WPS7919

Policy Research Working Paper 7919

Services in the European Union

What Kinds of Regulatory Policies Enhance Productivity?

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WORLD BANK GROUP
Trade and Competitiveness Global Practice Group
December 2016

Policy Research Working Paper 7919

Abstract

This paper is the first one to show the effects of services regulations on downstream firms in the goods and services sectors in a multiple-country setting using firm-level data. The study selected a group of countries that are economically relatively services-oriented and show varying degrees of services regulations over time, namely the European Union. The paper employs four alternative firm-level measures of total factor productivity that have recently been developed in the economics literature and provide robust conclusions. Overall, the results suggest that regulatory barriers in services have diverse effects on downstream manufacturing performance, depending on the type of regulatory measure in question. The policy variables are split into pure entry barriers and those that relate to the anti-competitive policies on the operations of the firm, which the paper calls conduct regulations. The latter appear to play the most important role in explaining downstream performance across services and goods firms. Furthermore, the results show that regulations matter significantly more in the cases when a country is institutionally weak, an industry is considered as relatively close to the technology frontier, or a firm is foreign owned.

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Produced by the Research Support Team

Services in the European Union: What Kinds of Regulatory Policies Enhance Productivity?

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JEL classification: D24, L80, F15, F20, O52

Keywords: services reform; productivity; EU single market

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1 Introduction

While there are various sources of growth, one outstanding factor determining growth rates across developed economies such as in the European Union (EU) is how productively economic resources, for instance labor and capital, are used. This process of productivity is summarized as Total Factor Productivity (TFP). In particular, research has shown that what actually explains the divergent cross-country economic growth performance across European countries is strongly related to developments in the services sector (Timmer *et al*., 2008, 2007). At the same time, one of the main driving forces for improvements in the services sector is its optimal allocation of resources which can be established through market deregulation. The focus of this paper is therefore to look at how services regulation or the liberalization of services markets affects productivity in the wider downstream economy of the EU.

Services dominate in most (if not all) European economies. On average, the EU holds a level of value added in services that is comprised of around 73 percent of its Gross Domestic Product (GDP). Per country this level ranges from 87 percent in Luxembourg or 80 percent in Greece to 59 percent in the Czech Republic. Although the importance of the services sector expands with the level of development, this, however, is not necessarily the case. For instance, Germany holds a percentage in services of 68 percent, well below the European average, which may be due to its advanced manufacturing base in which many services are integrated. Greece and Portugal rank among the top countries with high levels of services value-added which in fact is mainly due to their large tourism sector.

The share of an economy's domestic services value-added is an important indicator for the extent to which a country's economy is successful internally as well as externally. Better quality of services markets affects downstream productivity as many services are used as inputs by other firms in their business processes. In other words, a country's competitive "services base" is indicative of how effective it is in terms of overall economic performance. Moreover, within Europe a larger share of value-added in services is associated with greater levels of trade in services as part of the economy. This, in turn, is linked with greater levels of productivity and overall growth across European countries. For instance, in 2014 Europe's growth rate averaged 1.44 percent. Countries above this average had higher services trade while countries below this average had a lower level of services trade, indicating the important role of open services markets.

In large part, domestic services value-added and the tradability of services is determined by unnecessary regulations in services markets that increase excessive costs for firms, particularly for firms active in the downstream economy. Because of the non-tradable history of many services sectors, one important policy element of rendering services markets more productive is related to domestic regulations. Domestic regulatory barriers in services usually consist of rules and procedures deep down inside a country's jurisdiction. These barriers can be discriminate or non-discriminate as well as related to entry or to the operations of the firm, and at the same time could affect foreign as well as domestic services transactions. (See Table 1.) Liberalizing services markets is therefore related to greater levels of creating value-added, which is reflected in a firm's productivity rate or overall level of TFP.

Figure 1 points out that within Europe, not all economies are on an equal path regarding regulations in services. Some countries such as Luxembourg and Greece still hold high levels of overall restrictions. Figure 1 also tells us that this pattern is not obviously linked to any level of development which on a global scale is otherwise shown in Borchert *et al*. (2012) regarding services trade barriers. For instance, countries such as Poland or France have different levels of development, but share equal levels of

regulations. In the same way, Hungary shows a similar level of low restrictions compared to Ireland and Denmark. Moreover, Figure 1 also points out that between 2006 and 2013, some countries actually moved away from the diagonal axis to a greater extent than others. This means that several countries decreased their level of services regulations such as Greece, Slovenia or Italy, while others reformed their services markets at a much lower pace such as in the case of Finland or Luxembourg which has actually increased its level or services regulations somewhat.[1] Naturally, this should have an effect on how these countries have overall performed in terms of productivity over time.

The link between services reforms and economy-wide productivity effects has gained increasing attention from researchers and has been a focal point in various previous studies. Earlier papers such as Nielson and Taglioni (2003) highlight the fact that services trade liberalization and regulatory reform are likely to lead to larger gains from increasing efficiency and competitiveness rather than increased market access abroad. In another study, based on using a general equilibrium model, Robinson *et al.* (2002) come to similar conclusions in that services liberalization has a large indirect effect (next to a direct effect) on downstream sectors using services as inputs. They state that notably for developing countries TFP would rise in sectors using services as efficiency gains run through upstream to downstream inter-industry linkages. Triplett and Bosworth (2004) investigate this issue by focusing on the role of TFP in services sectors themselves and conclude that in particular greater productivity in the distribution sector as well as the financial services sector has helped to a significant extent the US productivity surge after 1995.

This study is closely related to the more recent works that empirically investigate the role of services reforms on downstream or economy-wide productivity performance, in particular those that use firm-level data.[2] Several studies stand out in this regard. One is by Arnold *et al*. (2011) that shows how increased foreign participation of firms in services sectors caused an improvement in downstream manufacturing sectors in the Czech Republic. In this paper the authors use economy-wide indexes of services reform employing the EBRD data base on services policy reform and interact those with a services input reliance coefficient using Czech input-output tables. Another study is done by Arnold *et al*. (2015) in which the authors undertake a similar empirical strategy but then for India by means of a comparable approach which is comprised of interacting a self-constructed reform index for India with a comparable services input dependency ratio for the Indian economy. They also show that for India reform in services has had a positive impact on downstream manufacturing firms. In addition, this study also exploits sector-specific indexes as opposed to only an economy-wide index of services reform.

Two separate studies associated with quantifying services linkages on downstream manufacturing productivity focus solely on the role of Foreign Direct Investment (FDI).[3] Fernandes and Paunov (2012)

[1] Figure 1 shows the level of regulation of EU countries using the OECD NMR regulations database for the year 2006 and 2013, which is the timeframe of our empirical analysis and is interpolated for missing series. Note that other indexes of restrictiveness in services are on a one-year basis only such as the OECD's Services Trade Restrictiveness Index (STRI) which to date has only collected data for 2014 and the World Bank's STRI that extends to developing countries for the year 2009 alone.

[2] Some earlier studies that analyze the effects of services reform on economy-wide performance without using firm-level data are Mattoo *et al*. (2006) and Eschenbach and Hoekman (2006). The former relates services reform to economic growth effects while the latter concentrates on services reform, including liberalization, on economic performance in a sample of 20 transition economies using EBRD reform indexes.

[3] Note, however, that Arnold *et al*. (2011) also use FDI as one of the explanatory linkage variables using the share of the presence of foreign providers of services next to their EBRD measure of services liberalization.

demonstrate the causal impact of FDI penetration on manufacturing TFP in Chile. Rather than using a services reform indicator, the authors exploit the issue of whether the extent to which Chile's accumulated net real FDI inflows in services, i.e. stock, had any significant impact on domestic firm performance. Their multiplicative form of FDI stock and Chile's input coefficients relies on a firm-level dependence indicator of services input as opposed to using input coefficients from input-output tables as done in other firm-level studies. They find a positive impact of services FDI on TFP for Chilean manufacturing industries, which in fact can explain 7 percent of its contribution to total TFP increase in Chile. Using Indonesian firm-level data, Duggan *et al*. (2013) provide evidence that services reform using the OECD's regulatory restrictiveness index in FDI for Indonesia showed a positive contribution to manufacturing firm TFP. In this study the authors construct an input reliance variable using Indonesian input-output tables.

Most of these studies have been conducted using country-specific firm-level data for mainly developing economies, while no study to date has taken up a multiple country approach or used a developing economy, not to mention the European Union (EU) as a central point.[4] Of course, a focus on developing countries is logical if one thinks of the fact that many of these economies still have restrictive services policies in place which make their sectors still relatively locked. From this perspective, concentrating on the potential welfare gains for poorer countries is therefore important. Yet, it is somewhat surprising that although much debate on potential productivity gains in Europe has been allocated to its divergent services sector performance, which implies that levels of restrictions significantly differ across European countries as can be seen in Figure 2, no comprehensive study on the EU's services sector and its effect on the wider downstream economy has until now been undertaken. This paper therefore performs a first step to fill that gap and takes the European market as a point in case. In sum, this is the first study to perform firm-level analysis with a multiple country dimension using developed economies.

In particular, our study contributes to the existing literature as hitherto discussed in the following ways. First, we augment all the previous country-specific papers by using firm-level data that spans multiple (European) countries so as to have a consistent cross-country (almost balanced) panel sample for both goods and services firms. This is important as it could provide us with close estimates of the real economic potential of future reforms across the entire European landscape rather than concentrating specifically on one country and / or on the manufacturing sector only. These are two valuable additions in our paper that have so far not been exploited. Previous firm-level works related to our topic only takes up one country and only the manufacturing sector. Our rich data set allows for changing this tradition by not only concentrating on multiple countries, but also by taking into account all other downstream services sectors at a disaggregated level that are present in European economies.

Second, we exploit alternative TFP estimates which have been developed over recent years and have been applied individually in each previous study and never together.[5] The productivity literature has presented several estimates of how to construct a credible TFP indicators with estimation strategies from Olley and Pakes (2003) and Levinsohn and Petrin (2008) as the most commonly used ones.[6] This recent literature has also brought forward new TFP measures such as the one by Ackerberg *et al*. (2006;

[4] A study by Bourlès *et al*. (2013) and Barone and Cingano (2011) do seek to explain downstream TFP through services linkages as explained above in a multiple developed country setting. However, both papers use industry-level data as opposed to firm-level data which our paper takes as a starting point.

[5] Apart from Fernades and Paunov (2012) which show the results of three different types of TFPs.

[6] Duggan *et al*. (2013) use a TFP computation following Aw *et al*. (2001).

2015) that improves the previous two approaches for their collinearity problem. A final TFP measure that has lately been developed is from Hsieh and Klenow (2009, 2014). In their methodology the authors follow a structural approach using a Cobb-Douglas estimate with commonly used labor shares so as to explicitly take into account policy distortions that would otherwise affect traditional TFP measures in their revenue as opposed to physical TFP. In our paper, we use all four TFP proxies so as to compare results.

Moreover, since we are dealing with a cross-sectional panel dimension we can also employ country-consistent indexes of services reform. In this way we could endorse whether reform indexes found in previous research papers are stable with our findings across a like-minded group of countries with similar level of development as opposed to a single developing or emerging economy. Ideally, the results would be consistent across our four performance measures. The fact that we chose the EU is furthermore interesting since this part of the world has embarked on a great effort to synchronize its differing services sectors across member states into a common market. Over the years, the experience of the EU has proven to be a difficult one, but could nonetheless amount to considerable economic benefits as some studies suggest. Earlier works suggesting significant trade and welfare gains stemming from services reform are mostly done for an individual sector such as Maijoor, Buijink, Meuwissen and van Witteloostuijn (1998) and Cummins and Rubio-Misas (2006). One likely reason why these studies have taken a sectoral approach lies is the inherent difficulty of finding international comparable performance estimates. Taken from this perspective, a third major contribution that this paper develops is to use sector and country-specific TFP and regulatory policy measures that use firm-level data from one common source.[7]

The results of this paper suggest that regulatory barriers in services have diverse effects on downstream manufacturing performance depending on the *type* of regulatory measure in question. Our policy variables are split into pure *entry* barriers and those that relate to the anti-competitive policies on the operations of the firm, which we call *conduct* regulations. At the aggregate level for the economy as a whole, conduct regulations have a most significant negative effect. A second result found in this study is that economic gains arising from reform in services are particularly large, and in some instances larger than previously has been found for individual developing countries. This finding is interesting in itself as services market reforms have been particularly on the minds of policy makers as a tool for development for lower income countries. Our results suggest that at least equally large gains can be reached for developed economies, which are expected to have already better functioning services sectors.

Third, our findings using interaction terms also show that in fact regulatory measures that are restrictive in countries with weaker institutions are relatively more burdensome for downstream firms. One potential explanation is that services are regulation-intense and sound institutions in the form that strong regulators would be able to put in place a well-designed set of regulations so as to correct the many market failures from which services suffer. Further interaction results show that firms holding a significant foreign share are particularly hurt by regulations on the conduct of the firm compared to firms which are purely domestic, which points to the fact that although these regulations are in principle applied on a non-discriminatory basis affecting domestic and foreign firms equally, they nonetheless *de facto* are more burdensome for international firms. Finally, we also check whether the results are any

[7] In addition, this paper also uses international comparable reform indexes from the OECD, plus comparable input-output linkages that are obtained from Eurostat and are hence developed methodologically in a consistent manner.

different compared to including manufacturing as a downstream sector only. Surprisingly, for manufacturing firms entry barriers are the main regulatory barrier for better productivity performance. From a wider perspective this suggests that the relative importance between conduct and entry barriers is moving along shifts that the domestic economy makes into services.

The rest of this paper is organized as follows. The next section discusses the data and gives an overview of the various productivity measures, liberalization reform indicators and input-output coefficients used for this paper. Section 3 presents the estimation strategy, and Section 4 reviews the estimation results. Finally, the last section concludes by interpreting the results in a wider European context.

2 Data

As in all previous papers which are very close to our line of research, one needs to have three types of data in order to perform our empirical analysis, namely services reform indexes, TFP performance at the firm level, and finally input-output coefficients measuring the extent to which downstream (services and manufacturing) industries use services as inputs. These latter coefficients will be interacted with the reform indexes so as to have a "weighted" score of services reform.

2.1 Services Reform

The EU has a long history regarding its integration process of services. Next to goods, capital and skills, the EU strives for the free flow of services across member states' borders which was initially defined in the Treaty of Rome in 1957. Together this objective of free factor movement is more commonly referred to as the "four freedoms" or, in other words, the EU's internal market. Although legislation in the areas of goods and capital has progressed over the years, reforms in services regulation appear to be difficult. For instance, the recent passing of the Services in the Internal Market Directive (2006/123/EC) in 2006 did not happen without fierce public opposition and was eventually significantly watered down by the European Parliament with many sectors such as broadcasting, audio-visuals and postal services being excluded.

