	-21.18
		(2)	(4)	
Assets	10^3 €	1,622	1,762	-1.13
		(81)	(48)	
lnTFP	*unit*	2	1	200
		(0)	(0)	
Number of workers	*unit*	8	11	-16.09
		(0.11)	(0.14)	

Source: Authors' own calculations based on IES.

a Test of equality of means in treated and control groups.

The *treated* and *control* sectors used in the *DiD* estimation have, by construction, very different intensities of electricity and gas input usage: between 4% and 54% of total inputs for the *treated*

[18] For a discussion on the *pros* and *cons* of each type of indicator, see Égert and Wanner (2016).
[19] Appendix A6 presents detailed information on the *wide* and *narrow* indicator for each sector and year.

and from 0% to 1% for the *control*.[20] In addition to these difference, Table 3 shows that firms in *treated* sectors are more productive but are also smaller, both in terms of number of employees and output. Operational costs and the cost of employees are higher in the *control* group.

5. Empirical Results and Robustness Checks

5.1 Impact on Productivity

We start by estimating equation [2] to analyse the effects of upstream regulation on firm productivity. The results, presented in Table 4, indicate the presence of short-run costs, as reforms are curbing productivity one year after their implementation. To assess the validity of our results, we conduct several robustness tests. In particular, we replace our regulatory impact indicator with its narrow version. As argued by Égert and Wanner (2016), while the wide indicator is more suitable for cross-country or cross-sector studies, the narrow indicator is better suited for time-series analysis (as only the network indicator has an annual frequency). Furthermore, we test the regression with Labour Productivity, instead of TFP, as our performance variable. The results are qualitatively the same, pointing to short-run costs.

It is thus important to understand if these costs are broad-based, affecting different firms and sectors equally, or if we face heterogeneous effects.

5.2 Heterogenous Effects

In this section, we explore heterogeneous effects across firms with different productivity levels and in different sectors.

We start by extending equation [2] with an interaction variable (as described in the methodology section), and show that frontier firms are actually gaining from a less stringent regulatory framework in the intermediate sectors one year after the reforms, while laggards are losing (Table 5). However, productivity spillovers from frontier firms are positive, both in terms of pass-through and catching-up, at least partially compensating for the negative direct effects on laggard firms. These results may be explained by the fact that frontier firms are better equipped to deal with competitive pressures and to grasp the benefits of higher competition in upstream sectors, by using the additional profit margin to reduce prices. Laggards have more compressed profit margins and thus have less scope to do so. The results using the narrow regulatory impact indicator and LP as our performance measure are qualitatively in line with the core estimations.

To assess if different sectors are affected differently, we also estimate equation [2] by sector. Table 6 presents the main results for the different sectors. We show that while some sectors are facing short-term costs, some others, namely Agriculture, hunting, forestry and fishing, Other Business Activities, Real estate activities, Hotels & Restaurants, Fabricated metal products except machinery and equipment, and Transport and storage, have increased productivity growth already one year after the reforms. The results of the same regression but using the narrow version of the reform indicator, LP instead of TFP and with the distinction of the effect on frontier and laggard firms are available in Tables B1 to B5 in the Annex. Overall, the results are qualitatively the same, with some exceptions for specific sectors.[21]

[20] Details about the construction of *treated* and *control* groups available in Section 4.

[21] Note that the definition of the frontier depends on the performance indicator used; thus, some sectoral differences are expected when using different performance indicators.

Table 4 – Results of equation [2] estimation – baseline

Variable	ΔTFP	ΔTFP	ΔLP
ΔFrontier	0.99***	0.99***	4.45***
	(0.02)	(0.02)	(0.09)
DTF	0.6***	0.6***	0.51***
	(0)	(0)	(0)
Regimpact (wide)	0.07***	-	0.08***
	(0.01)		(0.02)
Regimpact (narrow)	-	0.13**	-
		(0.07)	
Small Firm	0.16***	0.16***	0.12***
	(0)	(0)	(0)
Medium Firm	0.30***	0.30***	0.29***
	(0)	(0)	(0.01)
Large Firm	0.43***	0.43***	0.52***
	(0.01)	(0.01)	(0.02)
Sectoral Fixed Effects	YES	YES	YES
Region Fixed Effects	YES	YES	YES
Time Fixed Effects	YES	YES	YES
Constant	-0.61***	-0.61***	-0.8***
	(0)	(0)	(0)
N	1,680,539	1,680,539	1,846,810
R^2	36%	36%	35%

Source: Authors' own calculations.

