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Sourcing of services and total factor productivity

by Emmanuel Dhyne and Cédric Duprez

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Abstract

This paper studies how outsourcing of services activities affects TFP at the firm level. Using the universe of buyer-supplier relationships in Belgium, we first document several new empirical facts about how firms engage in the outsourcing of supporting activities. We show that virtually all firms source from at least one services supplier, but there is substantial heterogeneity in the services sourcing of firms. Geographic proximity plays a key role for the matching of services suppliers and customers as firms mostly connect with services suppliers at a distance of no more than 35 km. Finally, the extensive margin goes a long way to explaining both the aggregate trend and the firm-level fluctuations in services outsourcing growth. Based on these findings, we develop a model with endogenous choice of the set of tasks produced in-house. Consistent with the model, we estimate the probability of a supplier-buyer relationship and how this affects the productivity of the buyer. We find that productivity gains from outsourcing of services activities may be substantial. Reducing local trade costs might lead to significant productivity gains. Reductions of variable trade costs by 10 or 50% lead respectively to average productivity gains of 3% and 7%. On the other hand, a 25% reduction in the probability of a transaction, due for example to a permanent increase in unconditional fixed costs, would lead to an average 1.3% TFP decline at the firm level. Reducing the costs associated with the sourcing of services can be achieved in many ways, ranging from digitalization to reducing congestion or removing cultural barriers that may bring local discontinuities in the organisation of the production network. This is true for Belgium but also in the European Single Market context.

Keywords: Outsourcing, Services, Productivity.

JEL Classifications: D22; D23, L14, L23, L25.

Authors:
Emmanuel Dhyne, Economics and Research Department, NBB and UMons
e-mail: Emmanuel.dhyne@nbb.be
Cédric Duprez (corresponding author), Economics and Research Departement, NBB
e-mail: cedric.duprez@nbb.be

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Non-technical summary

Across a wide range of industries, firms are increasingly focusing on their “core competencies”, using specialized suppliers to provide “supporting activities” -such as legal and accounting services, human resources, cleaning, security, catering, consultancy, etc - that were once performed by their own employees. By so doing, they increase their productivity through a better labor organization. Saving on labor costs is an important driver behind this mechanism. More generally, services suppliers provide increased flexibility for firms whose needs evolve throughout the year, or provide specialized skills or technology that would be more costly for a firm to invest in. This is valuable for firms. This phenomenom is so widespread that virtually all firms are engaged in the outsourcing of some activities.

This paper examines how outsourcing services affects firms’ TFP. Using an exhaustive dataset on firms’ buyer-seller linkages in Belgium, we document a set of facts about the services sourcing behavior of individual firms. We show that virtually all firms source from at least one services supplier, but there is substantial heterogeneity in the services sourcing of firms. Geographic proximity plays a key role for the matching of services suppliers and customers as firms mostly connect with services suppliers at a distance of no more than 35 km. Finally, the extensive margin goes a long way to explaining both the aggregate trend and the firm-level fluctuations in services outsourcing growth.

Guided by these facts, we have developed a simple model in which firms can outsource tasks and search for services suppliers based on their geography and their core TFP. In this model, firms differ in their ability to carry out tasks and must pay a fixed cost each period for each service supplier they choose to source from.

In our framework, expenditure on a services supplier is seen as a trade in tasks. For instance, when a car manufacturer sources cleaning services, it in fact outsources the task of cleaning from its services supplier. This is what makes trade in services different from trade in goods in our model. As a result, a firm’s output depends on its own primary inputs - labor, capital and materials - but also on the primary inputs that its services suppliers mobilized at its request. So the contribution to a firm’s output of one input, say labor, not only includes its own workers, but is also augmented by the number of workers carrying out tasks required by the firm outside its own legal perimeter.

Besides this direct effect of outsourcing on production, outsourcing services also raises firm productivity through an additional term, which is the number of services suppliers. Outsourcing tasks enables firms to concentrate on their core activities, delegating the performance of the tasks for which they have low comparative advantage to their subcontractors. Because of this force, the firm’s own productivity increases with the number of its services suppliers. Intuitively, higher ex-ante core TFP allows firms to select from a larger set of specialized suppliers, which in turn increases their ex-post TFP comparative advantage.

Bringing this model to the data, we find compelling evidence that the number of services suppliers matters for firm performance.