Although the EU strives for reforms of services markets to make them explicitly more tradable across countries, the reform indexes taken up in this study are closely linked to the domestic regulatory setting within each European economy.[8] Our index proxies for services reform are taken from the OECD's PMR database which are known as the Non-Manufacturing Regulations (NMR) in services as explained in Koske *et al*. (2013) and which have been used in previous industry-level studies such as Barone and Cingano (2011). The database covers 12 services sector-specific reform barriers such as in electricity, post and telecommunications, transportation and professional services. The main reason for using these indicators is because of their multiple year coverage. In fact, the PMR database provides good time-

[8] Hence, these measures take up not only the foreign entry of firms into the domestic economy, as otherwise trade restrictiveness indicators would do, but also domestic entry *in addition to* the potential of foreign entry. Moreover, it should be stressed that our reform indicators are really measuring regulations at the (unilateral) domestic level and therefore reflect within country scenarios as opposed to indicators that measure the cross-border regulations. Partly, our indicators will pick up some elements of the latter, but as to date no precise reform indexes exist at the EU-level which takes up the pure trade-related aspects for reform in a longer time-series.

series which allows us to precisely analyze the liberalizing trends over time as opposed to investigating cross-country difference only in case we use alternative services policy reform measures. Note, however, that these reform proxies capture (anti-competitive) restrictiveness of regulations, but they do not capture enforcement of existing regulations at the EU level. We also use a second set of regulatory measures that vary over time and which is country-sector specific, namely the Foreign Direct Investment (FDI) restrictiveness indicators, and also comes from the OECD. Assessing the effect of these measures is important as many foreign service suppliers enter markets through a foreign affiliate. Again, the FDI restrictiveness indicator does not pick up the enforcement of existing EU regulations.

The NMR indexes vary on a scale between 0 to 6 with lower values indicating lower levels of restrictions and higher values reflecting the most restrictive conditions in services sectors. In all, they measure the restrictiveness of competition in services in domestic economies. Moreover, each overall index is made up of several sub-indexes analyzing different aspects of reforms. With these distinctions, one is able to make a difference between the different *types* of regulations in services as provided in Table 1. Some reform measures are purely related to the entry of domestic as well as foreign firms in the market, whereas others are comprised of barriers connected to anti-competitive rules and practices specifically targeted to the conduct of the firm, or firm operations. We regroup these sub-indicators together so as to create this difference of regulatory type and use them separately in our regressions next to an overall index measure of reform that summarizes both entry and conduct. Table A1 in the annex shows in detail which sub-barriers are taken up for each of the two types of indexes. We follow the OECD in constructing these indexes in the sense that we use equal weights across indicators, which the OECD does for its overall index as well.

As said, next to the NMR this paper also exploits the OECD's FDI restrictiveness indicator as put forward in Kalinova *et al*. (2010). This index ranges from 0 to 1 with also lower values indicating lower levels of restrictions and higher values reflecting greater levels of FDI barriers. This index is made up of several sub-indicators that measure separately various barriers such as equity restrictions, screening requirements, economic needs test, or movements of key-personnel. In total, there are 20 different service sectors covered. In the regressions we do not separate them out as they do not make an analytical separation according to a functional type of restriction as in the NMR between entry and conduct and as such the overall index of FDI restrictiveness is employed. Table A2 in the annex also shows in detail which barriers are included for the services sectors taken up in our sample. Note that each barrier, as explained in column 3 in this table, is common across all services sectors presented in column 1 of Table A2.

All reform indexes are rescaled from 0-1 so as to have consistent interpretation of the coefficient indexes after regressions. In terms of time series, years covered for each index varies. The NMR indexes for telecommunications and post, transport and electricity and gas start in 1975 and are provides on a yearly basis. Retail services have been collected for the years 1998, 2003, 2008 and 2013, while professional services are beginning in 1996 with 2003, 2008 and 2013 with subsequent years. The FDI reform index starts in 1997 up to 2014 with missing years in between but yearly as of 2010. Missing years are interpolated so as to optimize good time series. There are two ways of taking care of this, namely on a linear basis assuming reform is a gradual process that takes place each year, or on a constant basis supposing that reform is a "lumpy" process that is not always implemented each year. Both choices come along with their weaknesses. It is hard to imagine that reform, particularly in services, is really taking place each year. On the other hand, the constant approach may actually create a mismatch

between when reform is implemented and when measured by the OECD in a particular year. However, Figure 3 shows that for instance in the case of France the transport services sector for which information is available on a yearly basis the reform process is rather uneven. Therefore, we prefer the constant interpolation strategy.

2.2 Firm-Level Performance

The firm-level data for estimating our TFP measures were retrieved from the Amadeus / Orbis database from Bureau van Dijk (BvD). In fact, the Amadeus database is a sub-set of the world-wide Orbis database which only contains European firms. This corresponds nicely to our interest in EU countries and so we exclude non-EU European firms from our analysis. Although our aim is to include as many European countries as possible, unfortunately Amadeus does not report all variables needed in order to calculate TFP for each country (see below). Moreover, some microstates such as Luxembourg, Malta and Cyprus show few firm observations for which we also check the robustness of our results. Data in Amadeus are given for the period 1995-2014, but with substantially improved firm-level observations as of 2005, and even better after 2007. As said before, both manufacturing and services firms are considered in our TFP computations so as to take stock of the wider downstream economy as most European countries nowadays are relatively more dependent on services in terms of value-added than manufacturing. See Table A3 in the annex for a yearly overview of firm observations for services and goods.

One note of caution is warranted for our firm coverage. Although preferably one would like to have an entirely balanced panel data set with only surviving firms, in our case that seems rather difficult. Although a balanced set can be found for the years 2008-2013, our preferred time frame is 2006-2013 which covers a less than perfect panel format of surviving firms. The main reason for preferring the latter time period is that with purely surviving firms as of 2008 only, our observations drop by 60 percent. Partly this is due to the shorter time period; yet in large part this is due to the so few firms that are consistently present in Amadeus. Moreover, Figure 1 shows that there is some interesting policy variation across EU countries to be exploited as some countries have lowered their regulations more significantly than others which as of 2008 is less the case. Nonetheless, to somehow compensate for this trade-off our chosen sample from 2006 onwards contains only firms that report at least four years of data. Furthermore, robustness checks for post-2008 are also provided in this paper and in large part confirm our main results.

Firm-level TFP measures used in this paper are computed in different ways. Over the years, various methodologies have been developed in the international economic literature which have been taken up in recent empirical works with Olley and Pakes (2003) and Levinsohn and Petrin (2008) as most commonly used ones. Several papers that are very close to our line of research such as Fernandes and Paunov (2012) and Arnold *et al*. (2015) have used the TFP estimation developed by Ackerberg *et al*. (2006; 2015). Although all three approaches correct for the endogeneity of input choices, including the choice of services as inputs, for the TFP estimates, the Ackerberg specification improves the former two TFP methods by correcting for potential collinearity problems, which could otherwise occur from a distorting factor with regards to the identification of the variable input coefficients. Ackerberg *et al*. (2006; 2015) also provide correction for the timing of the input choice decision.

Moreover, we also use the Hsieh and Klenow (2009, 2014) way of estimating TFP which is relatively new and follows a different structure. More precisely, in their methodology the authors follow a structural approach using a Cobb-Douglas estimate with commonly used labor shares so as to explicitly take into account policy distortions that would otherwise affect traditional TFP measures in their revenue as opposed to physical TFP.

We estimate all four approaches and use them in our regression output discussion. In order to do so one needs to estimate sector-specific production functions. These production functions are sector-specific because industries differ in production technology. The main idea of estimating these production function is that through this way, unobserved firm productivity shocks can be approximated by a non-parametric function of observable firm characteristics. Since we are dealing with multiple countries in our data set, we estimate these production functions for each 2-digit services and manufacturing sectors by country, although in some cases we regroup some countries due to their insufficient numbers. They are Germany with Austria, the Benelux, Sweden with Denmark, Estonia with Latvia, and finally UK with Ireland. The reason for choosing these groupings is that we think that each pair are fairly like-minded in their economic structures. Regarding sector division, in total we have 57 different sectors, which is considerably more than in previous studies, because the high number of firm observations in each sector allows us to go ahead with this selection although some industries are also regrouped together. The industry groupings together with an overview of firm observations can be seen in Table A4 in the Annex.[9] Table A5 reports a similar overview by country.

To start estimating production functions we need firm-level data on value-added. Normally value-added at the firm is defined as sales minus the value of inputs, which includes materials, services and energy. In the Amadeus data set, unfortunately only operating net revenue and material costs are reported, which we hence use to compute value-added. Moreover, materials are not reported either for any firm in Cyprus, Denmark, UK, Greece, Ireland, Lithuania and Malta. Since this forms a substantial number of countries, we proxy material inputs for these countries. The way we choose to do so is based on Basu *et al*. (2009) in which the authors compute materials as operational revenue minus operational profits and wages taking into account depreciation. Since this is of course a less precise measure of material inputs, we therefore check whether a strong correlation exists between both measures: the direct and proxied approach for all countries that report both types of methods. Table A6 report the regressions as correlations of the indirect measure on materials reported directly for these countries. The result shows that correlations are very strong with a high R2. Once we use this proxied method, the number of firms increases by 11 percent.[10]

The production functions themselves are estimated using the standard approach of Cobb-Douglas in logarithmic form, as shown in the following equation:

[9] An interesting minor detail is that the frequency share of firm observations between services and goods closely follows their value-added composition in GDP which in 2014 for goods was 24.3 percent, while for services this figure was 74 percent according to the World Development Indicators.

[10] Note, however, that Malta only has 39 observations and are not included in the final data set. Furthermore, in Amadeus firms from Greece, Cyprus and Lithuania have neither reported nor proxied materials, and are therefore excluded from any further analysis in this paper.

$$lnY_{it} = \beta_K \cdot lnK_{it} + \beta_L \cdot lnL_{it} + \omega_{it} + \epsilon_{it} \quad (1)$$

In equation (1), Y_{it} stands for output of a firm *i* in year *t* and represents variable of value-added as explained above with the caveats described; K_{it} denotes the capital stock of a firm and is calculated as the two period average of real fixed tangible capital for all four approaches while L_{it} designates the labor input of a firm, which is proxied by the number of employees as it is the only reliable proxy variable in Amadeus because other variables such wages are not available.[11] Furthermore, ω_{it} is the unobserved total factor productivity and ϵ_{it} is the random iid shock. As explained in the introduction of this section, we do not use OLS to estimate equation (1) as this estimation strategy suffers from simultaneity bias in its inputs. Instead, we use the various approaches of TFP from Ackerberg *et al*. (2006; 2015), Olley and Pakes (1996) and Levinsohn and Petrin (2003). For the Ackerberg and Levinsohn and Petrin specifications, we use material inputs as a proxy for unobserved time-varying productivity shocks. For the Olley and Pakes approach one needs investment instead, which is computed as the difference between capital stock of two subsequent years corrected for depreciation, i.e. Inv_{it}.

As previously stated, we also use a fourth TFP measure that has newly been developed in the economic literature which is put forward by Hsieh and Klenow (2009, 2014). For their TFP calculations, the authors follow a structural approach also using a Cobb-Douglas estimate, but with commonly used labor shares so as to explicitly take into account policy distortions that would otherwise affect traditional TFP measures in their revenue as opposed to physical TFP. Hence, their TFPQ is estimated which is put in relative terms compared to each 2-digit NACE classification sector code. As said, for this approach one needs to have common labor shares from one country which is most likely to serve as a reference point. We use Germany as it represents the EU's most important economy across all its members. Labor market shares are defined as the wages and salaries for each 2-digit NACE sector divided by each of their sectoral value-added. Furthermore, we also take the EU as an average benchmark against which the TFPQ measure is made firm-specific for each 2-digit code. Although one could criticize this approach since we include multiple countries, the results obtained from employing the EU-wide benchmark are much more meaningful. Besides, this approach is also justified on the grounds that actually the EU as a whole is by now a fairly integrated market.[12]

Of note, all the appropriate proxy variables are first deflated and then put in Euros using constant exchange rate. Price data come from Eurostat's National Accounts database and are mostly available at 2-digit NACE industries. In case these data was missing we used either higher level of aggregation, or otherwise simple GDP deflators were used. For value-added we used the value-added in gross price index (i.e. implicit deflator) in constant prices with 2010 as reference year for all countries. For materials we used the deflator for intermediate consumption and finally for capital stock we used the consumption of fixed capital price index.

[11] Note that subscripts for country and industry are supressed for now as they are estimated for each of them. Moreover, Amadeus does in fact report the firm's total wage bill but has worse coverage than the number of employees as we use in this paper. In Amadeus there is no variable available that distinguishes employees by skill category.

[12] Moreover, upon request we are also able to show that in fact normalization at country-sector-level as could be done with the relative TFPQ measure cannot capture the average effect from a regression if explanatory variables are also country-sector-year specific under the assumption of log-normality and constant effect for all firms.

The production functions finally contain 18 countries times 52 sectors, which provides us with a total of 936 cells.[13] Note that the production functions were estimated twice: first using the approach of proxy materials and then, second, with reported materials and value-added. They are also estimated only with firms that consistently report values for at least four years so as to remain as much as possible in line with previous works. As a result, we have tried to the feasible extent possible to come up with a balanced panel data set for our TFP estimates. In all, based on the three unbiased sets of estimates plus the TFPQ measure, we obtain eight firm-level country-specific time-varying logarithmic TFP specifications as residuals from equation (1). Table A7 in the annex provides summary statistics for the variables used in equation (1) production function while Table A8 and A9 show summary statistics for our TFP estimates.

2.3 Input-Output Tables

Country specific input-output tables are also taken from Eurostat and are constant price matrices with 2010 as reference point which is the earliest year for which these tables are available.[14] Several types of input-output tables are provided on their website, but we choose the one with the best sector-country coverage, namely the "Use Tables at Purchasers' Prices". One big disadvantage with these matrices is that the Retail sector is not well recorded for many countries which do not report any inputs in this sector. This may be due to reasons related to misreporting or perhaps due to an unclear sector definition of retail activities as the entire distribution sector to which retail belongs is also made up of two other sub-sectors, namely Wholesale trade and Trade and repair of motor vehicles. There are several solutions with this problem. One is that we use the whole distribution sector as representative (excluding Trade and repair of motor vehicles) from where each industry and services sector sources its inputs regarding retail services; or that we chose wholesale services only. Both approaches are imperfect and have their weaknesses, but we have checked both strategies and prefer the ones that includes both Wholesale trade and Retail trade.

Another issue that we are faced with is that some services policy indicators are more disaggregated than that the input-output tables allow us to compute any input coefficients. In order to tease out any sub-sector coefficients from these tables, we use Eurostat's production data which serve us with an indirect way of carving out any sub-sectors within an aggregate service sector. Admittedly, this method is not a prefect substitute, but allows us nonetheless to be as consistent and detailed as possible.

Furthermore, as part of our robustness check we also use EU-wide input-output coefficients in which all 28 member economies are taken up, including a good coverage of the retail sector, in addition to input-output coefficients from one exogenous country only which is the US. The main reason for using these two non-country specific input-output tables for computing input sourcing coefficients stems from the fact that there seems to be debate in the economic literature about whether one should use the assumption of equal industry technologies across countries or not. Equal technology coefficients seem reasonable if one thinks that the country selection in the sample are reasonably similar in their economic structures and technology endowments. Practically, this might as well form a convenient assumption if a suspicion exists that input-output tables at the country level are not very well measured for some

[13] An overview of this matrix with the number of firms in each of these cells is available upon request.
[14] Note that for Bulgaria we used 2011 as a reference year for reasons related to data availability.

economies. This could be in particular the case for less developed countries which suffer from weak reporting capacities. We check both approaches.[15]

3 Empirical Strategy

This section sets out the empirical strategy in a two-step approach. First a so-called services linkage will be developed following previous works in that the policy variable indicators used for our regressions are "weighted" with the input-output coefficients. Then, in a second step, our baseline specification for the regressions is presented.

3.1 Services Linkage

The empirical estimation strategy follows the one which is pioneered by Arnold *et al*. (2011; 2015) and which has been used in all subsequent papers with the purpose of creating a so-called services reform index. This means that one needs to interact the input-output coefficient of services input reliance for each manufacturing and services sector with the sector-specific regulatory barrier index in services for each country. This is an identification strategy that relies on the assumption that manufacturing as well as services industries which are more reliant on services inputs would be more affected by changes in regulation within each input services sector over time. This "weighted" average of services policy regulation that relies on services intensities is a more just approach to measure the effect of services regulation on TFP in contrast to an unweighted one.