Table 5 – Results of equation [2] estimation – interaction [reform] and [frontier]

Variable	ΔTFP	ΔTFP	ΔLP
ΔFrontier	1.08***	1.08***	5.17***
	(0.02)	(0.02)	(0.09)
DTF	0.65***	0.65***	0.59***
	(0)	(0)	(0)
Regimpact (wide)	0.14***	-	0.17***
	(0.01)		(0.02)
Regimpact (narrow)	-	0.32***	-
		(0.06)	
DummyFrontier	0.86***	0.78***	1.23***
	(0)	(0)	(0.01)
DummyFrontier*Regimpact (wide)	-0.73***	-	-1.04***
	(0.02)		(0.02)
DummyFrontier*Regimpact (narrow)	-	-0.94***	-
		(0.02)	
Small Firm	0	0	0.1
	(0)	(0)	(0)
Medium Firm	0	0	0.2
	(0)	(0)	(0.01)
Large Firm	0	0	0.3
	(0.11)	(0.01)	(0.02)
Sectoral Fixed Effects	YES	YES	YES
Region Fixed Effects	YES	YES	YES
Time Fixed Effects	YES	YES	YES
Constant	-0.75***	-0.75***	-1.05***
	(0)	(0.01)	(0.01)
N	1,680,539	1,680,539	1,846,810
R^2	43%	43%	0.42

Source: Authors' own computations.

Table 6 – Results of equation [2] estimation – baseline by sector

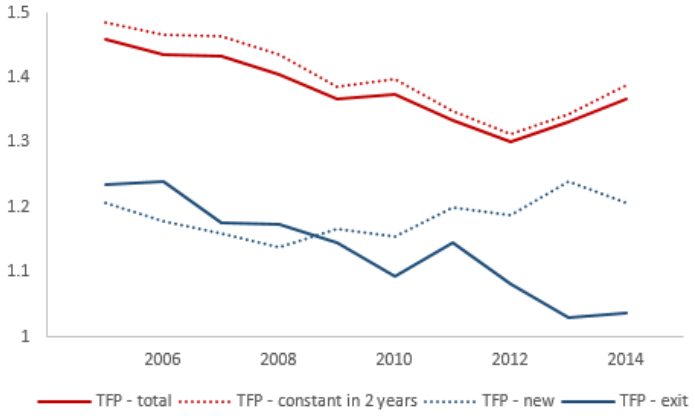
Variable ΔTFP	ΔFrontier	DTF	Regimpact	N	R^2
Agriculture, hunting, forestry and fishing	1.75***	0.52***	-1.03***	64,059	41%
Mining and quarrying	-1.45***	0.52***	4.11***	6,577	29%
Food products, beverages and tobacco	-4.01***	0.53***	1.86***	50,122	36%
Wood and products of wood and cork	-2.91***	0.54***	0	23,500	29%
Pulp, paper, paper products, printing and publishing	-0.84***	0.5***	3.13***	21,024	50%
Coke, refined petroleum products and nuclear fuel	2	0.59***	2	1,410	37%
Chemicals and chemical products	-2	0.4***	4.22***	3,813	21%
Rubber and plastics products	1.66***	0.5***	2.05***	8,092	31%
Other non-metallic mineral products	4.25***	0.43***	5.4***	22,910	22%
Textiles, textile products, leather and footwear	-0.32***	0.53***	1.51***	72,709	26%
Basic metals	-9.57***	0.39***	-1	2,245	28%
Fabricated metal products except machinery and equipment	-11.51***	0.59***	-3.1***	49,580	34%
Machinery and equipment n.e.c	-3.64***	0.52***	1.5***	10,217	29%
Motor vehicles, trailers and semi-trailers	4.92***	0.48***	5***	3,705	29%
Other transport equipment	-4	0.62***	2	1,292	43%
Electricity, gas and water supply	1	0.57***	0	2,906	51%
Construction	-5.37***	0.74***	5.53***	302,312	42%
Transport and storage	-9.02***	0.55***	-1.39***	153,744	27%
Post and telecommunications	0	0.72***	2.49***	2,009	50%
Real estate activities	-11.62***	0.69***	-34.86***	67,638	45%
Office, accounting and computing machinery	-2	0	-17	119	13%
Electrical machinery and apparatus n.e.c	0	0.6***	1	2,542	40%
Radio, television and communication equipment	1	0.42***	-9	198	35%
Medical, precision and optical instruments	0	0.64***	0	6,677	40%
Manufacturing n.e.c; recycling	-5.76***	0.56***	2.83***	21,758	32%
Wholesale and retail trade, repairs	-8.4***	0.46***	0.08***	429,587	29%
Hotels and restaurants	-4.04***	0.55***	-4.34***	217,696	34%
Renting of machinery and equipment	-1.54***	0.53***	15.12***	1,633	34%
Computer and related activities	-0.95**	0.63***	5.15***	30,667	40%
Other Business Activities	12.26***	0.59***	-10.87***	95,321	34%
Research and Development	11	0.58***	70	1,770	41%

Source: Authors' own computations.

5.2 Improved Resource Allocation

Figure 3 shows the changing pattern of firm entry and exit in the last decade. While up to 2008 the firms exiting the market have higher productivity than those entering, from 2009 the pattern is reversed. In this section, we investigate whether this is related with product market reforms.