Our results show that the productivity gains from outsourcing services are
substantial. Our estimates imply that trade costs reductions would lead to sig-nificant productivity gains. Removing variable trade costs in services outsourcing completely would lead to a productivity gain of 11 percent. Reductions of variable trade costs by 10 or 50% lead respectively to average productivity gains of 3% and 7%. On the other hand, a 25% reduction in the probability of a transaction, due for example to a permanent increase in unconditional fixed costs, would lead to an average 1.3% TFP decline at the firm level.

The numbers obtained should naturally be viewed with caution as they are based on very stylized counterfactual exercises. However, they are still indicative of potential significant TFP gains related to the reduction in the costs of outsourcing. Reducing the costs associated with the sourcing of services can be achieved in many ways, ranging from digitalization of the economy, improving electronic communication to reducing congestion, but also in the Belgian context and more broadly in the European context, by reducing cultural barriers that may bring local discontinuities into an otherwise well integrated Single Market.

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1 Introduction

Across a wide range of industries, firms are increasingly focusing on their "core competencies", using specialized suppliers to provide "supporting activities" - such as legal and accounting services, human resources, cleaning, security, catering, consultancy, etc - that were once performed by their own employees (see Weil, 2017, for a qualitative survey). By so doing, they increase their productivity through a better labor organization. Saving on labor costs is an important driver behind this mechanism (Goldschmidt and Schmieder, 2017). More generally, services suppliers provide increased flexibility for firms whose needs evolve throughout the year, or provide specialized skills or technology that would be more costly for a firm to invest in. This is valuable for firms, as they themselves acknowledge[1]. This phenomenom is so widespread that virtually all firms are engaged in the outsourcing of some activities.

There are numerous case studies on the outsourcing of supporting activities in the literature (see Baraldi et al., 2014, Nordin and Agndal, 2008, and Lacity, Khan, and Yan, 2016, for a survey), but little is know about how it affects TFP at the firm level. The goal of this paper is to document the importance of the sourcing of services by using an exhaustive dataset on buyer-seller linkages in Belgium[2]. Our data provides a full description of the sourcing strategies chosen by a very large set of Belgian firms. In our sample, firms have on average 72 domestic suppliers (see Table 1). Excluding suppliers that are operating in the wholesale, retail, and utility industries (electricity, gas and water), this average number drops to 38. Among these, the provision of services represents a large fraction as the average firm sources from 18 services suppliers. Allmost all firms source from at least one services supplier. Interestingly, Table 1 also displays substantial heterogeneity in the sourcing of services at the firm level. The number of services suppliers from which firms source from range from 0 to more than 120.

The goal of this paper is to stress the role of this extensive margin of sourcing services on TFP. Antràs, Fort, and Tintelnot (2017) have shown that the relative size advantage of importers is growing in the number of countries from which they source. We extend this evidence to show the importance of sourcing supporting activities on firm size. The blue line in Panel (a) in Figure 1 shows that sales premia are increasing with the number of services suppliers. As only one source of firm heterogeneity may fail to capture the bulk of firm size heterogeneity (Bernard et al., 2022) and as sourcing decisions are interdependent by nature, it is instructive to benchmark these results against those associated with the number of non-services suppliers[3] from which they source goods (Panel

[1] See for instance the Google's supplier site Google's Supplier site (www.google.com/corporate/suppliers/) or BASF suppliers and partners web page BASF suppliers and partners web page (www.basf.com/global/en/who-we-are/organization/suppliers-and-partners.html).

[2] See Dhyne, Magerman, and Rubinova (2015), for a description of that dataset and Dhyne et al. (2020), or Bernard et al. (2020), for most recent applications of this dataset.

[3] The non-services domestic suppliers include suppliers in the agriculture, manufacturing, construction or non market services sectors. Throughout the analysis, we exclude wholesalers,

Table 1: Sourcing strategies in 2012

	p1	p5	p10	p25	p50	p75	p90	p95	p99	Mean
Number of domestic suppliers	6	12	17	29	49	82	140	200	416	72.2
Number of domestic suppliers, excluding wholesalers, retailers,utility providers	3	5	8	13	23	42	78	116	259	38.3
Number of services domestic suppliers	2	3	4	6	11	19	36	54	120	17.9
Number of source foreign countries	0	0	0	0	0	0	3	7	16	1.0

{Note: This table is based on our sample of 104,535 firms in 2012.}

b) and those associated with the number of foreign countries from which they source (Panel c). The green line in Panel (b) suggests that the number of non-services domestic suppliers also matters, although to a lesser extent. As for the number of foreign countries from which firms source, our results for Belgian firms in Panel (c) are of similar magnitude to Antràs, Fort, and Tintelnot (2017) results for US firms.