For this reason, each of the country-sector specific reform indicators is multiplied with the proportion of services sourced as inputs in country *c*, from service sector *s*, for downstream services and manufacturing firm *j*, i.e. φ_{cjs}, which is the input-output coefficients as explained in the previous section. As a consequence, we apply the next formula:

$$Services\ Linkage\ (SL)_{cjt} = \sum_s \varphi_{cjs} * \ services\ reform\ index_{cst} \qquad (2)$$

where φ_{cjs} comes from the input-output tables from the year 2010 reported at 2-digit level in which the input shares are computed based on the total value-added of inputs used, and where the services reform index refers to the country-sector-year specific regulatory indexes in services from the OECD's NMR and the FDI indexes database. The fact that we chose our input-output coefficients to be industry-specific from these matrixes is because Arnold *et al*. (2015) claim that deployment of inputs reliance measures at firm-level may suffer from endogeneity issues in connection with the performance of the firm. Industry

[15] On a more technical note, some regulatory variable indexes from the NMR or related to FDI do not show much variance over time and therefore regressions could pick up any variation of the input-output coefficients for each country alone rather than the variation of input-output coefficients interacted with the regulatory variable indexes. This provides us with an additional argument to use EU-wide or one country-specific (i.e. US) input-output coefficients as explained in the main text of this section.

information gives us a certain average over all firms belonging to a similar NACE 2-digit category.[16] Clearly we are presented with a trade-off between precision and exogeneity, but feel that the latter is well-suited since Amadeus does not report any information on service input usage. Moreover, and as previously explained, instead of our country-sector specific φ_{cjs}, we also use common input-output coefficients from the EU as a whole and check for entirely exogenous US-specific input coefficients as well. Of note, equation (2) is also used to distinguish the overall index of regulatory barriers into two indexes that covers entry and conduct regulations separately.

3.2 Baseline Specification

Equation (2) is used in our baseline regression and measures the extent to which firm-level TFP are affected by the regulatory linkages in previous years. In other words, we regress the logarithm of our four TFP measures of a manufacturing services firms *i* in country *c* in industry *j* in time *t* on the services linkages which are lagged over two years. Our motivation for lagging is related to the fact that we believe that on a wider EU market scale it takes time before downstream firms across all member states benefit from opening services markets for entry and increased competition. As such our baseline specification takes the following form:

$$TFP_{icjt} = \Phi + \theta SL_{cjt-2} + \lambda_i + \delta_{jt} + \varsigma_{jt} + \varepsilon_{icjt} \quad (3)$$

In equation (3) the terms λ_i, δ_{jt} and ς_{jt} refer to the fixed effects by, respectively, firm, country-year and sector-year. This very stringent specification is possible since our variable of interest, SL_{cjt-2} varies by country-sector-year and only variation in the data from this perspective will be picked up in the regressions. Last, ε_{icjt} is the residual. Regressions are estimated with standard error clustered by country-sector-year. Finally, for all regressions we take the years 2006-2013, which at first sight may be affected by the global financial crisis but we are not too much concerned about this since extremely restricted time fixed effects are applied, in combination with our country and sector dimension. However, in subsequent robustness checks we also correct for later time periods post-2008.

Lastly, equation (3) could also control for other policy influences. In previous works such correction was comprised of a variable that measures the within industry tariff and input-tariff reductions, the latter following similar strategy of multiplying input-output coefficients as in our case of input services. Furthermore, another control variable present in previous works is one that measures, over time, the

[16] This is different compared to Fernandes and Paunov (2012) who use firm-specific services inputs coefficients. Although further endogeneity issues may be solved by using input-output tables from the first year in our analysis, i.e. 2008, these were unfortunately not available. Similarly, one could also think of applying completely exogenous input-output tables from, for instance, the US. Two problems may actually arise with such approach. One, the US economic structure may be entirely different compared to some of the EU economies which are still categorized as upper-middle income countries, which in particularly may affect their services input reliance for each sector. Second, reclassification schedules from the US system of sector classification, namely NAICS, to the European NACE scheme may result in an imprecise consistency across the two schedules. All former studies take country-specific input-output tables.

extent to which firms have a foreign share. In our case, information on both variables are hard to find. Ideally, we would need tariffs at 2-digit NACE level, but this information is not directly reported at Eurostat or WITS. On the other hand, since a long time tariffs within the EU have been set at community level encompassing all member countries. Even though these EU-wide tariffs are available in WITS, they only have a time-varying dimension and would therefore drop out from the regressions due to our sector-year fixed effects.

Similarly, although input tariffs are multiplied with country-sector varying input-output coefficients and should therefore not be dropped from our regressions, since tariffs are measured at EU-level what we would measure otherwise is precisely these coefficients and not any country-sector variation stemming from restrictiveness. Furthermore, regarding the foreign share of firms, unfortunately the Amadeus database does not report time-varying information on this variable, which means that this variable remains constant throughout our period selection. It therefore does not allow for any variation over time at the level of the firm, country and sector and so this variable would be dropped from our regressions as well. Taken together, all our control variables are regrettably omitted in our specification.

3.3 Baseline Extension

In a next step, we would also like to expand our baseline specification to take into account any differential impact of services reform on TFP of firms located in a country that is institutionally strong. The recent empirical services literature has found that domestic institutions matter as a type of governance for services reform because of a variety of reasons. First, Van der Marel (2016) shows that domestic institutions in terms of strong regulators are essential in terms of "shaping" domestic competitive markets after services liberalization has taken place. Merely opening up a services sector would not suffice due to the many market failures from which services sectors suffer and which therefore requires additional design of regulations in order to create markets that are *effectively* competitive. Setting this regulatory framework should ideally be done by competent regulators. Consequently, countries that are institutionally strong are most likely to be well-placed to have these qualified regulators. In his work, Van der Marel (2016) uses rule of law as a proxy for institutions from the World Bank governance indicators database following standard practice.

In a second work, Beverelli *et al*. (2015) take a similar stand but from the trade perspective. They argue that the institutional capacity of countries is important in order to attract foreign services suppliers into the domestic market. Most services are supplied through a foreign affiliate that carries along a so-called proximity burden in which the foreign services provider needs to be on the domestic market. Only the best services firm will be able to detect institutionally strong countries as a sort of natural self-selection, which in turn has an effect on downstream productivity for firms using services from those firms. In their work, the authors use the level of corruption from the World Bank governance indicators database. Interestingly, in our regressions we use the FDI restrictiveness index which could test for such channel of proximity by foreign affiliate as the former is closely associated with foreign affiliate sales.[17]

[17] Note, however, that FDI is an imperfect variable for foreign affiliate sales, and so therefore FDI restrictiveness is an imprecise variable for regulations in services trade through foreign affiliates, which would not directly confirm the results of Beverelli *et al*. (2015). Yet, since the majority of FDI takes place in services it could stand for a rough proxy variable. Note that their regulatory services variable is for one-year only which is therefore cross-sectional.

In all, therefore, we come up with the following augmented baseline specification in which we interact our services linkage, SL_{cjt-2}, with an institutional variable varying by country and time, such that:

$$TFP_{icjt} = \Phi + \theta_1 SL_{cjt-2} + \theta_2 SL_{cjt-2} * INST_{ct} + \lambda_i + \delta_{jt} + \varsigma_{jt} + \varepsilon_{icjt} \quad (4)$$

In the process of selecting an appropriate proxy variable for domestic institutions, our experience shows that the variables from the World Bank governance indicators database are highly correlated with each other. Based on Van der Marel (2016) and Beverelli *et al*. (2015) we select both level of corruption and rule of law, plus a third indicator called regulatory quality and perform a factor component analysis so as to take out the common variation between the three institutional measures. The selection of the third variable is based on the fact that regulatory quality is important proxy indicator for strong and independent regulatory bodies that oversee services markets as outlined in Sàez *et al*. (2015).

Furthermore, we provide additional interaction effects with variables varying at different levels. One is that we also include our time-invariant firm-level foreign share variable to see whether foreign firms are significantly more hurt by regulations, and for which type, as opposed to pure domestic firms. Second, we also develop an industry-specific variable of see where goods and services sectors are placed in terms of their productivity relative to the so-called technology frontier. Through this way we have three different types of interaction strategies to see whether essential country, sector and firm characteristics have any differential influence on the relationship between services regulations and downstream economic performance.

4 Results

The results of our baseline estimations are presented in Tables 2 and 3. These tables report the results using our baseline regression as specified in equation (3) using the Ackerberg TFP since this is our preferred measure following the economic literature. Results for the alternative TFP measures (i.e. Olley and Pakes, Levinsohn and Petrin, and Hsieh and Klenow) are presented in the annex (Table A10). Table 2 shows the regression results using country-specific input-output coefficients as explained above. The results clearly show that the overall services linkage is significant and negative in column (1).[18] This result suggest that increasing restrictions in service regulation has a negative effect on productivity performance of firms active in both downstream services and manufacturing industries, i.e. the entire economy. When splitting up this overall services index into the two types of regulations of entry and conduct, Table 2 also shows that the variable of entry barriers remains insignificant when entered separately.[19] On the other hand, conduct regulation remains significant with an expected negative sign.[20] The services linkage using FDI restrictions are insignificant. When entering all variables together, conduct

[18] Results for alternative TFP measures in Table A10 also show a negative sign for overall services linkages as can be seen in columns (1), (7) and (13).

[19] The same happens for the Hsieh and Klenow TFPQ measure. Yet, the TFP specifications by Olley and Pakes and Levinsohn and Petrin show that entry regulations are significant when entered separately (see Table A10).

[20] The negative sign of conduct regulation variable remains robustly significant throughout all the remaining three TFP measures although coefficient sizes vary depending on the specific TFP measures (see Table A10).

regulations appears to be the one which robustly stands out as significant. This latter result remains robust when using our alternative preferred TFP measures of Hsieh and Klenow. (See Table A10.)

The estimated coefficients of Table 2 and Table A10 imply that for an average EU country, a reduction in overall services regulations to a targeted average level of the three most deregulated European economies means an increase in the level of firm productivity performance of about 2.8 percent. When breaking down the overall regulatory restrictions into entry and conduct barriers, a similar reduction in services regulation would imply an increase in the average productivity level of the firm by, respectively, 1.39 percent and 1.59 percent. Note that these numbers represent an average of the coefficients found in our preferred TFP specifications from Ackerberg and Hsieh and Klenow. In a comparable scenario in which one takes the highest coefficient outcome in Table A10, the results would imply a productivity level increase of the firm by 5.34 percent when reducing overall barriers; a 2.83 percent increase when reducing entry barriers; and a 3.38 percent increase when reducing conduct regulatory barriers. Table A11 in the annex provides more detail on these computations while Table A12 shows TFP impact results by country.

Following our discussion on using common versus country-specific input-output coefficients, we repeat our analysis using the EU-wide input-output tables. The results are presented in Table 3 and show that much less significant coefficient results are obtained. Nonetheless, they substantiate our results found in the previous table in the sense that conduct regulations are negatively significant for TFP levels using the Ackerberg specification. Results from Table 3 confirm the negative effect of conduct barriers in services on downstream TFP when entered separately (albeit weakly) and is reinforced when entered with the other regulatory services linkage variables. Other coefficient outcomes remain entirely insignificant as part of this specification. In column (6), the regulatory services linkage index for FDI now receives a negative and significant sign as well when entered next to the other regulatory variables.[21]

In sum, although different types of regulatory measures appear to affect downstream productivity depending which TFP specification one uses, one thing that clearly stands out in this regard is that conduct regulations remains the most robust indicator that explains services reform as having an effect on the wider economy in the EU when taking both downstream services and goods into account. These results suggest that removing conduct regulations to an achievable level of the three most deregulated EU economies would increase the TFP level performance of the firm in both services and goods sectors for an average EU country by a maximum of 3.38 percent.

4.1 Role of Institutions

Our regression results for the role of institutions as having a differential effect on firm-level TFP are reported in Tables 4 and 5, all using our preferred Ackerberg measure. Tables A14 and A15 present results for the remaining three TFP specifications. In similar order, the results are presented for the country-specific input-output coefficients (Table 4) as well as when using EU-wide input-output

[21] Table A13 in the annex shows the estimation results for the three remaining TFP measures and show that both the Olley and Pakes as well as the Hsieh and Klenow TFP measures provide a negative and significant sign for conduct regulations. Moreover, in Table A13 columns (15), (17) and (18) in addition show that the significance of conduct regulations corroborates our initial findings as presented in Table 2 in that it remains significant when entered separately as well as when entered together with the other regulatory variables.

coefficients (Table 5). Our data on institutions originally vary with increasing values indicating better institutions, but are rescaled so that increasing values represent worse domestic institutions along with our regulatory variables that have a similar functional scale.[22] Hence, our main motivation for reversing these values is because such a transformed scale would be consistent with our regulatory variable and which could facilitate the ease of interpretation of the results. For instance, if a negative and significant sign is found on the interaction term, it would mean that higher levels of regulations in services are particularly harmful in countries which have weak domestic institutions.

Results in Table 4 show that none of the institutional interaction terms have a significant sign when entered separately. This is quite the opposite however when we look at the other three specifications presented in Table A14, including our second preferred TFP measure from Hsieh and Klenow. They all show that regulatory barriers in institutionally weak countries have an additional negative impact on economic performance. This significant effect is for the overall regulatory index, entry barriers as well as conduct regulations when entered separately. The differential effect using the FDI indicator does not come out significant in any of its individual entries. However, when putting the services linkages together, the only significant effect as part of the interactive effect of institutions using Ackerberg is for FDI restrictions as shown in Table 4. It means that, FDI restrictions are particularly harmful in EU countries with relatively weaker domestic institutions, which would confirm previous work by Beverelli *et al*. (2015). Yet, as a second very strong result is that also entry barriers are showing to have a significant differential effect for countries with weak institutions in all other three TFP specifications (presented in Table A14) when entering separately as well as together in columns (6), (12) and (18). Throughout all three performance measures, this differential negative impact in institutionally weak countries is quite substantial as the coefficient sizes are large.

Again, we repeat our results by using common input-output coefficients from the EU-wide input-output matrix (see Tables 5 and A15). The interaction effects obtain a lot of explanatory power in the sense that entry regulations come out strongly significant for all TFP specifications, this time also for our preferred Ackerberg measure. However, this significance drops when entered with the entire range of institutional interactions. In Table 5, columns (4) and (6) also show that the FDI restrictions remains a robust indicator for negative performance in countries that exhibit a lower level of domestic institutions. In all other TFP methods presented in Table A15, the differential effect of having weak institutions repeats the outcomes as obtained in Tables 4 and A14. Throughout these results, therefore, entry regulation in combination with the role of institutions have strong predictions for explaining the performance of TFP in downstream industries. Note again that the coefficient sizes are particularly large so that this negative interaction effect is very harmful in countries which institutionally are lagging behind.

Summarizing our results, it turns out that on the whole institutions matter for benefitting from lowering regulatory restrictions in services. Countries that are institutionally weak appear to have significantly lower levels of economic performance in the process of deregulation.

[22] The original indicators from rule of law, level of corruption and regulatory quality vary from -2.5 to + 2.5 with increasing levels signifying stronger institutions. In our case, we first rescale this index with +2.5 so that our measure varies from 0-5 and then reverse all indicators. Next, we perform a factor component analysis so as to retrieve the main variation among these three variable indicators since they are all highly correlated with each other. The reason for doing so is that the recent literature has used all three indicators as a proxy for the role of institutions. A principle or factor component analysis transforms these variables into one meaningful proxy.