Figure 3 – TFP by status of firm: incumbents, new and exit firms



Source: Authors' own computations based on IES.

By estimating a probit model on the probability of exiting the market (as defined in equation [3] of the methodological section), we show that low productivity firms are more prone to exit the market. But deregulation in upstream sectors *per se* does not foster firm exit (Table 7); however, the coefficient of the interaction between productivity and the reform variable is negative, meaning that reforms are, as expected, increasing the exit rates for low productivity firms.

In Figure 4 we report the marginal effect of the interaction variable varying TFP, with regulation set at its maximum and minimum, and varying regulation. In Panel 4A, we show that the lower the level of productivity, the higher the impact of regulation on the exit probability. Similarly, by comparing two firms with different productivity levels (Panel 4B), one highly productive and the other less so, we again show that the difference between their exit probabilities is much higher in less rigid regulatory environments.

Following the aforementioned procedure to test the robustness of our calculations, the same equation was estimated using the narrow version of the reform indicator, and using LP instead of TFP (Table 7). The sign of the interaction term remains negative and significant for all specifications.

Table 7 – Results of equation [3] estimation - probability of exiting (Probit)

Pr(Exit)	Coef	Coef	Coef
Regimpact (wide)	0	-	4.59***
	(0.28)		(1.42)
Regimpact (narrow)	-	0	-
		(0.15)	
lnTFP	-0.13**	-0.14***	-
	(0.04)	(0.03)	
lnLP	-	-	-0.11**
			(0.06)
Regimpact (wide)*lnTFP	-0.2*	-	-
	(0.11)		
Regimpact (narrow)*lnTFP	-	-0.8***	-
		(0.2)	
Regimpact (wide)*lnLP	-	-	-0.51***
			(0.15)
Constant	-1.03**	-1.04***	0.02
	(0.05)	(0.05)	(0.5)
N	1,678,664	1,678,664	1,847,730
Pseudo R^2	1%	2%	5%

(Standard Errors adjusted for clusters in sector)

Source: Authors' own computations.

Figure 4 – Predictive Margins

Figure 4A – Predictive Margins (Fixing Regulatory Impact indicator)

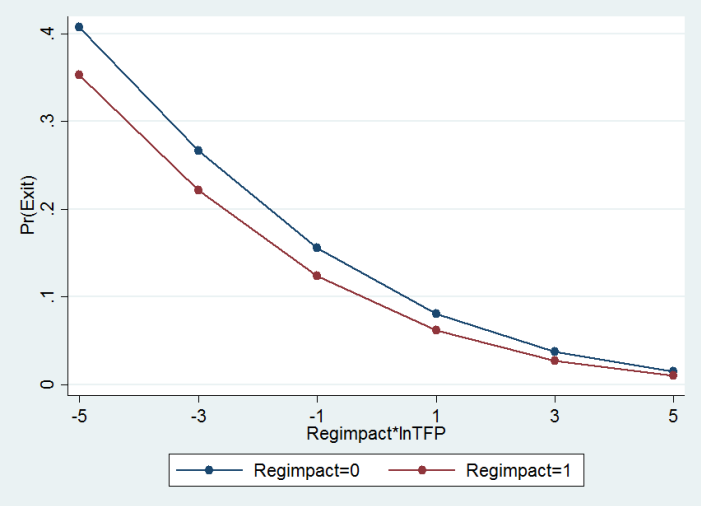
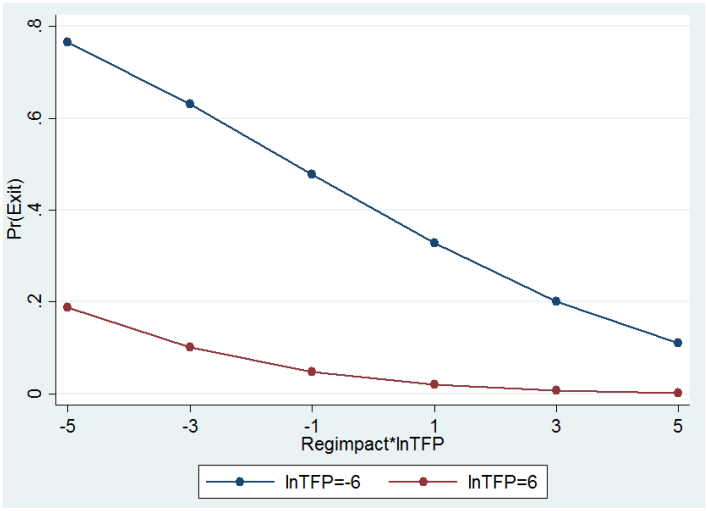


Figure 4B – Predictive Margins (Fixing lnTFP)