Sales premia rise naturally in each source of firm heterogeneity separately. When we control for the other two sources of heterogeneity and firm characteristics such as firme size and number of business customers, sales premia are naturally lower, as depicted by the black lines in Figure 1. However, outsourcing of services is still an important source of size dispersion. Panel (a) indicates that, when we control for other factors and firm characteristics, firms that source services from at least 5 suppliers are 50% larger than firms that do not source services, firms that source from at least 13 suppliers are twice the size, and firms sourcing from at least 40 services suppliers are 1.5 log point bigger than firms that do not source services at all. This is suggestive of fixed costs that hamper firms that are less able to source services from a large number of suppliers.

Motivated by this heterogeneity in the number of services suppliers, we formulate a model of firms with endogenous choice of tasks produced in-house. In this model, firms differ in their ability to carry out tasks. Firms must pay a fixed cost each period for each service supplier they choose to source from. With the complementarity mechanism embedded in our model to rationalize the sourcing decisions made by firms, more able firms can afford to add more services suppliers. Our model is closely related to the international sourcing framework in Antràs, Fort, and Tintelnot (2017) and the domestic sourcing framework in Bernard, Moxnes, and Saito (2019), but we modify these models to allow for trade in tasks.

retailers and utility providers as the fixed cost associated with starting a business relationship is arguably very low for these suppliers.

In our framework, expenditure on a services supplier is seen as a trade in tasks. For instance, when a car manufacturer sources cleaning services, it in fact outsources the task of cleaning from its services supplier. This is what makes trade in services different from trade in goods in our model. As a result, a firm's output depends on its own primary inputs - labor, capital and materials - but also on the primary inputs that its services suppliers mobilized at its request. So the contribution to a firm's output of one input, say labor, not only includes its own workers, but is also augmented by the number of workers carrying out tasks required by the firm outside its own legal perimeter. Besides this direct effect of outsourcing on production, outsourcing services also raises firm productivity through an additional term, which is the number of services suppliers. Outsourcing tasks enables firms to concentrate on their core activities, delegating the performance of the tasks for which they have low comparative advantage to their subcontractors. Because of this force, the firm's own productivity increases with the number of its services suppliers. Intuitively, higher ex-ante core TFP allows firms to select from a larger set of specialized suppliers, which in turn increases their ex-post TFP comparative advantage.

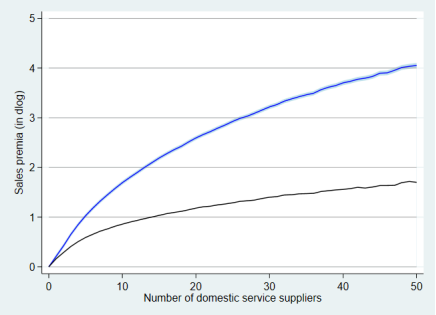
In the first half of the paper, we develop and estimate this model using Belgian firm-level data. Our model puts us in a position to estimate the probability for a firm to outsource supporting activities from a given supplier, where ex ante more able firms are more likely to connect with better and less distant services suppliers. This is consistent with Bernard, Moxnes, and Saito (2019). What is novel here is that we study how it affects productivity. We show that the higher the number of suppliers, the higher the ex-post productivity. By doing this, we face well-known empirical challenges because the number of services suppliers, like any variable input, is chosen endogenously by the firm. To estimate this production function, we rely on a standard estimation procedure based on the control function approach like the Levinsohn and Petrin (2003) or the Wooldridge (2009) estimation procedures assuming that the number of services suppliers is set after the realisation of the TFP shock and should be properly instrumented.

Belgium provides an interesting setting to conduct an analysis of the determinants of sourcing, because trade frictions are arguably expected to be very low. Belgium is a very small country[4], with the largest distance between two cities of 277km. It is also a very densely populated country with more than 780,000 firms within a geographic area no bigger than 30,000km^2. Despite this, our results show that productivity distribution is shaped by the ability of more efficient firms to source from a larger set of specialized suppliers and that productivity gains from outsourcing services are substantial. During our sample period, which extends from 2002 to 2014, changes in the outsourcing strategy of individual firms improved on average total factor productivity by 0,15 percent each year and by 2% over a 10 years period. This may seem relatively modest but during the period covered, no major shock affected the cost of domestic

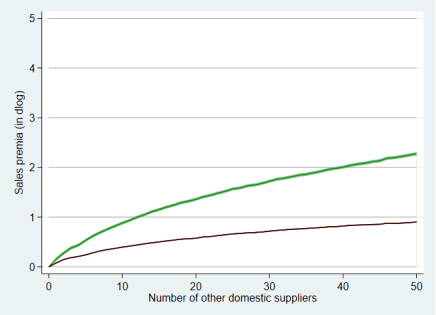
[4]Moreover, Belgium has a very dense transportation infrastructure (155,000 km of roads, 3,500 km of railways and 2,000 km of waterways) and no natural geographical obstacles such as lake or mountain that may hamper trade between firms.