4.2 Robustness Checks

4.2.1 Foreign Share

We also perform further robustness checks with the available data at hand. As explained, in our baseline regression it was impossible to include our foreign share variable as a control variable since this dummy proxy varies by firm only and would be wiped out due to the firm fixed effects. However, we can include this variable as part of an interaction term as we have done with the level domestic institutions in an attempt to estimate the differential effect of services regulation on TFP across type of firm. Our foreign share variable indicator takes up a value of 1 when the foreign share is strictly 50% or more, which is in other words an indicator of a foreign majority owned company.[23] By interacting this variable we get an interaction term that varies by country-sector-firm and so the standard fixed effects we apply should not prevent us from including this additional information. Based on the previous regression results, and to save space, we choose to perform this interaction effect of foreign share firms for the Ackerman TFP specification only. We do however check whether the results are consistent with country-specific and EU-wide input-output coefficients.

The results are reported in Tables 6. Results using the country-specific input-output coefficients in left-hand panel tell us that the overall index of services regulation that summarizes regulatory barriers for both entry and conduct regulations are negatively significant for foreign firms. The coefficient is of equal size indicating regulations in services have a double effect on majority foreign owned firms. This significance is reasonably high at the 5 percent level. Additionally, the following regressions results show that this significant differential effect for foreign firms is not so much felt with reference to entry barriers, but rather to regulations related to the anti-competitive practices regarding operations of the firm. In effect, there is no statistical significant difference whether higher entry regulations are more harmful for foreign firms compared to domestic firms. What does seem to matter is indeed our conduct regulatory indicator which shows that higher regulations on the conduct of the firm are particularly harmful for foreign firms compared to domestic firms in EU member states. This result remains robust when entered with the other regulatory indicators. When using common input-output coefficients across EU countries, which are shown in the right-hand panel, we obtain a similar strong impact regarding this difference in the effect of conduct regulations on foreign firms with coefficient sizes that are more than twice the original one.[24]

4.2.2 Technology Gap

The next extension of our baseline regression is at sector-level and takes into account where firms are placed relative to the technology frontier. The technology frontier is composed of those firms which are performing best in terms of TFP. This follows the empirical investigations using a so-called technology gap developed by Acemulglu *et al*. (2006) and Aghion and Howitt (2006, 2009). From a conceptual

[23] Note that not all firms report whether they have a foreign share or not, which therefore provides us with some unreported observations for this foreign share dummy. We therefore assume that these firms are pure domestic firms and fill missing information with a zero, which incidentally provides us with more observations. We also check whether not filling would change our main results in any significant way, which is actually not the case.

[24] We also regressed our baseline regression with the foreign dummy employing alternative TFP measures such as the Hsieh and Klenow approach and the main results do not alter in any significant way.

perspective these studies put forward the neo-Shumpeterian growth theory in the sense that both innovation and imitation activities also have a separate bearing on growth and productivity. This approach has found empirical underpinnings in studies such as Nicoletti and Scarpetti (2003), Greffith *et al*. (2004), Aghion *et al*. (2004; 2005) and more recently by focusing on EU countries using industry-level data by McMorrow *et al*. (2010). The bottom line of these studies is that certain economic or policy characteristics such as factor endowments or regulatory policies have a different effect depending on the fact in which type of industry firms are placed, i.e. an industry that is characterized with many firms relatively close or relatively far away from the technology frontier.

Since we have firm-level data we calculate the technology gap as developed in Aghion *et al*. (2005) so as to derive a within-industry specific measure which is the proportional distance of a firm relative to the technology frontier in terms of TFP as defined by the following equation:

$$Technology\ gap_{icjt} = \frac{lnTFP_{Fcjt} - lnTFP_{icjt}}{lnTFP_{Fcjt}}$$

in which the technology gap is measured for each firm within an industry by country over time. In this equation firm *F* is the firm with the highest TFP while all other firms which are non-frontier firms are indicated with the usual *i*. As in Aghion *et al*. (2005), the technology gap for the frontier firm is set at zero. Similarly, as in their work this measure of firm-specific technology gap is then transformed into an average over each industry and services sector for each country and year. Hence, industries showing a low value of the technology gap are those industries which are characterized by a "neck-and-neck" situation in which firm share equal technology levels whereas a higher value of the gap reflects so-called "unleveled" sectors in which sectors are marked by many followers with unequal technology levels compared to the leader firm. Table A16 in the annex sets out the value of the technology gap for each 2-digit NACE sectors across the EU for the years 2013-14 in our sample for both goods and services.

Note that a lower value of the technology gap indicates that on average firms in a sector are technologically closer to the frontier (or best performing firm) which on the whole are more sensitive to the fact that competition may increase rewards from R&D and innovation in these neck-and-neck sectors.[25] On the other hand, a higher value of the technology gap stands for the so-called unleveled industries in which a higher level of competition may actually reduce the incentive to innovate since increased competition creates a fall in the reward for the lagging firms to catch up with the technological leader. Note furthermore that a negative coefficient result on the interaction term between regulation and technology gap indicates that regulation has a negative effect on TFP which is increasing with distance to the frontier, i.e. especially important for industries marked as unleveled while a positive coefficient outcome on the interaction term stands for the negative effects of regulation that is

[25] More precisely, Aghion *et al*. (2005) indicate that these industries are comprised of oligopolistic firms facing more similar production costs. On the other hand, the firm with lower (resp. higher) unit costs is referred to as the technological leader (resp. follower) in the corresponding industry, and when both firms have the same unit costs they are referred to as neck-and-neck firms.

decreasing with distance to the frontier, i.e. especially significant for industries identified as neck-and-neck.

As in our previous extensions and robustness checks, we prefer to work with the Ackerberg specification in our regressions and so our results show the coefficient outcomes accordingly. The results of interacting our regulatory variables with the technology gap are presented in Table 7. In this table it becomes clear that the separate services barriers overall in the left-hand panel has the expected negative sign and that the interaction term using this regulatory variable also have a negative and significant outcome in column (1). Splitting up the variable again, it shows that in columns (5) and (6) entry barriers obtain a negative and significant result while conduct regulations obtain a positive and significant result although weakly. This indicates that entry barriers are particularly hurtful for industries which are classified as unleveled, but that conduct barriers have a particularly negative impact for industries that are categorized as neck-and-neck.

We have performed alternative specifications to come up with a robust result. For instance, the results remain stable when using the EU-wide input coefficient results as shown in the right-hand panel. We also obtain similar results when including a dummy variable that distinguishes between the two types of industries (output omitted). Moreover, recent papers such as McMorrow *et al*. (2010) and Bourlès *et al*. (2013) have used alternative technology gaps based on non-firm-level data. We follow Bourlès *et al*. (2013) so that our alternative specification of technology gap is the simple difference of $\ln(TFP_F)$ and $\ln(TFP_i)$ and then averaged by sector.[26] The results support the idea that entry barriers are particularly important for unleveled sectors whereas conduct regulations are more important for neck-and-neck sectors. Additionally, the last two papers use TFP growth rather than levels which we are also able to compute as the log difference of TFP between two years. However, no meaningful results are obtained through this way.

4.2.3 Post-Crises Performance

Up till now we have selected our time frame to be 2006-13 in an attempt to exploit more observations and regulatory variance present in the data. However, this time period covers the global financial crisis in which precisely many firm would feel forced to exit the market, although it is unlikely that outgoing firms would represent an equivalent drop of 60 percent which is the difference between our two data sets as previously explained. This is likely to be due to reporting issues. However, we nonetheless would like to check whether our results are robust to including firms as of 2008 only. Admittedly, this will be done by reducing only two years, but it may give us nonetheless extra evidence whether our results of conduct barriers are really the main policy area of concern. Furthermore, the OECD's NMR point of measurement of regulation for quite some services sector is done in 2008 with previous year of measurement 2003. As such, by selecting our data as of 2006 till latest year available we may also have been picking up any inconsistent real regulatory variation at the time of collecting regulatory data before the year 2008.

[26] Of note, although we are able to compute the technology gap at the firm, we nonetheless prefer to compute an average so as to have industry-specific variation of technology gap in order to be consistent with Aghion *et al*. (2005) and other papers. Moreover, both McMorrow *et al*. (2010) and Bourlès *et al*. (2013) do not work with firm-level data and therefore use industry-specific TFP which automatically creates a technology gap that is industry-specific. As a result, none of these papers has used a firm-specific technology gap in their regressions.

We therefore replicate our baseline regression as presented in equation (3) and use, again, the Ackerman, plus the Hsieh and Klenow specification of TFP to see whether any difference appears. Again we use both types of input-output coefficients to check the stability of our results. Table 8 shows the results and confirm the fact that conduct barriers in services are in large part the most important issue that inhibits downstream firms from reaping higher economic benefits in terms of productivity. Yet, this results does not hold up all the time. In fact, using Ackerberg this variable only becomes marginally significant in the left-hand panel when employing country-specific input-output tables while EU-wide tables do not bring any significant results on this conduct variable at all. Instead, FDI restrictions comes out as significantly strong. In contrast, the Hsieh and Klenow measure of TFP provides robust evidence that conduct barriers are indeed the main regulatory index variable that affects TFP in downstream sectors which therefore substantiates our earlier findings.

4.2.4 Manufacturing Firms

So far, all firm-level studies mentioned in our literature review have used manufacturing firms as the only downstream sector without taking downstream services into account. For some developing economies this is understandable as their manufacturing sector is relatively more important compared to their services activities in terms of value-added. Yet, for developed economies this inter-sectoral relationship changes into one where the services sector is generating more importance. Seen in this light, it is reasonable to expect that services sectors themselves are the main users of services as inputs. Indeed, our input-output tables show that when taking stock of all services sectors in the economy, on average the manufacturing sector takes up only 21.6 percent of all services as inputs, while the services sector absorbs around 63 percent of this total input use from services. However, we are interested whether our results are stable when taking out services firms so that we are left with the sole situation in which services only go into the downstream manufacturing sector.

The results of this exercise are reported in Table 9 for both our preferred TFP variables from Ackerberg and Hsieh and Klenow respectively. In this table columns (1) through (12) show that actually this time it is not conduct regulations that seem to matter most, but entry barriers. This is visible by the negatively and significant outcome on entry barriers only as the conduct regulatory barriers remain insignificant. Note that when using EU-wide input coefficient, these results become somewhat weaker although still significant. Furthermore, in columns (10) and (12) the FDI restrictions become again significant with a negative and sizable coefficient sign. Surprised by these results, we repeat the manufacturing-only sample for using the Hsieh and Klenow TFP measure and are confirmed with this outcome in case of using the country-specific input-output tables. No significant results were found when using EU-wide tables for the Hsieh and Klenow TFP measure in the right-hand panel.

This is a somewhat surprising result and could point to two explanations. One is that including the manufacturing sector only in the analysis could create biased results in the sense that for some economies this sector count for a relatively minor share compared to the firms active in the services sector. An alternative explanation, and which is more likely, is that the results indicate that different types of regulatory restrictions matter for different types of economies: economies which are more reliant on manufacturing firms experience entry barriers as the main regulatory barrier at stake. Yet, when a country is moving more and more into services, the relative importance between conduct and entry barriers changes accordingly with regulations on the operations of the firm being the main issue of

importance. This seems consistent with our previous findings that (a) entry barriers seem to matter more for countries exhibiting low levels of institutions which are usually economies which are more reliant on industry rather than services, and (b) entry barriers appear to me most important for sector which are lying further away from the technology frontier which is most likely the case for countries which are less-developed and incidentally also more dependent on industry than services.

4.2.5 Exogenous US I/O coefficients

As our discussion on country-specific or EU-wide input-output coefficients indicated, either approach could still run the risk that there could be cases where a higher downstream productivity term of sectors leads to higher input sourcing within or across EU countries. To reduce this endogeneity problem, we use completely exogenous input-output coefficients from the US. When we do this, the detailed 6-digit Input-Output Use Tables from the US Bureau of Economic Analysis (BEA) are employed to compute these sourcing coefficients and are consequently concorded into our NACE classification system. They are then mapped with our regulatory regulations variables and used in the regressions.[27]

The results of our regression using these concorded US coefficients are shown in Table 10 where we replicate the baseline model using the Ackerberg and Hsieh and Klenow TFP specifications. The results show a consistent pattern in that conduct regulations are across all columns highly significant. Note that for the Ackerberg measure when entered the various regulatory variables separately or together, conduct regulation is the only regulatory variable that comes out negatively significant. This is somewhat different when looking at the Hsieh and Klenow TFP. In there, both the overall, entry and conduct regulations are highly significant, also when entered jointly. However, looking at the coefficient sizes of all coefficients, conduct regulations appear to have and almost twice as large impact on downstream TFP compared with entry regulations. Both outcomes across the two TFP measures reassures us that our baseline regressions are capturing an important role for conduct regulations and that the potential endogeneity does not form a risk.

4.2.6 TFP Distribution

Our last robustness check takes into account the entire TFP distribution. Figure A1 in the annex gives a graphical representation of the cumulative distribution function of our preferred TFP specification for manufacturing as well as services firms, namely from Ackerberg. As expected, and as shown in many other works on firm-level productivity, this figure shows that there is a relatively small number of firms with extremely high productivity figures in addition to a low frequency of firms with relatively low productivity while having a large middle range of firms performing in between these two extremes. Hence, the lower quantiles encompass firms with lower productivity distribution whereas the higher quantiles carry firms with a higher TFP distribution. Overall, it means that the entire distribution is not very symmetric. It motivates us to see whether firms in the EU placed in the upper, middle or lower

[27] To see how we have matched the detailed 6-digit BEA classification scheme with our NACE classification and to find out how we have classified the regulatory variables with each 6-digit BEA services sectors, a concordance schemed can be obtained upon request.

range perform any different with respect to the regulatory policy linkages we have developed and investigated in our paper.

By doing so we take our baseline specification and perform quantile regressions. Yet, only one problem arises, which is the huge amount of fixed effects by firm that need to be taken up in our computations and which limits our econometric computational capacity. Unfortunately, in our case the amount of fixed effects is too large to be technically feasible for running any quantile regressions in our econometric package. Therefore, we transform our preferred regression into first differences so that we difference away any firm effects and as a first step check the results with our standard fixed effects model. Specifically, we apply this difference on three years, which provides us with the best results and cluster by country-sector-year. Table 11 shows the results of both specifications.

First, column 1 repeats the results found in our baseline regressions in Table 2 with standard errors clustered by country-sector-year for easy comparison. Second, when applying our first-difference approach, column 2 shows that results are exactly similar, which comforts us that differencing away firm-effects is a good way of getting around our quantile regressions. Regarding the results across all quantile groups, the outcome of this exercise confirms our main conclusion of the paper in that in great part conduct barriers are the main policy variable that are of importance.[28] However, the results also show that conduct barriers have no significant effect in the higher quantile groups, i.e. for the most productive firms, but that FDI restrictions are the main barrier although with weak significance for the highest quantile group. Note furthermore that surprisingly entry barriers have positive and significant coefficient results for the highest quantile groups. This results presents a puzzle, but one potential explanation is that the largest corporations in the EU are in political economy terms able to uphold existing high entry barriers due to their size, which benefits them as they keep out competition from smaller new entrants.

5 Conclusion

Services are often found to be the next step for economic development since the production and tradability of services is associated with higher levels of value-added and therefore growth. Yet, in many countries services markets are not (yet) freed from restrictive regulatory burdens which inhibits firms to efficiently source services that are needed to operate their businesses. This factor is important as many services are used as inputs into downstream production processes of manufacturing firms as well as services firms. Greater levels of regulatory restrictions in services have indeed been shown to form a negative burden in the productivity of these downstream firms.