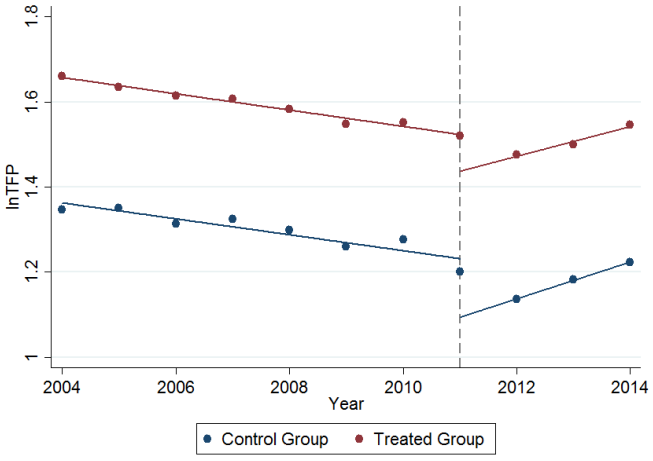


Source: Authors' own computations.

5.4 Enhanced resilience to shocks

We now use a difference in differences estimation to assess if firms in sectors most affected by reforms (*treated* group) were better equipped to face the 2011 economic crisis, as suggested by the preliminary evidence in Figure 5.

Figure 5 – Mean TFP levels for *treated* and *control* groups



Source: Author's own calculations using IES data for the years 2004-2014. N= 1,373,056. Note: This graph was produced using Binscatter command in Stata.

The results in Table 8 confirm that firms in *treated* sectors are more resilient to negative shocks when compared to the control group, i.e. in the face of the 2011 crisis their TFP decreased less markedly.

Table 8 – Difference in Differences Estimation Results

lnTFP	Complete	Without Electicity and Gas Sectors	Complete (LP)
Time	-0.12***	-0.12***	-0.29***
	(0)	(0)	(0.01)
Treated	0.29**	0.29**	0.12
	(0.11)	(0.11)	(0.2)
DiD	0.04**	0.04**	0.11***
	(0.01)	(0.01)	(0.02)
Cons	1.31***	1.31***	10.6***
	(0.01)	(0.01)	(0.02)
Controls	YES	YES	YES
N	1,373,056	1,373,056	1,490,905
R^2	3%	3%	1%

Source: Authors' own computations.

Ideally, we should have a placebo group, running the same *DiD* in a period with a crisis but no deregulation policies. However, this is not possible, as our dataset only covers the period starting in 2004. In any case, we perform two robustness checks based on the available data. First, we compute the same regression without the electricity and gas sectors. These sectors could potentially bias our results, as they were directly affected by the reforms (on top of the usual downstream effects affecting all sectors). The results remain unchanged, as we continue to see more resilience in the *treated* group (Table 8). In addition, using LP instead of TFP also keeps the results qualitatively unchanged.

6. Conclusion and way forward

In recent years, Portugal implemented a large number of structural reforms. Quantitative information on their effects in the economy is crucial for policy makers, as it allows fine-tuning past reform efforts and better designing future reforms. Taking stock of what was achieved so far is crucial to define the way forward.

In this study we focus on the effects of product market reforms, given their relevance in the Portuguese reform agenda in recent years, their large potential pay-offs and the usual resistance to reform, particularly acute in this area (with concentrated costs and diffuse benefits). In particular, we assess the short-run effects of product market reforms in upstream sectors on the firm-level productivity of downstream sectors, evaluating also the impact on the allocation of resources and on the resilience to adverse shocks. Short-term effects are particularly relevant given their role on the political economy of the reform process.

Relying on firm-level data for Portugal covering the period between 2004 and 2014, we show that the short-run impact of product market reforms on firm-level productivity is positive for the most productive firms (those belonging to the sectoral technological frontier), who are able to leverage on the increased competitiveness in the upstream sectors.[22] Additionally, we show that the exit of the least productive is potentiated by the reform process, potentiating a better resource allocation in the economy. For those firms that stay in the market, there are second round effects from the gains at the frontier, as we find evidence of positive pass-through and catching-up mechanisms. In addition, our results corroborate existing studies that show that effects across sectors are differentiated: while some sectors are benefiting from upstream deregulation already after one year, some others see their productivity growth curbed. Finally, we find evidence that reforms increase firms' resilience to negative shocks.

[22] We assess the effects of the reforms implemented up to 2013. Reform efforts in more recent years can only be evaluated when additional data periods become available. Also, we assess the impacts on the average firm; aggregate effects would need to rely on aggregate data or on weighted regressions.

Going forward, it would be important to enrich our results in a number of ways.

First, our analysis provides a partial picture of the effects of the reforms, as it focuses solely on the short-run. We opted for this time horizon because some of the reforms are very recent and our available time-series is not long. In any case, our assessment of the increased resilience to adverse shocks already points to these positive long-term effects. As more data becomes available, it will be possible to evaluate the longer-term effects of reforms on firms' productivity.

In addition, it would be informative to better understand the driving forces behind short-term costs. Following the literature, we could enlarge our analysis by accounting for the effect of the cycle. A preliminary attempt with the existing data shows that the effects of reforms before the financial and economic crisis are positive and only become negative during the downturn. However, a robust assessment would need to rely on a longer time-series. We could also explore the role of the initial framework conditions and the interactions with other reform areas, as existing literature highlights their relevance, in particular in the short-run.

Finally, and while total factor productivity is a key determinant of growth, a full assessment of the reforms' impact can only be done by also considering the impact on investment and labour utilisation (in particular on employment). Equity considerations are also key and it would thus be important to complement our firm-level analysis with worker or household level data.

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Annex

Table A – Literature review summary

Long-term effects		
Model based		IMF (2016); Andrés, Arce and Thomas (2014); Everaert and Schule (2008); Arpaia, Alfonso, Roeger, Varga and Veld (2007)
Empirical models		Égert and Gal (2016); IMF (2015); OECD (2015); Arnold and Barbosa (2015); Barnes, Bouis, Briard, Dougherty and Eris (2013); Bouis, Causa, Demmou, Duval and Zdzienicka (2012); Bouis and Duval (2011)
Short-term effects		
Model based		IMF (2016); Cacciatore, Duval, Fiori and Ghironi (2015); Eggertsson, Ferrero and Raffo (2013)
Empirical models	Productivity growth	Santos, Gouveia and Gonçalves (2017); Adhikari, Duval, Hu and Loungani (2016); Égert and Gal (2016); Gal and Hijzen (2016); Lanau and Topalova (2016); IMF (2016); Cacciatore and Fiore (2015); Dabla-Norris et al (2015); Bourles, Cette, Lopez, Mairesse and Nicoletti (2013); Bouis, Causa, Demmou, Duval and Zdzienicka (2012); Forlani (2012); Barone and Cingano (2011); Nicoletti and Scarpeta (2003)
	Entry and exit rates	Gal and Hijzen (2016); Lanau and Topalova (2016); European Commission (2005); Schiantarelli (2005)
	Mark-ups	Folque (2017); Amador and Soares (2013)
	Resilience	Cacciatori and Fiori (2016); Pelkmans, Montoya and Maravalle (2008); Duval, Elmeskov and Vogel (2007); Ernst, Gong and Semmler (2007)

Table B1 - The Impact of Product Market Reforms on TFP growth - by sector with interaction (*wide Regimpact*)

Variable							
ΔTFP	**ΔFrontier**	**DTF**	**Regimpact**	**Dummy Frontier**	**DummyFrontier* Regimpact**	**N**	**R^2**
Agriculture, hunting, forestry and fishing	1.88***	0.57***	-1.41***	0.56***	2.52***	64,059	44%
Mining and quarrying	-1.47***	0.57***	4.22***	0.81***	-2.04	6,577	34%
Food products, beverages and tobacco	-3.92***	0.58***	1.82***	0.44***	0.47	50,122	34%
Wood and products of wood and cork	-2.51***	0.59***	-0.41	0.65***	-0.2	23,500	35%
Pulp, paper, paper products, printing and publishing	-0.83***	0.55***	3.21***	0.67***	-2.34**	21,024	30%
Coke, refined petroleum products and nuclear fuel	1.17	0.6***	3.81	0.25	3.24	1,410	40%
Chemicals and chemical products	-1.77	0.42***	4.16***	0.17	1.08	3,813	23%
Rubber and plastics products	1.77***	0.56***	2.02***	0.25**	1.17	8,092	35%
Other non-metallic mineral products	4.19***	0.47***	5.46***	0.71***	-2.29***	22,910	26%
Textiles, textile products, leather and footwear	-0.16	0.58***	1.09***	0.28***	1.68***	72,709	32%
Basic metals	-8.79***	0.43***	-1.18	0.42	0.42	2,245	29%
Fabricated metal products except machinery and equipment	-10.28***	0.64***	-2.85***	0.5***	0	49,580	39%
Machinery and equipment n.e.c	-3.53***	0.58***	1.39***	0.59***	-0.52	10,217	37%
Motor vehicles, trailers and semi-trailers	4.85***	0.51***	4.76***	0.32**	0.47	3,705	33%
Other transport equipment	-2.85	0.68***	0.18	-0.48	13.15**	1,292	48%
Electricity, gas and water supply	0.81	0.62***	0.7***	1.11***	-0.94	2,906	54%
Construction	-5.39***	0.77***	5.27***	0.72***	4.22***	302,312	53%
Transport and storage	-9.38***	0.62***	-1.21***	1.5***	-2.6***	153,744	36%
Post and telecommunications	0.32	0.77***	2.12***	0.94	-1.49	2,009	56%
Real estate activities	-13.5***	0.74***	-41.98***	0.74***	29.41***	67,638	55%
Office, accounting and computing machinery	-1.5	0.07	-12.41	4.6**	-35.39**	119	17%
Electrical machinery and apparatus n.e.c	-0.16	0.65***	1.13	0.54	0.13	2,542	45%
Radio, television and communication equipment	1.22	0.51***	-9.83	0.4	2.35	198	37%
Medical, precision and optical instruments	0	0.69***	0.01	0.56	-0.61***	6,677	47%
Manufacturing n.e.c; recycling	-5.7***	0.62***	2.87***	0.66***	-0.59	21,758	39%
Wholesale and retail trade, repairs	-8.07***	0.51***	0.06***	0.54***	0.17***	429,587	33%
Hotels and restaurants	-3.8***	0.59***	-3.81***	0.78***	-2.99***	217,696	39%
Renting of machinery and equipment	-1.46***	0.58***	13.84***	0.06	0.06	1,633	38%
Computer and related activities	-0.71*	0.68***	4.49***	0.63***	0.3	30,667	46%
Other Business Activities	11.75***	0.65***	-10.5***	-0.3***	2.14***	95,321	42%
Research and Development	10.49	0.61***	68.67	2.7***	-31.28**	1,770	48%