This paper is the first to asses this effect of services regulation on productivity using a multiple-country setting for a group of developed economies that is often assessed as the most progressed in terms of services markets integration, namely the EU. Developments of lowering regulatory barriers have significantly advanced in the EU although cross-country variation still exists. With consistent services policy indicators across countries, reliable TFP measures at the micro-level, and cross-country services input reliance indexes from a similar source, we have been able to track down the effect of services regulation on TFP according to their functional form. More specifically, we separate our overall index of

[28] Of note, the technical infeasibility of including our preferred stringent three-level clustering dimension appeared to be computationally too demanding and therefore we were left with including robust standard errors only.

regulations into those restrictions that are solely comprised of entry barriers and those that exclusively affect the operations of the firm. Furthermore, we also use up-to-date TFP specifications that have been put forward in the economic literature to come to credible outcomes.

Overall, our results suggest that lowering overall service restrictions to an average feasible level of the three most deregulated EU economies would increase the productivity performance (in levels) of firms operating in both services and manufacturing industries by a maximum of 5.34 percent. When splitting the overall service index into types of regulations (conduct, entry or FDI), our results show that indeed different types of regulatory barriers matter for different sorts of firms, industries and even countries. First, regulations on the operations of the firms seem to form the most robust indicator for EU countries to have an impact on firm-level TFP as opposed to entry barriers. Second, we show that institutionally weak countries are more likely to suffer significantly more from restrictive levels of regulations across many of our types of regulatory indicators. Third, industries which are marked by a high level of neck-and-neck competition are more affected by conduct regulations as opposed to entry barriers. Fourth, firms which are have a majority foreign-owned share are in addition more prone to regulatory restrictions on the conduct of the firm. Fifth, our robustness checks also show that in fact entry barriers are the main factor explaining TFP performance when only downstream manufacturing firms are taken into account. This last point may suggest that as economies are shifting from manufacturing to services economies, the relative importance of conduct regulations as opposed to entry regulations also alters.

From a technical perspective, our many robustness results indicate that it could be insufficient to analyze the policy outcome variable at the firm level with only one TFP specification. As a matter of fact, different TFP measures provide marginally important differences in outcome results. This should be researched further as more and more cross-country firm-level data sets will be available. To date, most previous studies on this subject at least undertake analysis for a one single country only with sometimes one preferred TFP indicator. This paper shows that this may not always be helpful and suggests that in further research multiple robustness checks regarding different productivity measures should be taken into account so as to derive a common pattern, which hopefully this paper has achieved in a satisfactory way. Moreover, this paper shows that it makes a difference when only manufacturing industries are taken up in the sample as opposed to including services sectors as well. Although TFP measures for services are more prone to measurement errors, this research has made a first attempt in doing so at the firm-level and shows that future research in this area is warranted.

From a wider policy perspective, the significant outcome of conduct regulations could have important implications such as in the field of trade policy. Negotiating services either at the WTO in GATS, or as part of regional trade agreements (RTAs), is divided into those barriers regarding market access (Article XVI GATS) and national treatment (Article (XVII). The former relates to foreign entry to the domestic market whereas the latter categorizes restrictions foreign firms face in treatment after entry in the domestic market has taken place. However, most of the regulatory barriers used in our empirical specification are of a domestic regulatory nature, which is dealt with under GATS Article VI. Our results therefore suggest that special attention is warranted to this article when negotiating trade as domestic regulatory barriers, and in particular conduct regulations, may have the effect of greatly impeding the ability of foreign firms to contest the market.

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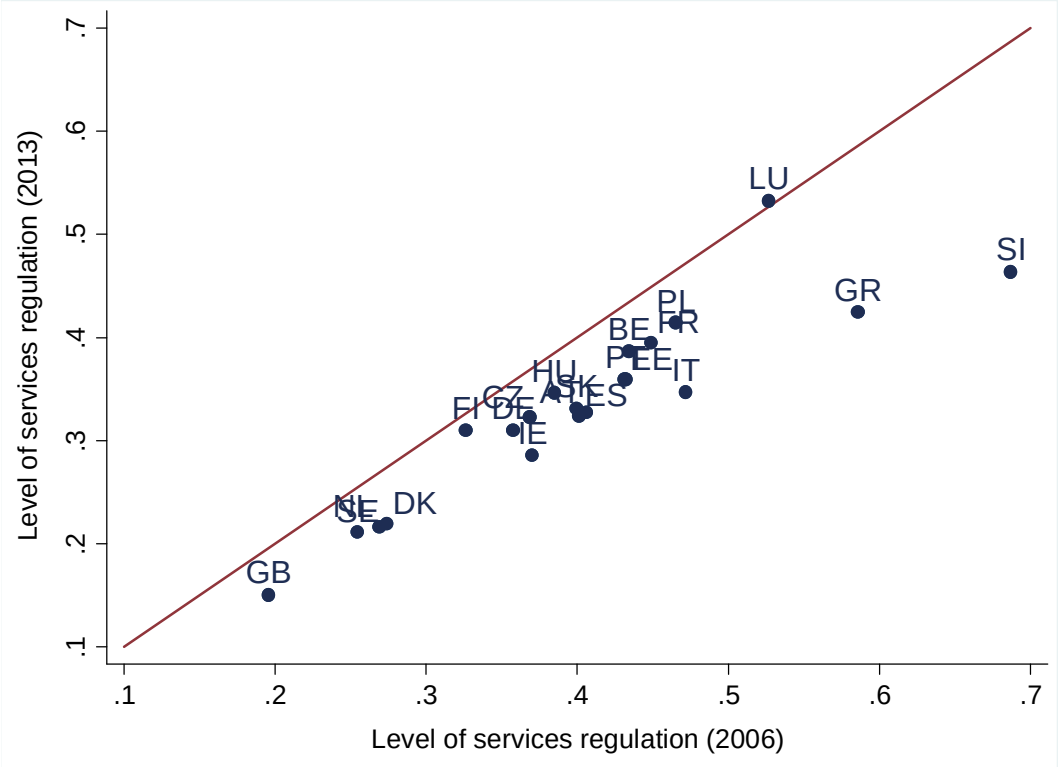
Figures and Tables

Table 1: Typology of regulatory barriers in services affecting (Foreign) Supply

	Impact on entry	Impact on operations (conduct)
Discriminatory	E.g., nationality quotas for managers of affiliates; minimum equity stake required for national investors; economic needs tests	E.g., foreign insurance firms not permitted to offer certain types of coverage or product innovations; price controls
Non-discriminatory	E.g., A limit of three mobile phone providers permitted to operate in the country	E.g., all retail banks required to maintain a minimum level of capital, independent of type of legal entity

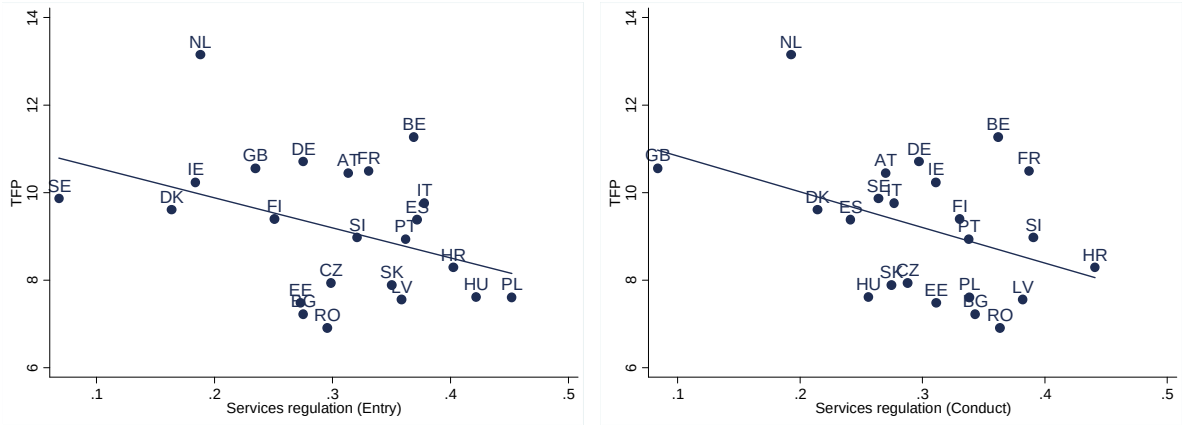
Source: Francois and Hoekman (2010)

Figure 1: Services regulation in the EU (2006-2013)



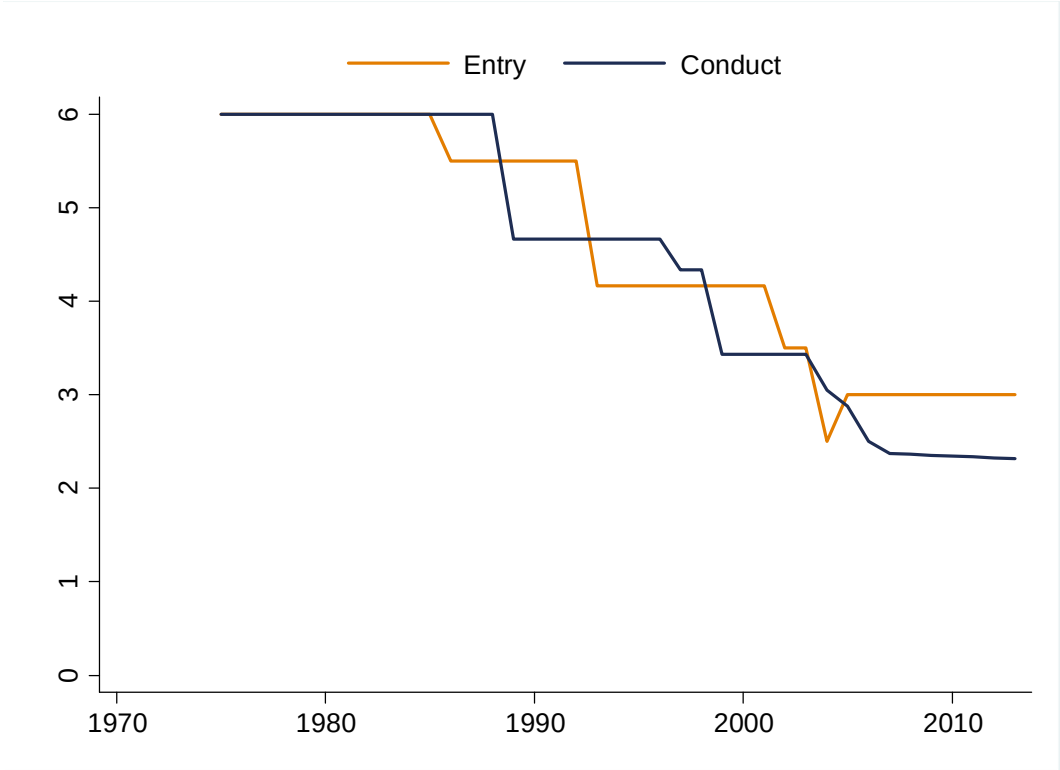
Source: OECD, and author's own calculations; 0 is low regulations, 1 is high regulations.

Figure 2: Firm-level TFP and services regulations in the EU (2013)



Source: OECD, and author's own calculations. TFP figures are based on Ackerberg *et al*. (2006). The TFP estimates are a weighted average taking the size of the firm into account within its own sector to which it belongs for both goods and services. In our case we use the number of employees of a firm relative to the total amount of employees in the 2-digit NACE sector. Luxembourg is excluded because of being an outlier.

Figure 3: Regulatory reform in France over time in Transportation services



Source: OECD

Table 2: Regression results from baseline specification

	(1)	(2)	(3)	(4)	(5)	(6)
	TFP Ackerberg *et al*.					
Overall $_{t-2}$	-0.357***					
	(0.000)					
Entry $_{t-2}$		0.015			-0.085	-0.080
		(0.835)			(0.283)	(0.313)
Conduct $_{t-2}$			-0.198***		-0.217***	-0.221***
			(0.000)		(0.000)	(0.000)
FDI Overall $_{t-2}$				0.085*		-0.074
				(0.078)		(0.102)
FE firm	YES					
FE c-y	YES					
FE s-y	YES					
Observations	4983642	5431331	5064175	5848487	4983642	4983292
R2A	0.982	0.981	0.982	0.985	0.982	0.982
R2W	0.000	0.000	0.000	0.000	0.000	0.000
RMSE	0.130	0.135	0.129	0.135	0.130	0.130

Note: * p<0.10; ** p<0.05; *** p<0.01. The dependent variable is in log. Robust standard errors clustered at the country-industry-year level.

Table 3: Regression results from baseline specification with EU-wide input-output coefficients

	(1)	(2)	(3)	(4)	(5)	(6)
	TFP Ackerberg *et al.*					
Overall $_{t-2}$	-0.229					
	(0.109)					
Entry $_{t-2}$		-0.025			-0.063	-0.042
		(0.873)			(0.659)	(0.762)
Conduct $_{t-2}$			-0.139*		-0.146*	-0.167**
			(0.058)		(0.052)	(0.027)
FDI Overall $_{t-2}$				-0.090		-0.174***
				(0.125)		(0.000)
FE firm	YES					
FE c-y	YES					
FE s-y	YES					
Observations	4966253	5413942	5046786	5818544	4966253	4965903
R2A	0.982	0.981	0.982	0.985	0.982	0.982
R2W	0.000	0.000	0.000	0.000	0.000	0.000
RMSE	0.130	0.135	0.129	0.135	0.130	0.130

Note: * p<0.10; ** p<0.05; *** p<0.01. The dependent variable is in log. Robust standard errors clustered at the country-industry-year level.

Table 4: Interaction results using institutions from baseline specification

	(1)	(2)	(3)	(4)	(5)	(6)
	TFP Ackerberg *et al*.					
Overall $_{t-2}$	-0.361***					
	(0.000)					
Overall $_{t-2}$ * Inst	0.030					
	(0.296)					
Entry $_{t-2}$		0.014			-0.094	-0.078
		(0.846)			(0.259)	(0.348)
Entry $_{t-2}$ * Inst		0.001			0.032	0.055
		(0.982)			(0.441)	(0.206)
Conduct $_{t-2}$			-0.198***		-0.203***	-0.213***
			(0.000)		(0.000)	(0.000)
Conduct $_{t-2}$ * Inst			-0.001		-0.025	-0.011
			(0.971)		(0.684)	(0.860)
FDI Overall $_{t-2}$				0.085*		-0.110**
				(0.074)		(0.013)
FDI Overall $_{t-2}$ * Inst				0.001		-0.179***
				(0.984)		(0.000)
FE firm	YES					
FE c-y	YES					
FE s-y	YES					
Observations	4983642	5431331	5064175	5848487	4983642	4983292
R2A	0.982	0.981	0.982	0.985	0.982	0.982
R2W	0.000	0.000	0.000	0.000	0.000	0.000
RMSE	0.130	0.135	0.129	0.135	0.130	0.130

Note: * p<0.10; ** p<0.05; *** p<0.01. The dependent variable is in log. Robust standard errors clustered at the country-industry-year level.