Source: Authors' own computations using IES and OECD data for the years 2004-2014.

Table B2 – The Impact of Product Market Reforms on LP growth - by sector without interaction

Variable				N	R^2
ΔLP	**ΔFrontier**	**DTF**	**Regimpact**		
Agriculture, hunting, forestry and fishing	-78.09	0.49*	-6.34**	73,894	40%
Mining and quarrying	-7.72*	0.49*	5.61***	7,031	31%
Food products, beverages and tobacco	29.38*	0.49*	0.67*	52,599	36%
Wood and products of wood and cork	-23.99*	0.48*	-4.62*	24,574	30%
Pulp, paper, paper products, printing and publishing	17.9*	0.45*	6.9*	22,276	28%
Coke, refined petroleum products and nuclear fuel	487.26*	0.4*	41.31*	1,534	34%
Chemicals and chemical products	9.57***	0.4***	1.60	4,042	28%
Rubber and plastics products	6.55***	0.45***	1.24**	8,443	30%
Other non-metallic mineral products	6.99***	0.46***	2.95***	23,760	25%
Textiles, textile products, leather and footwear	0.60	0.44***	1.49***	74,738	29%
Basic metals	21.47***	0.29***	0.21	2,338	27%
Fabricated metal products except machinery and equipment	36.81***	0.58***	-0.91**	50,918	34%
Machinery and equipment n.e.c	12.57**	0.47***	1.84**	10,685	28%
Motor vehicles, trailers and semi-trailers	41.37***	0.52***	-1.05	3,834	33%
Other transport equipment	-0.03	0.62***	8.73**	1,347	39%
Electricity, gas and water supply	-1.75	0.34***	1.54***	4,948	44%
Construction	-23.03***	0.58***	0.99**	326,518	39%
Transport and storage	20.64***	0.41***	-0.96***	164,517	28%
Post and telecommunications	omitted	0.62***	-1.41	2,152	55%
Real estate activities	18.23***	0.56***	-5.91	106,335	43%
Office, accounting and computing machinery	-15.95	0.31**	-83.11	131	24%
Electrical machinery and apparatus n.e.c	-1.08	0.55***	-4.2***	2,680	39%
Radio, television and communication equipment	-12.21	0.46***	39.11	209	41%
Medical, precision and optical instruments	-10.34***	0.56***	-2.90	7,051	41%
Manufacturing n.e.c; recycling	51.99***	0.47***	5.28***	22,918	32%
Wholesale and retail trade, repairs	66.18***	0.42***	-0.66***	465,573	31%
Hotels and restaurants	-77.65***	0.62***	-3.89***	231,121	38%
Renting of machinery and equipment	35.91***	0.48***	-30.59***	2,059	37%
Computer and related activities	7.93***	0.55***	0.57	35,986	40%
Other Business Activities	29.55***	0.5***	0.06	107,250	36%
Research and Development	3.74	0.53***	3.27	2,295	42%

Source: Authors' own computations using IES and OECD data for the years 2004-2014.

Table B3 - The Impact of Product Market Reforms on LP growth - by sector with interaction

Variable						N	R^2
ΔLP	**ΔFrontier**	**DTF**	**Regimpact**	**Dummy**	**DummyFrontier***		
Agriculture, hunting, forestry and fishing	-63.81	0.57*	-5.95**	0.8*	4.32***	73,894	45%
Mining and quarrying	-7.05*	0.57*	5.03***	0.52	3.42	7,031	37%
Food products, beverages and tobacco	31.66*	0.56*	0.67**	0.85*	-0.13	52,599	40%
Wood and products of wood and cork	-24.8*	0.55*	-5.08***	0.74*	1.21	24,574	35%
Pulp, paper, paper products, printing and publishing	17.11*	0.51*	6.65*	0.79*	-0.81	22,276	33%
Coke, refined petroleum products and nuclear fuel	469.82*	0.45*	40.62*	1.05*	-2.40	1,534	37%
Chemicals and chemical products	10.04***	0.42***	1.48	0.35	1.50	4,042	30%
Rubber and plastics products	6.98***	0.52***	0.95	0.55***	1.41	8,443	35%
Other non-metallic mineral products	7.09***	0.52***	2.99***	0.8***	-0.29	23,760	29%
Textiles, textile products, leather and footwear	1.2**	0.53***	1.02***	0.54***	3.08***	74,738	34%
Basic metals	22.29***	0.34***	-0.05	0.52	0.67	2,338	28%
Fabricated metal products except machinery and equipment	35.56***	0.64***	-1.02***	0.62***	0.95	50,918	40%
Machinery and equipment n.e.c	11.94**	0.55***	1.41	0.6***	2.24	10,685	35%
Motor vehicles, trailers and semi-trailers	43.03***	0.58***	-1.45	0.78***	1.15	3,834	39%
Other transport equipment	0.35	0.69***	6.86	0.11	10.50	1,347	46%
Electricity, gas and water supply	-1.04	0.38***	1.4***	0.84***	0.25	4,948	42%
Construction	-25.97***	0.72***	0.34	0.81***	10.31***	326,518	50%
Transport and storage	20.43***	0.48***	-0.88***	1.01***	-0.72	164,517	33%
Post and telecommunications	omitted	0.7***	-1.53	0.94	-0.12	2,152	60%
Real estate activities	15.64***	0.65***	-9.8***	1.33***	22.94***	106,335	51%
Office, accounting and computing machinery	-19.37	0.36***	-96.17	6.54	-45.54	131	27%
Electrical machinery and apparatus n.e.c	-0.92	0.62***	-4.5***	0.32	4.60	2,680	43%
Radio, television and communication equipment	-12.99	0.47***	37.46	-6.19	54.98	209	42%
Medical, precision and optical instruments	-9.59***	0.63***	-2.59	0.88***	0.88	7,051	46%
Manufacturing n.e.c; recycling	54.25***	0.55***	5.33***	0.75***	1.04	22,918	38%
Wholesale and retail trade, repairs	64.21***	0.47***	-0.68***	0.64***	0.29***	465,573	35%
Hotels and restaurants	-75.75***	0.67***	-3.76***	0.72***	-0.21	231,121	44%
Renting of machinery and equipment	34.6***	0.54***	-31.4***	-0.22	14.92**	2,059	40%
Computer and related activities	8.71***	0.61***	-0.25	0.55***	5.35***	35,986	46%
Other Business Activities	27.38***	0.58***	0.01	0.59***	0.7**	107,250	42%
Research and Development	4.19	0.6***	3.07	1.52	-4.87	2,295	48%

Source: Authors' own computations using IES and OECD data for the years 2004-2014.

Table B4 – The Impact of Product Market Reforms on TFP growth - by sector without interaction (*narrow* Regimpact)

Variable				N	R^2
ΔTFP	**ΔFrontier**	**DTF**	**Regimpact**		
Agriculture, hunting, forestry and fishing	-0.51	0.52***	-4.11***	64,059	41%
Mining and quarrying	-0.17	0.52***	5.82***	6,577	29%

Food products, beverages and tobacco	-0.09	0.53***	2.98***	50,122	36%
Wood and products of wood and cork	-2.42***	0.54***	omitted	23,500	29%
Pulp, paper, paper products, printing and publishing	1.12***	0.5***	8.63***	21,024	26%
Coke, refined petroleum products and nuclear fuel	4.23***	0.59***	-4.56	1,410	37%
Chemicals and chemical products	1.6**	0.4***	4.55***	3,813	21%
Rubber and plastics products	-0.03	0.5***	4.35***	8,092	31%
Other non-metallic mineral products	0.94**	0.43***	3.44***	22,910	22%
Textiles, textile products, leather and footwear	0.44***	0.53***	2.89***	72,709	26%
Basic metals	14.20	0.39***	15.59	2,245	28%
Fabricated metal products except machinery and equipment	5.6***	0.59***	8.36***	49,580	32%
Machinery and equipment n.e.c	-1.53*	0.52***	3.3***	10,217	29%
Motor vehicles, trailers and semi-trailers	0.89	0.48***	8.06***	3,705	29%
Other transport equipment	-0.95	0.62***	3.64	1,292	43%
Electricity, gas and water supply	0.65	0.57***	0.52	2,906	51%
Construction	-0.94***	0.74***	5.33***	302,312	42%
Transport and storage	4.69**	0.55***	0.55***	153,744	27%
Post and telecommunications	0.91**	0.72***	3.27***	2,009	50%
Real estate activities	5.59***	0.69***	4.84***	67,638	45%
Office, accounting and computing machinery	0.97	0.06	2.64	119	13%
Electrical machinery and apparatus n.e.c	2.58	0.6***	11.61	2,542	40%
Radio, television and communication equipment	6.13	0.42***	8.35	198	35%
Medical, precision and optical instruments	-0.06	0.64***	0	6,677	40%
Manufacturing n.e.c; recycling	-0.33	0.56***	5.54***	21,758	32%
Wholesale and retail trade; repairs	-4.76***	0.46***	3.58***	429,587	29%
Hotels and restaurants	4.19***	0.55***	18.21***	217,696	34%
Renting of machinery and equipment	-0.01	0.53***	33.49***	1,633	34%
Computer and related activities	0.94***	0.63***	6.7***	30,667	40%
Other Business Activities	-0.07	0.59***	11.76***	95,321	34%
Research and Development	1.44	0.58***	13.28	1,770	41%