Table 5: Interaction results from baseline specification using institutions with EU-wide input-output coefficients

	(1)	(2)	(3)	(4)	(5)	(6)
	TFP Ackerberg *et al.*					
Overall $_{t-2}$	-0.203					
	(0.158)					
Overall $_{t-2}$ * Inst	-0.123*					
	(0.053)					
Entry $_{t-2}$		0.024			-0.018	0.091
		(0.876)			(0.901)	(0.532)
Entry $_{t-2}$ * Inst		-0.127**			-0.059	-0.023
		(0.015)			(0.316)	(0.698)
Conduct $_{t-2}$			-0.093		-0.132	-0.134
			(0.227)		(0.123)	(0.116)
Conduct $_{t-2}$ * Inst			-0.125*		-0.077	-0.064
			(0.063)		(0.349)	(0.430)
FDI Overall $_{t-2}$				-0.057		-0.130**
				(0.294)		(0.012)
FDI Overall $_{t-2}$ * Inst				-0.229***		-0.367***
				(0.001)		(0.000)
FE firm	YES					
FE c-y	YES					
FE s-y	YES					
Observations	4966253	5413942	5046786	5818544	4966253	4965903
R2A	0.982	0.981	0.982	0.985	0.982	0.982
R2W	0.000	0.000	0.000	0.000	0.000	0.000
RMSE	0.130	0.135	0.129	0.135	0.130	0.130

Note: * p<0.10; ** p<0.05; *** p<0.01. The dependent variable is in log. Robust standard errors clustered at the country-industry-year level.

Table 6: Interaction results from baseline specification using foreign share

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	TFP Ackerberg *et al*. using country specific IO						TFP Ackerberg *et al*. using EU-wide IO					
Overall $_{t-2}$	-0.338***						-0.206					
	(0.000)						(0.152)					
Overall $_{t-2}$ * For	-0.357**						-0.547***					
	(0.020)						(0.001)					
Entry $_{t-2}$		0.006			-0.097	-0.093		-0.037			-0.090	-0.070
		(0.928)			(0.215)	(0.234)		(0.809)			(0.526)	(0.615)
Entry $_{t-2}$ * For		0.094			0.125	0.148		0.110			0.214	0.230
		(0.332)			(0.340)	(0.261)		(0.358)			(0.253)	(0.221)
Conduct $_{t-2}$			-0.186***		-0.207***	-0.212***			-0.122*		-0.131*	-0.153**
			(0.000)		(0.000)	(0.000)			(0.100)		(0.084)	(0.045)
Conduct $_{t-2}$ * For			-0.245***		-0.212**	-0.190**			-0.421***		-0.412***	-0.394***
			(0.003)		(0.018)	(0.034)			(0.000)		(0.000)	(0.000)
FDI Overall $_{t-2}$				0.075		-0.069				-0.093		-0.171***
				(0.120)		(0.133)				(0.114)		(0.000)
FDI Overall $_{t-2}$ * For				0.057*		-0.092*				0.059		-0.066
				(0.067)		(0.099)				(0.257)		(0.394)
FE firm	YES											
FE c-y	YES											
FE s-y	YES											
Observations	4983642	5431331	5064175	5848487	4983642	4983292	4966253	5413942	5046786	5818544	4966253	4965903
R2A	0.982	0.981	0.982	0.985	0.982	0.982	0.982	0.981	0.982	0.985	0.982	0.982
R2W	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RMSE	0.130	0.135	0.129	0.135	0.130	0.130	0.130	0.135	0.129	0.135	0.130	0.130

Note: * p<0.10; ** p<0.05; *** p<0.01. The dependent variable is in log. Robust standard errors clustered at the country-industry-year level.

Table 7: Interaction results from baseline specification using technology gap

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	TFP Ackerberg *et al*. using country specific IO						TFP Ackerberg *et al*. using EU-wide IO					
Overall $_{t-2}$	-0.252***						-0.161					
	(0.008)						(0.272)					
Overall $_{t-2}$ * Gap	-0.455***						-0.321					
	(0.003)						(0.327)					
Entry $_{t-2}$		0.112			0.151	0.161		-0.030			0.068	0.090
		(0.165)			(0.125)	(0.108)		(0.852)			(0.668)	(0.566)
Entry $_{t-2}$ * Gap		-0.309**			-0.786***	-0.778***		-0.172			-0.831***	-0.763**
		(0.022)			(0.000)	(0.001)		(0.458)			(0.005)	(0.011)
Conduct $_{t-2}$			-0.134***		-0.304***	-0.310***			-0.136		-0.297***	-0.302***
			(0.006)		(0.000)	(0.000)			(0.122)		(0.003)	(0.003)
Conduct $_{t-2}$ * Gap			-0.305*		0.536*	0.553*			0.207		0.924**	0.886*
			(0.063)		(0.072)	(0.068)			(0.587)		(0.049)	(0.059)
FDI Overall $_{t-2}$				0.190***		0.011				0.122		-0.029
				(0.002)		(0.885)				(0.270)		(0.795)
FDI Overall $_{t-2}$ * Gap				-0.560**		-0.354				-0.841*		-0.535
				(0.034)		(0.315)				(0.052)		(0.230)
FE firm	YES											
FE c-y	YES											
FE s-y	YES											
Observations	4983642	5431331	5064175	5848487	4983642	4983292	4966253	5413942	5046786	5818544	4966253	4965903
R2A	0.982	0.981	0.982	0.985	0.982	0.982	0.982	0.981	0.982	0.985	0.982	0.982
R2W	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RMSE	0.130	0.135	0.129	0.135	0.130	0.130	0.130	0.135	0.129	0.135	0.130	0.130

Note: * p<0.10; ** p<0.05; *** p<0.01. The dependent variable is in log. Robust standard errors clustered at the country-industry-year level. Technology gap is constructed following Aghion *et al*. (2005) and is included as a separate control variable in the regressions.

Table 8: Regression results from baseline specification for post-crisis year, i.e. post-2008

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	TFP Ackerberg *et al*. using country specific IO						TFP Ackerberg *et al*. using EU-wide IO					
Overall $_{t-2}$	-0.076						-0.021					
	(0.469)						(0.894)					
Entry $_{t-2}$		0.080			0.051	0.057		0.173			0.078	0.135
		(0.302)			(0.584)	(0.540)		(0.238)			(0.625)	(0.376)
Conduct $_{t-2}$			-0.082*		-0.069	-0.070			-0.046		-0.037	-0.056
			(0.085)		(0.197)	(0.189)			(0.565)		(0.654)	(0.495)
FDI Overall $_{t-2}$				-0.050		-0.061				-0.196***		-0.209***
				(0.401)		(0.247)				(0.003)		(0.000)
FE firm	YES											
FE c-y	YES											
FE s-y	YES											
Observations	4209830	4548544	4290363	4947880	4209830	4209542	4192387	4531101	4272920	4923729	4192387	4192099
R2A	0.984	0.983	0.984	0.987	0.984	0.984	0.984	0.983	0.983	0.987	0.984	0.984
R2W	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RMSE	0.124	0.129	0.124	0.130	0.124	0.124	0.124	0.129	0.123	0.130	0.124	0.124

Note: * p<0.10; ** p<0.05; *** p<0.01. The dependent variable is in log. Robust standard errors clustered at the country-industry-year level.

Table 8: Regression results from baseline specification for post-crisis year, i.e. post-2008 (continued)

	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(21)	(22)	(24)
	TFPQ Hsieh and Klenow using country specific IO						TFPQ Hsieh and Klenow using EU-wide IO					
Overall $_{t-2}$	-1.855**						-3.575*					
	(0.025)						(0.060)					
Entry $_{t-2}$		-0.039			-0.341	-0.392		1.057			1.165	1.037
		(0.944)			(0.619)	(0.566)		(0.429)			(0.452)	(0.500)
Conduct $_{t-2}$			-1.125***		-1.219***	-1.192***			-2.463***		-2.393**	-2.351**
			(0.001)		(0.002)	(0.003)			(0.006)		(0.012)	(0.014)
FDI Overall $_{t-2}$				0.708*		0.654*				0.631		0.456
				(0.052)		(0.072)				(0.243)		(0.407)
FE firm	YES											
FE c-y	YES											
FE s-y	YES											
Observations	4133795	4464783	4213758	4848904	4133795	4133511	4116776	4447758	4196738	4825498	4116776	4116492
R2A	0.816	0.808	0.817	0.819	0.816	0.816	0.867	0.862	0.868	0.872	0.867	0.867
R2W	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RMSE	0.410	0.420	0.409	0.423	0.410	0.410	0.561	0.573	0.560	0.579	0.561	0.561

Note: * p<0.10; ** p<0.05; *** p<0.01. The dependent variable is in log. Robust standard errors clustered at the country-industry-year level.

Table 9: Regression results from baseline specification for manufacturing only

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	TFP Ackerberg *et al*. using country specific IO						TFP Ackerberg *et al*. using EU-wide IO					
Overall $_{t-2}$	-0.377						-1.113					
	(0.440)						(0.128)					
Entry $_{t-2}$		-0.349			-1.921***	-1.936***		-0.508			-1.403*	-1.379*
		(0.418)			(0.000)	(0.000)		(0.449)			(0.064)	(0.067)
Conduct $_{t-2}$			0.222		0.335	0.323			-0.627		-0.378	-0.455
			(0.473)		(0.284)	(0.303)			(0.236)		(0.457)	(0.372)
FDI Overall $_{t-2}$				-0.059		-0.675				-1.510**		-1.327**
				(0.904)		(0.114)				(0.031)		(0.021)
FE firm	YES											
FE c-y	YES											
FE s-y	YES											
Observations	1417951	1523104	1440022	1618931	1417951	1417951	1407773	1512926	1429844	1601608	1407773	1407773
R2A	0.985	0.985	0.985	0.987	0.985	0.985	0.984	0.984	0.984	0.987	0.984	0.984
R2W	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RMSE	0.128	0.131	0.127	0.132	0.128	0.128	0.128	0.131	0.127	0.131	0.128	0.128

Note: * p<0.10; ** p<0.05; *** p<0.01. The dependent variable is in log. Robust standard errors clustered at the country-industry-year level.

Table 9: Regression results from baseline specification for manufacturing only (continued)

	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(21)	(22)	(24)
	TFPQ Hsieh and Klenow using country specific IO						TFPQ Hsieh and Klenow using EU-wide IO					
Overall $_{t-2}$	7.123*						-6.482					
	(0.088)						(0.265)					
Entry $_{t-2}$		-9.129***			-10.406***	-10.337***		-4.288			-4.195	-4.346
		(0.006)			(0.009)	(0.010)		(0.247)			(0.472)	(0.455)
Conduct $_{t-2}$			7.208**		7.538**	7.597***			-6.396		-6.250	-5.770
			(0.013)		(0.010)	(0.010)			(0.140)		(0.143)	(0.178)
FDI Overall $_{t-2}$				3.847		3.080				2.574		8.144
				(0.290)		(0.513)				(0.674)		(0.190)
FE firm	YES											
FE c-y	YES											
FE s-y	YES											
Observations	1392899	1495481	1414829	1587437	1392899	1392899	1382913	1485494	1404843	1570712	1382913	1382913
R2A	0.840	0.838	0.841	0.847	0.840	0.840	0.840	0.838	0.841	0.847	0.840	0.840
R2W	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RMSE	0.509	0.515	0.507	0.517	0.509	0.509	0.508	0.514	0.507	0.515	0.508	0.508

Note: * p<0.10; ** p<0.05; *** p<0.01. The dependent variable is in log. Robust standard errors clustered at the country-industry-year level.

Table 10: Regression results from baseline specification using US BEA input-output table coefficients

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	TFP Ackerberg *et al.*						TFPQ Hsieh and Klenow					
Overall $_{t-2}$	-0.097						-4.065***					
	(0.117)						(0.000)					
Entry $_{t-2}$		0.051			0.068	0.069		-1.539***			-1.422***	-1.404***
		(0.260)			(0.146)	(0.145)		(0.001)			(0.005)	(0.005)
Conduct $_{t-2}$			-0.129***		-0.136***	-0.135***			-2.554***		-2.413***	-2.331***
			(0.001)		(0.000)	(0.000)			(0.000)		(0.000)	(0.000)
FDI Overall $_{t-2}$				0.036		0.008				0.829***		0.657**
				(0.326)		(0.810)				(0.003)		(0.018)
FE firm	YES											
FE c-y	YES											
FE s-y	YES											
Observations	5598750	6046439	5679283	6486660	5598750	4983292	5598825	6046514	5679358	6486735	5598825	5598825
R2A	0.982	0.982	0.982	0.985	0.982	0.874	0.825	0.820	0.826	0.831	0.825	0.825
R2W	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RMSE	0.129	0.133	0.128	0.134	0.129	0.426	0.686	0.701	0.684	0.711	0.686	0.686

Note: * p<0.10; ** p<0.05; *** p<0.01. The dependent variable is in log. Robust standard errors clustered at the country-industry-year level.

Table 11: Quantile regressions results from preferred baseline specification

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	FE firm	FD	Q(0.10)	Q(0.25)	Q(0.50)	Q(0.75)	Q(0.90)
	---TFP Ackerberg *et al.*---						
Entry $_{t-2}$	-0.080	-0.057	-0.612***	-0.318***	-0.068**	0.207***	0.459***
	(0.313)	(0.529)	(0.000)	(0.000)	(0.012)	(0.000)	(0.000)
Conduct $_{t-2}$	-0.221***	-0.221***	-0.486***	-0.316***	-0.116***	0.018	0.073
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.566)	(0.188)
FDI Overall $_{t-2}$	-0.074	-0.102	0.100**	-0.031	-0.133***	-0.197***	-0.113*
	(0.102)	(0.126)	(0.023)	(0.179)	(0.000)	(0.000)	(0.097)
FE c-y	---YES---						
FE s-y	---YES---						
Observations	4983292	2406496	2406496	2406496	2406496	2406496	2406496
PR2	0.985	0.030	0.015	0.024	0.029	0.018	0.008

Note: * p<0.10; ** p<0.05; *** p<0.01. The dependent variable is in log. Robust standard errors are in parenthesis. First difference is taken over 3-year period.

Annex

Table A1: Type of NMR regulatory barrier by sector

	Regulatory barriers NMR	
Sector	**Type**	**Barrier**
Electricity and Gas	Entry barriers	Entry barriers
	Conduct barriers	Public ownership
		Vertical integration
		Market structure
Telecom and Post	Entry barriers	Entry barriers
	Conduct barriers	Public ownership
		Market structure
Rail, Airline and Road	Entry barriers	Entry barriers
	Conduct barriers	Public ownership
		Vertical integration
		Market structure
		Prices (Post)
Retail	Entry barriers	Licenses or permits
		Regulation of large outlet
	Conduct barriers	Protection of existing firms
		Shop opening hours
		Price controls
		Promotion/ discount
Professional services: Accounting, Engineering, Legal and Architectural services	Entry barriers	Exclusive or shared exclusive rights
		Education requirements
		Compulsory chamber membership
		Quotas
	Conduct barriers	Regulations on prices and fees
		Regulations on advertising
		Regulations on the form of business
		Inter-professional co-operation

Source: OECD and authors own calculations. See Koske *et al*. (2014) for further details.

Table A2: Type of FDI regulatory barrier by sector

	Regulatory barriers FDI	
Sector	**Type**	**Barrier**
Electricity	Equity limits	No foreign equity allowed for start-ups or acquisitions
Construction	Screening and approval	Approval required for new FDI/acquisitions below and above USD 100mn or corresponding to more or below 50% of total equity
Distribution		
Transport		Notification with discretionary element
Hotels & Restaurants	Restrictions on key foreign personnel/directors	Foreign key personnel not permitted
		Economic needs test for employment of foreign key personnel
Media		Time bound limit on employment of foreign key personnel
Communications		Nationality/residence requirements for board of directors
	Other restrictions	Establishment of branches not allowed/local incorporation required
Financial services		Reciprocity requirement
Business services		Restrictions on profit/capital repatriation
		Access to local finance
Real estate		Acquisition of land for business purposes
		Land ownership not permitted but leases possible

Source: OECD and authors own calculations. See Kalinova *et al*. (2010) for further details.

Table A3: Number of firms by year

Year	Manufacturing	Services	Total	Percent
2006	135006	363390	498396	6.53
2007	196055	544023	740078	9.70
2008	212129	601331	813460	10.66
2009	226785	667044	893829	11.72
2010	234427	706450	940877	12.33
2011	246435	747734	994169	13.03
2012	249866	728956	978822	12.83
2013	238010	684455	922465	12.09
2014	220849	624950	845799	11.09
Total	**1959562**	**5668333**	**7627895**	**100**

Source: Amadeus. Note: sample contains only firms that have at least 4 years of data.

Table A4: Sector division with frequency numbers of firms from Amadeus in TFP data set

NACE 2-digit	Sector description	Frequency	Percent
10	Food products	239853	3.14
11, 12	Beverages; Tobacco products	32794	0.43
13	Textiles	63221	0.83
14	Wearing apparel	82963	1.09
15	Leather and related products	45219	0.59
16	Wood and of products of wood and cork, expect furniture	112784	1.48
17	Paper and paper products	34547	0.45
18	Printing and reproduction of recorded media	99826	1.31
19, 20	Coke and refined petroleum products; Chemical and products	60181	0.79
21	Basic pharmaceuticals products and preparations	10335	0.14
22	Rubber and plastic products	100012	1.31
23	Other non-metallic mineral products	103554	1.36
24	Basic metals	32740	0.43
25	Fabricated metal products, except machinery and equipment	370029	4.85
26	Computer, electronic and optical products	50662	0.66
27	Electrical equipment	57781	0.76
28	Machinery and equipment nec	149277	1.96
29	Motor vehicles, trailers and semi-trailers	33624	0.44
30	Other transport equipment	15992	0.21
31	Furniture	95020	1.25
32	Other manufacturing	70815	0.93
33	Repair and installation of machinery and equipment	98333	1.29
Total	**Manufacturing**	**1959562**	**25.7**

Source: Amadeus. Note: for the production functions estimates, some countries are grouped together due to the unreported or insufficient data, as explained in the main text. Malta is not included in the TFP estimates. For Greece, Cyprus and Lithuania no data on material are reported. The number of firms in the final data set used for regression analysis is lower due to missing values as part of the policy variables.

Table A4: Sector division with frequency numbers of firms from Amadeus in TFP data set (continued), services

NACE 2-digit	Sector description	Frequency	Percent
36	Waste collection, treatment and supply	12256	0.16
37, 38, 39	Sewerage, Waste collection, treatment and disposal activities	56546	0.74
45	Wholesale and retail trade of motor vehicles	458461	6.01
46	Wholesale trade (except motor vehicles)	1348350	17.68
47	Retail trade (except motor vehicles)	1278312	16.76
49	Land transport and transport via pipelines	463289	6.07
50	Water transport	12141	0.16
51	Air transport	3731	0.05
52	Warehousing and support activities for transportation	117129	1.54
53	Postal and courier services	9605	0.13
58	Publishing activities	61198	0.8
59	Motion picture, video, television and sound recording	38127	0.5
60	Programming and broadcasting activities	12103	0.16
61	Telecommunications	27984	0.37
62	Computer programming, consultancy and related	189334	2.48
63	Information services activities	50241	0.66
64	Financial services	40314	0.53
66	Activities auxiliary to finance and insurance services	70643	0.93
69	Legal and accounting activities	259225	3.4
70	Activities of head offices, management consultancy	193537	2.54
71	Architectural and engineering activities	289171	3.79
72	Scientific research and development	21769	0.29
73	Advertising and market research	115073	1.51
74, 75	Other professional, scientific, technical services, Veterinary act.	135283	1.77
77	Rental and leasing activities	63662	0.83
78	Employment activities	25977	0.34
79	Travel agency, tour operator reservation activities	61675	0.81

80	Security and investigation activities	27825	0.36
81	Services to buildings and landscape activities	107398	1.41
82	Office administrative, office support, other business	117974	1.55
Total	Services	5668333	74.30
Total	Manufacturing	1959562	25.70
Total	**All**	**7627895**	**100.00**

Source: Amadeus. Note: for the production functions estimates, some countries are grouped together due to the unreported or insufficient data, as explained in the main text. Malta is not included in the TFP estimates. For Greece, Cyprus and Lithuania no data on material are reported. The number of firms in the final data set used for regression analysis is lower due to missing values as part of the policy variables.

Table A5: Number of firms by country

Country	Manufacturing	Services	Total	Percent
BG	62128	197615	259743	3.41
CZ	80610	163894	244504	3.21
ES	460794	1347784	1808578	23.71
FI	27320	85780	113100	1.48
FR	138860	500065	638925	8.38
HR	46132	183036	229168	3.00
HU	55706	139593	195299	2.56
IT	409653	644458	1054111	13.82
PL	19544	36714	56258	0.74
PT	179950	600724	780674	10.23
RO	182108	766794	948902	12.44
SI	30907	74856	105763	1.39
SK	35083	111500	146583	1.92
AT, DE	20069	37096	57165	0.75
GB, IE	62117	163089	225206	2.95
EE, LV	18752	73046	91798	1.20
DK, SE	107387	473183	580570	7.61
BE, NL, LU	22442	69106	91548	1.20
Total	**1959562**	**5668333**	**7627895**	**100.00**

Source: Amadeus. Notes: Malta is not included in TFP estimates. For Greece, Cyprus and Lithuania there is no data on material inputs. Number of firms in final data set are lower, because of missing values in policy variables.

Table A6: Correlation regressions between directly reported and indirectly computed material inputs for countries included firms

	Manufacturing		**Services**	
Indirect materials	1.040***	0.962***	1.056***	0.932***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-1.061***		-1.623***	
	(0.000)		(0.000)	
Observations	1751827	1751827	4492525	4492525
R-2	0.916	0.997	0.714	0.986

Note: * p<0.10; ** p<0.05; *** p<0.01.

Table A7: Summary statistics of variables used in production function

Variable	Obs	Mean	Std. Dev.	Min	Max
ln(Y)	6255513	12.61	1.91	-1.97	23.34
ln(Y) proxied	7627895	12.08	1.94	-11.02	24.21
ln(materials)	6244352	12.09	2.6	-2.65	24.68
ln(materials) proxied	7627895	12.87	2.2	-2.33	26.17
ln(K)	7627895	11.06	2.33	-1.87	24.82
ln(Inv) in O&P	5189905	9.96	2.41	-6.15	23.84
ln(L)	7627895	1.96	1.43	0	13.38
Foreign	3475131	0.26	0.44	0	1

Note: O&P refers to TFP methodology from Olley and Pakes (1996)

Table A8: Summary statistics of TFP estimates

Variable	Obs	Mean	Std. Dev.	Min	Max
ln(TFP) ACF	6244277	9.37	1.45	0.64	22.74
ln(TFP) ACF proxied	7627820	8.94	1.32	-0.35	22.84
ln(TFP) O&P	6255438	9.96	1.99	-8.5	28.97
ln(TFP) O&P proxied	7627820	9.43	1.7	-15.23	29.27
ln(TFP) L&P	6255438	7.31	2.65	-15.81	27.17
ln(TFP) L&P proxied	7627820	7.57	1.96	-18.78	20.74
ln(rel TFPQ)	6255513	-0.07	1.17	-15.22	9.12
ln(rel TFPQ) proxied	7627895	-0.65	1.17	-23.9	8.04

Note: ACF refers to TFP methodology from Ackerberg *et al*. (2006; 2015), O&P to Olley and Pakes (1996), L&P to Levinsohn and Petrin (2003) and rel TFPQ to Hsieh and Klenow (2009; 2014)

Table A9: Pairwise correlation table between the TFP measures

	ln(TFP) ACF	**ln(TFP) ACF proxied**	**ln(TFP) L&P**	**ln(TFP) L&P proxied**	**ln(TFP) O&P**	**ln(TFP) O&P proxied**	**ln(rel TFPQ)**	**ln(rel TFPQ) proxied**
ln(TFP) ACF	1							
ln(TFP) ACF proxied	0.946	1						
ln(TFP) L&P	0.769	0.792	1					
ln(TFP) L&P proxied	0.711	0.768	0.899	1				
ln(TFP) O&P	0.777	0.802	0.856	0.799	1			
ln(TFP) O&P proxied	0.752	0.781	0.79	0.821	0.911	1		
ln(rel TFPQ)	0.481	0.497	0.588	0.541	0.619	0.615	1	
ln(rel TFPQ) proxied	0.446	0.458	0.554	0.622	0.585	0.672	0.876	1

Note: ACF refers to TFP methodology from Ackerberg *et al*. (2006; 2015), O&P to Olley and Pakes (1996), L&P to Levinsohn and Petrin (2003) and rel TFPQ to Hsieh and Klenow (2009; 2014)

Table A10: Regression results from baseline specification (alternative TFP estimations)

	(1)	(2)	(3)	(4)	(5)	(6)
	TFP Olley and Pakes					
Overall $_{t-2}$	-1.657***					
	(0.003)					
Entry $_{t-2}$		-1.400***			-1.616***	-1.614***
		(0.001)			(0.004)	(0.004)
Conduct $_{t-2}$			-0.417*		-0.801***	-0.811***
			(0.064)		(0.003)	(0.003)
FDI Overall $_{t-2}$				0.050		-0.099
				(0.809)		(0.719)
FE firm	YES					
FE c-y	YES					
FE s-y	YES					
Observations	4983642	5431331	5064175	5848487	4983642	4983292
R2A	0.910	0.912	0.910	0.926	0.910	0.910
R2W	0.000	0.000	0.000	0.000	0.000	0.000
RMSE	0.452	0.466	0.451	0.473	0.452	0.452

Table A10: Regression results from baseline specification (continued)

	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
	TFP Levinsohn and Petrin						TFPQ Hsieh and Klenow					
Overall $_{t-2}$	-1.463**						-3.168***					
	(0.011)						(0.001)					
Entry $_{t-2}$		-1.384***			-1.544***	-1.554***		-0.756			-1.310	-1.342
		(0.001)			(0.003)	(0.003)		(0.249)			(0.123)	(0.113)
Conduct $_{t-2}$			-0.306		-0.674**	-0.665**			-1.637***		-1.959***	-1.920***
			(0.189)		(0.015)	(0.017)			(0.000)		(0.000)	(0.000)
FDI Overall $_{t-2}$				0.295		0.155				0.555		0.562
				(0.165)		(0.568)				(0.108)		(0.204)
FE firm	YES											
FE c-y	YES											
FE s-y	YES											
Observations	4983642	5431331	5064175	5848487	4983642	4983292	4895403	5332744	4975366	5734307	4895403	4895058
R2A	0.874	0.870	0.874	0.905	0.874	0.874	0.856	0.851	0.856	0.862	0.856	0.856
R2W	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RMSE	0.426	0.437	0.425	0.445	0.426	0.426	0.577	0.589	0.576	0.593	0.577	0.577

Note: * p<0.10; ** p<0.05; *** p<0.01. The dependent variable is in log. Robust standard errors clustered at the country-industry-year level.

Table A11: Estimated impact of reduction in regulatory barriers on TFP

	Service reform index		Input share	Coefficient estimates			Estimated impact on TFP		
	Average	Target		Average	Low	High	Average	Low	High
Overall	0.210	0.112	0.171	-1.661	-0.357	-3.168	2.80%	0.60%	5.34%
Entry	0.152	0.050	0.171	-0.792	0.000	-1.614	1.39%	0.00%	2.83%
Conduct	0.209	0.106	0.171	-0.902	-0.221	-1.920	1.59%	0.39%	3.38%
FDI	0.039	0.005	0.337	0.000	0.000	0.000	0.00%	0.00%	0.00%

The average service reform index is average for all sector-countries in 2013. The so-called target level is defined as the average level of services regulation in three countries with lowest levels in 2013, which are GB, IT, NL for conduct regulations; SE, FI, DK for entry barriers; GB, SE, DK for overall regulations; and LU, NL, CZ for FDI. The input share is the average of total services inputs from the sectors covered in NMR and FDI regulations respectively. The estimated coefficients are taken from Table 2 in which the "Low" columns coefficients are from the Ackerberg TFP specification and the "High" columns represent the coefficients from the Hsieh and Klenow TFP specification. Non-significant values of TFP in either specification are represented with a 0. The estimated impact is calculated as the expected percentage increase in a firm's TFP level, at discrete change in service reform index from the average level to the target level. It is calculated as difference between average and target index, multiplied with input share and estimated coefficient.

Table A12: Estimated impact of reduction in regulatory barriers on TFP by country

Country	Input share	Overall				Entry				Conduct			
		Reform index	Average	Low	High	Reform index	Average	Low	High	Reform index	Average	Low	High
HR	0.151	0.339	5.71%	1.23%	10.89%	0.170	1.44%	0.00%	2.94%	0.383	3.79%	0.89%	8.06%
LU	0.093	0.413	4.67%	1.00%	8.91%	0.333	2.10%	0.00%	4.28%	0.429	2.72%	0.64%	5.79%
SK	0.187	0.254	4.42%	0.95%	8.43%	0.191	2.10%	0.00%	4.28%	0.223	1.97%	0.46%	4.20%
SI	0.160	0.276	4.36%	0.94%	8.32%	0.182	1.68%	0.00%	3.41%	0.281	2.53%	0.59%	5.39%
GR	0.165	0.262	4.12%	0.88%	7.85%	0.167	1.53%	0.00%	3.12%	0.266	2.37%	0.56%	5.05%
LT	0.200	0.216	3.47%	0.74%	6.61%	0.088	0.61%	0.00%	1.24%	0.246	2.53%	0.59%	5.39%
PL	0.159	0.234	3.22%	0.69%	6.14%	0.199	1.88%	0.00%	3.82%	0.211	1.50%	0.35%	3.19%
CZ	0.142	0.248	3.21%	0.69%	6.12%	0.150	1.13%	0.00%	2.30%	0.256	1.93%	0.45%	4.11%
EE	0.191	0.211	3.16%	0.68%	6.02%	0.095	0.68%	0.00%	1.39%	0.242	2.34%	0.55%	4.99%
FR	0.171	0.211	2.84%	0.61%	5.41%	0.130	1.09%	0.00%	2.22%	0.223	1.81%	0.42%	3.85%
IT	0.172	0.197	2.45%	0.53%	4.67%	0.246	2.68%	0.00%	5.46%	0.109	0.05%	0.01%	0.10%
PT	0.165	0.201	2.43%	0.52%	4.64%	0.178	1.68%	0.00%	3.42%	0.184	1.16%	0.27%	2.47%
HU	0.144	0.21	2.36%	0.51%	4.50%	0.178	1.46%	0.00%	2.98%	0.190	1.09%	0.25%	2.31%
DE	0.192	0.185	2.34%	0.50%	4.47%	0.134	1.28%	0.00%	2.60%	0.193	1.50%	0.35%	3.20%
ES	0.159	0.196	2.24%	0.48%	4.26%	0.210	2.02%	0.00%	4.11%	0.140	0.49%	0.12%	1.05%
IE	0.161	0.194	2.21%	0.47%	4.21%	0.097	0.61%	0.00%	1.24%	0.232	1.83%	0.43%	3.89%
AT	0.167	0.191	2.20%	0.47%	4.19%	0.182	1.75%	0.00%	3.57%	0.150	0.67%	0.16%	1.42%
BE	0.211	0.168	1.97%	0.42%	3.76%	0.139	1.49%	0.00%	3.03%	0.168	1.17%	0.27%	2.50%
NL	0.163	0.153	1.12%	0.24%	2.14%	0.140	1.16%	0.00%	2.37%	0.127	0.30%	0.07%	0.65%
FI	0.177	0.141	0.88%	0.19%	1.67%	0.051	0.01%	0.00%	0.03%	0.178	1.16%	0.27%	2.46%
DK	0.174	0.136	0.69%	0.15%	1.31%	0.057	0.10%	0.00%	0.21%	0.154	0.75%	0.18%	1.60%
SE	0.192	0.113	0.05%	0.01%	0.10%	0.041	-0.13%	0.00%	-0.26%	0.141	0.60%	0.14%	1.27%
GB	0.178	0.086	-0.75%	-0.16%	-1.44%	0.058	0.12%	0.00%	0.25%	0.082	-0.38%	-0.09%	-0.81%

See Table A11 for explanations. For entry barriers, the target level is 0.050, and estimated coefficients are 0, -0.792 and -1.614; for conduct regulations, the target level is 0.106, and estimated coefficients are -0.211, -0.902 and -1.920; for overall regulations, the target level is 0.112, and estimated coefficients are -0.357, -1.661 and -3.168.