Source: Authors' own computations using IES and OECD data for the years 2004-2014.

Table B5 – The Impact of Product Market Reforms on TFP growth - by sector with interaction (*narrow* Regimpact)

Variable						N	R^2
ΔTFP	**ΔFrontier**	**DTF**	**Regimpact**	**Dummy Frontier**	**DummyFrontier* Regimpact**		
Agriculture, hunting, forestry and fishing	-0.68	-0.68*	-5.33*	0.57*	6.72***	64,059	44%
Mining and quarrying	-0.21	0.57*	6.35*	1*	-6.69***	6,577	35%
Food products, beverages and tobacco	0.02	0.58*	3.18*	0.56*	-1.87	50,122	40%
Wood and products of wood and cork	-2.11***	0.59*	omitted	0.85*	-5.62**	23,500	35%
Pulp, paper, paper products, printing and publishing	1.04*	0.55*	9.24*	9.24*	-10.57***	21,024	31%
Coke, refined petroleum products and nuclear fuel	4.91*	0.6*	-8.79*	0.19	6.99	1,410	40%
Chemicals and chemical products	1.51**	0.42***	5.1***	0.55***	-4.88	3,813	23%
Rubber and plastics products	0	0.56***	4.21***	0.25***	3.36	8,092	35%
Other non-metallic mineral products	0.98**	0.47***	3.7***	0.69***	-3.79***	22,910	26%
Textiles, textile products, leather and footwear	0.47***	0.58***	2.78***	0.57***	-3.96***	72,709	32%
Basic metals	13.73	0.44***	15.46	0.8***	-7.32***	2,245	29%
Fabricated metal products except machinery and equipment	5.47***	0.64***	7.98***	0.64***	-3.47***	49,580	39%
Machinery and equipment n.e.c	-1.65**	0.58***	3.87***	0.91***	-10.56***	10,217	37%
Motor vehicles, trailers and semi-trailers	1.01	0.51***	8.69***	0.72***	-8.95***	3,705	33%
Other transport equipment	-0.52	0.69***	2.90	0.71***	-3.06	1,292	48%
Electricity, gas and water supply	0.95	0.62***	0.73***	1.05***	-0.87	2,906	54%
Construction	-0.88***	0.77***	5.41***	1.05***	0	302,312	53%
Transport and storage	5***	0.62***	8.18***	1.91***	-4.11***	153,744	36%
Post and telecommunications	0.78**	0.77***	2.77***	0.88	-1.49	2,009	56%
Real estate activities	6.04***	0.74***	54.1***	1.44***	10.54	67,638	55%
Office, accounting and computing machinery	1.02	0.07	5.11	1.43	-38.25	119	15%
Electrical machinery and apparatus n.e.c	2.12	0.65***	11.70	1.09***	-11.70	2,542	45%
Radio, television and communication equipment	6.15	0.52***	6.01	-0.61	30.99	198	38%
Medical, precision and optical instruments	-0.10	0.69***	-0.28	0.49***	0.10	6,677	47%
Manufacturing n.e.c; recycling	-0.28	0.62***	6.19***	0.87***	-6.97***	21,758	39%
Wholesale and retail trade, repairs	-4.82***	0.51***	4.54***	1.11***	-13***	429,587	33%
Hotels and restaurants	3.96***	0.59***	18.62***	0.9***	-14.46***	217,696	39%
Renting of machinery and equipment	0	0.58***	35.32***	1.23**	-30.90	1,633	38%
Computer and related activities	0.94***	0.68***	6.17***	0.73***	-3.28	30,667	46%
Other Business Activities	0.03	0.65***	12.62***	0.9***	-16.7***	95,321	42%
Research and Development	1.58	0.61***	14.90	1.32***	-29.29	1,770	48%

Source: Authors' own computations using IES and OECD data for the years 2004-2014.