Table A13: Regression results from baseline specification with EU-wide input-output coefficients

	(1)	(2)	(3)	(4)	(5)	(6)
	TFP Oley and Pakes					
Overall $_{t-2}$	-1.007					
	(0.238)					
Entry $_{t-2}$		0.395			0.670	0.679
		(0.535)			(0.371)	(0.361)
Conduct $_{t-2}$			-0.809**		-0.745*	-0.772*
			(0.049)		(0.090)	(0.080)
FDI Overall $_{t-2}$				0.070		-0.161
				(0.824)		(0.605)
FE firm	YES					
FE c-y	YES					
FE s-y	YES					
Observations	4966253	5413942	5046786	5818544	4966253	4965903
R2A	0.909	0.912	0.909	0.926	0.909	0.909
R2W	0.000	0.000	0.000	0.000	0.000	0.000
RMSE	0.452	0.466	0.451	0.472	0.452	0.452

Table A13: Regression results from baseline specification with EU-wide input-output coefficients (continued)

	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
	TFP Levinsohn and Petrin						TFPQ Hsieh and Klenow					
Overall $_{t-2}$	-0.980						-3.249**					
	(0.291)						(0.036)					
Entry $_{t-2}$		0.086			0.474	0.462		1.761			2.371*	2.352*
		(0.894)			(0.535)	(0.545)		(0.106)			(0.057)	(0.058)
Conduct $_{t-2}$			-0.703		-0.663	-0.658			-2.691***		-2.443***	-2.437***
			(0.119)		(0.170)	(0.176)			(0.000)		(0.002)	(0.002)
FDI Overall $_{t-2}$				0.328		0.064				0.576		0.091
				(0.295)		(0.832)				(0.242)		(0.854)
FE firm	YES											
FE c-y	YES											
FE s-y	YES											
Observations	4966253	5413942	5046786	5818544	4966253	4965903	4878430	5315764	4958392	5705387	4878430	4878085
R2A	0.873	0.869	0.873	0.904	0.873	0.873	0.856	0.851	0.857	0.862	0.856	0.856
R2W	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RMSE	0.425	0.437	0.424	0.444	0.425	0.425	0.577	0.588	0.575	0.592	0.577	0.577

Note: * p<0.10; ** p<0.05; *** p<0.01. The dependent variable is in log. Robust standard errors clustered at the country-industry-year level.

Table A14: Interaction results using institutions from baseline specification

	(1)	(2)	(3)	(4)	(5)	(6)
	TFP Oley and Pakes					
Overall $_{t-2}$	-1.505***					
	(0.008)					
Overall $_{t-2}$ * Inst	-1.147***					
	(0.000)					
Entry $_{t-2}$		-0.775			-1.004	-1.011
		(0.107)			(0.106)	(0.104)
Entry $_{t-2}$ * Inst		-0.707***			-0.887***	-0.893***
		(0.000)			(0.000)	(0.000)
Conduct $_{t-2}$			-0.409*		-1.098***	-1.099***
			(0.069)		(0.000)	(0.000)
Conduct $_{t-2}$ * Inst			-1.157***		-0.000	-0.007
			(0.000)		(0.999)	(0.985)
FDI Overall $_{t-2}$				0.062		0.006
				(0.763)		(0.983)
FDI Overall$_{t-2}$* Inst				-0.315		0.061
				(0.150)		(0.815)
FE firm	YES					
FE c-y	YES					
FE s-y	YES					
Observations	4983642	5431331	5064175	5848487	4983642	4983292
R2A	0.910	0.912	0.910	0.926	0.910	0.910
R2W	0.000	0.000	0.000	0.000	0.000	0.000
RMSE	0.452	0.466	0.451	0.473	0.452	0.452

Table A14: Interaction results using institutions from baseline specification (continued)

	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
	TFP Levinsohn and Petrin						TFPQ Hsieh and Klenow					
Overall $_{t-2}$	-1.299**						-2.970***					
	(0.022)						(0.002)					
Overall $_{t-2}$ * Inst	-1.242***						-1.435***					
	(0.000)						(0.000)					
Entry $_{t-2}$		-0.644			-0.903	-0.932		0.241			-0.511	-0.589
		(0.152)			(0.116)	(0.105)		(0.744)			(0.579)	(0.522)
Entry $_{t-2}$ * Inst		-0.837***			-1.075***	-1.117***		-1.125***			-1.791***	-1.907***
		(0.000)			(0.000)	(0.000)		(0.000)			(0.000)	(0.000)
Conduct $_{t-2}$			-0.298		-1.059***	-1.039***			-1.624***		-2.670***	-2.614***
			(0.186)		(0.001)	(0.001)			(0.000)		(0.000)	(0.000)
Conduct $_{t-2}$ * Inst			-1.155***		0.202	0.197			-1.227***		0.883	0.874
			(0.000)		(0.549)	(0.552)			(0.000)		(0.124)	(0.118)
FDI Overall $_{t-2}$				0.299		0.318				0.553		0.886*
				(0.156)		(0.271)				(0.109)		(0.067)
FDI Overall$_{t-2}$* Inst				-0.115		0.239				0.049		0.634
				(0.601)		(0.357)				(0.888)		(0.134)
FE firm	YES						YES					
FE c-y	YES						YES					
FE s-y	YES						YES					
Observations	4983642	5431331	5064175	5848487	4983642	4983292	4895403	5332744	4975366	5734307	4895403	4895058
R2A	0.874	0.870	0.874	0.905	0.874	0.874	0.856	0.851	0.856	0.862	0.856	0.856
R2W	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RMSE	0.426	0.437	0.424	0.445	0.426	0.426	0.577	0.589	0.576	0.593	0.577	0.577

Note: * p<0.10; ** p<0.05; *** p<0.01. The dependent variable is in log. Robust standard errors clustered at the country-industry-year level.

Table A15: Interaction results from baseline specification using institutions with EU-wide input-output coefficients

	(1)	(2)	(3)	(4)	(5)	(6)
	TFP Olley and Pakes					
Overall $_{t-2}$	-0.620					
	(0.464)					
Overall $_{t-2}$ * Inst	-1.865***					
	(0.000)					
Entry $_{t-2}$		0.901			1.177	1.323*
		(0.165)			(0.120)	(0.080)
Entry $_{t-2}$ * Inst		-1.303***			-1.373***	-1.317***
		(0.000)			(0.000)	(0.000)
Conduct $_{t-2}$			-0.265		-0.994**	-0.997**
			(0.510)		(0.041)	(0.041)
Conduct $_{t-2}$ * Inst			-1.501***		-0.446	-0.405
			(0.000)		(0.332)	(0.379)
FDI Overall $_{t-2}$				0.136		-0.089
				(0.655)		(0.762)
FDI Overall $_{t-2}$ * Inst				-0.454		-0.604
				(0.202)		(0.106)
FE firm	YES					
FE c-y	YES					
FE s-y	YES					
Observations	4966253	5413942	5046786	5818544	4966253	4965903
R2A	0.909	0.912	0.909	0.926	0.909	0.909
R2W	0.000	0.000	0.000	0.000	0.000	0.000
RMSE	0.452	0.466	0.451	0.472	0.452	0.452

Table A15: Interaction results from baseline specification with EU-wide input-output coefficients (continued)

	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
	TFP Levinsohn and Petrin						TFPQ Hsieh and Klenow					
Overall $_{t-2}$	-0.603						-2.733*					
	(0.511)						(0.077)					
Overall $_{t-2}$ * Inst	-1.815***						-2.457***					
	(0.000)						(0.000)					
Entry $_{t-2}$		0.631			0.891	1.017		2.529**			2.696**	2.813**
		(0.333)			(0.250)	(0.190)		(0.024)			(0.035)	(0.028)
Entry $_{t-2}$ * Inst		-1.405***			-1.516***	-1.467***		-1.992***			-2.896***	-2.848***
		(0.000)			(0.000)	(0.000)		(0.000)			(0.000)	(0.000)
Conduct $_{t-2}$			-0.216		-1.084**	-1.061**			-2.200***		-3.730***	-3.704***
			(0.622)		(0.040)	(0.046)			(0.003)		(0.000)	(0.000)
Conduct $_{t-2}$ * Inst			-1.342***		-0.138	-0.080			-1.341**		0.900	0.966
			(0.001)		(0.776)	(0.869)			(0.032)		(0.259)	(0.225)
FDI Overall $_{t-2}$				0.369		0.147				0.630		0.207
				(0.232)		(0.612)				(0.196)		(0.663)
FDI Overall $_{t-2}$ * Inst				-0.281		-0.630*				-0.365		-0.641
				(0.441)		(0.098)				(0.509)		(0.286)
FE firm	YES											
FE c-y	YES											
FE s-y	YES											
Observations	4966253	5413942	5046786	5818544	4966253	4965903	4878430	5315764	4958392	5705387	4878430	4878085
R2A	0.873	0.869	0.873	0.904	0.873	0.873	0.856	0.851	0.857	0.862	0.856	0.856
R2W	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RMSE	0.425	0.437	0.424	0.444	0.425	0.425	0.577	0.588	0.575	0.592	0.577	0.577

Note: * p<0.10; ** p<0.05; *** p<0.01. The dependent variable is in log. Robust standard errors clustered at the country-industry-year level.

Table A16: Industry measure of Technology Gap across EU (2013-14); neck-and-neck sectors

NACE 2-digit	Sector description	Gap	Type sector
12	Tobacco products	0.089	m
39	Remediation activities and other waste management	0.111	s
37	Sewerage	0.124	s
78	Employment activities	0.125	s
75	Veterinary activities	0.129	s
72	Scientific research and development	0.130	s
21	Basic pharmaceuticals products and preparations	0.136	m
80	Security and investigation activities	0.138	s
30	Other transport equipment	0.139	m
32	Other manufacturing	0.142	m
51	Air transport	0.143	s
62	Computer programming, consultancy and related	0.144	s
24	Basic metals	0.146	m
26	Computer, electronic and optical products	0.147	m
19	Coke and refined petroleum products	0.148	m
79	Travel agency, tour operator reservation activities	0.149	s
13	Textiles	0.149	m
27	Electrical equipment	0.150	m
17	Paper and paper products	0.152	m
53	Postal and courier services	0.155	s
63	Information services activities	0.158	s
38	Waste collection, treatment and disposal activities	0.162	s
18	Printing and reproduction of recorded media	0.162	m
15	Leather and related products	0.162	m
33	Repair and installation of machinery and equipment	0.162	m
36	Waste collection, treatment and supply	0.166	s
28	Machinery and equipment nec	0.166	m
31	Furniture	0.170	m
22	Rubber and plastic products	0.171	m

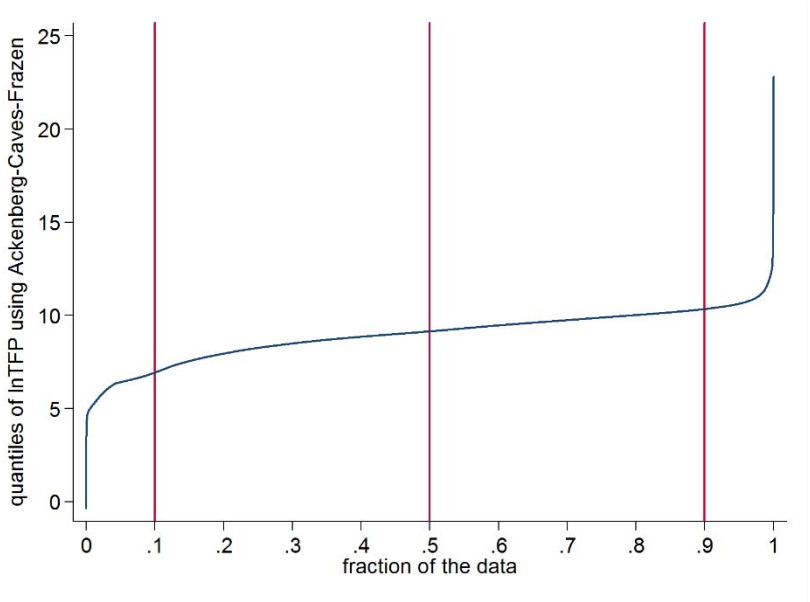
Source: Amadeus; authors' calculations. The Gap stands for Technology gap as defined in Aghion *et al*. (2005) and the distinction between Neck-and-neck industries and Unleveled industries is based on the median value of the industry outcomes across all EU countries taken up in the sample.

Table A16: Industry measure of Technology Gap across EU (2013-14); unleveled sectors (continued)

NACE 2-digit	Sector description	Gap	Type sector
25	Fabricated metal products, except machinery and eq.	0.171	m
58	Publishing activities	0.172	s
70	Activities of head offices, management consultancy	0.172	s
81	Services to buildings and landscape activities	0.174	s
29	Motor vehicles, trailers and semi-trailers	0.178	m
74	Other professional, scientific and technical services	0.180	s
69	Legal and accounting activities	0.181	s
11	Beverages	0.184	m
52	Warehousing and support activities for transformation	0.185	s
66	Activities auxiliary to finance and insurance services	0.191	s
20	Chemical and products	0.193	m
73	Advertising and market research	0.193	s
71	Architectural and engineering activities	0.195	s
16	Wood and of products of wood and cork, expt. furniture	0.196	m
14	Wearing apparel	0.198	m
23	Other non-metallic mineral products	0.200	m
64	Financial services	0.204	s
50	Water transport	0.209	s
10	Food products	0.214	m
82	Office administrative, office support, other business	0.216	s
45	Wholesale and retail trade of motor vehicles	0.218	s
59	Motion picture, video, television and sound recording	0.224	s
61	Telecommunications	0.230	s
60	Programming and broadcasting activities	0.257	s
47	Retail trade	0.261	s
46	Wholesale trade (except motor vehicles)	0.263	s
49	Land transport and transport via pipelines	0.268	s
77	Rental and leasing activities	0.315	s

Source: Amadeus; authors' calculations. The Gap stands for Technology gap as defined in Aghion *et al*. (2005) and the distinction between Neck-and-neck industries and Unleveled industries is based on the median value of the industry outcomes across all EU countries taken up in the sample.

Figure A1: Cumulative Distribution Function (CDF) of Ackerman *et al*. TFP



Note: This graph represents the cumulative distribution function of the Ackerman *et al*. TFP specification for both 4-digit goods as well as services sectors.