FIGURE 1 : Sales premia and sources of firm-level heterogeneity

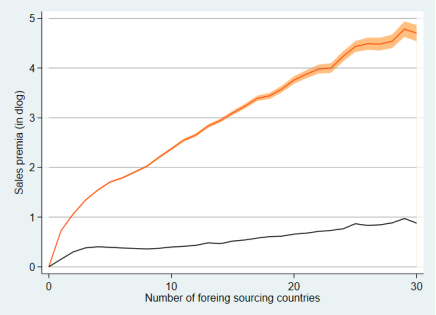
panel (a)



panel (b)



panel (c)



Note : This table is based on our sample of 104,535 firms in 2012. To construct the blue line, we regress the log Sales on cumulative dummies for the minimum number of domestic suppliers of services from which the firm sources, and sector and time dummies. For the green line, we regress the log Sales on cumulative dummies for the minimum number of other domestic suppliers (excluding retailers and wholesalers and utility providers) from which the firm sources, and sector and time dummies. For the orange line, we regress the log Sales on cumulative dummies for the minimum number of countries from which a firm imports, and sector and time dummies. To construct the black lines, we regress the log Sales on cumulative dummies for the minimum number of domestic suppliers of services from which the firm sources, cumulative dummies for the minimum number of other domestic suppliers, cumulative dummies for the minimum number of foreign countries from which the firm imports and additional countrols such as cumulative dummies for the number of Business customers to which the firm sales, its size (log employment) and sector and time dummies.

transactions and most firms were already close to their optimal level of outsourcing of services. Still, this does not mean that policies aiming at decreasing the cost of outsourcing may not have significant impact on productivity and that sourcing of services do not contribute to the actual level of efficency of firms. In our sample, the outsourcing strategy of firms leads on average to a 16% higher TFP, compared to a counterfactual in which there would be no outsourcing at all.

In the second half of the paper, we develop some applications to study the economic and policy implications of our estimates. We quantify the impact of a reduction in the cost of outsourcing services. Our estimates imply that reductions in variable trade costs would lead to significant productivity gains. Removing variable trade costs in services outsourcing completely would lead to an additional improvement of productivity of around 10 percent. This suggests that there are still potential productivity gains from wider outsourcing of services, in a country where this process is already well developed. Thus, not only have outsourcing services already contributed substantially to economic growth in Belgium, but further integration might still have a sizable aggregate effect. In less extreme scenarios, we estimate that reductions of 10 or 50% in variable trade costs would lead to average productivity gains of 3% and 7% respectively. In a post-Covid era, where firms improved their ability to use remote distance communication tools, one may expect a decline in bilateral business to business trade costs that may also fuel productivity gains through a better organization of the work across plants, through increased outsourcing.

Our paper is closely related to the growing literature on the determinants of domestic sourcing (Bernard, Moxnes, and Saito, 2019, Furusawa et al., 2018). Our results complement the findings of Bernard, Moxnes, and Saito (2019), who emphasize the importance of buyer-supplier relationships for firm performance. They show that opening a high-speed train link in Japan has significantly improved firm performance as well as creating more buyer-seller links. As in our model, new links matter for firm productivity, although our focus is to quantify productivity gains from outsourcing supporting activities and conduct counterfactual analysis.

Our paper is also related to the literature on foreign sourcing (Amiti and Konings, 2007, Goldberg et al., 2010, Halpern, Koren, and Szeidl, 2015, Bøler, Moxnes, and Ulltveit-Moe, 2015, Antràs, Fort, and Tintelnot, 2017) that examines the role of imported inputs in firm productivity where foreign and domestic inputs are imperfect substitutes. Our paper departs from this literature because only very few firms are involved in international sourcing, while domestic sourcing concerns the vast majority of firms.

The paper is also related to the wide-ranging literature on trade in tasks (Antràs, Garicano, and Rossi-Hansberg, 2006, Antràs, Rossi-Hansberg, and Garicano, 2008, Grossman and Rossi-Hansberg, 2008, Rodriguez-Clare, 2010, Baldwin and Robert-Micoud, 2014). We follow this literature by considering that the production process is a mix of different tasks that are combined to deliver a final product.

The paper is organized as follows. Section 2 describes our data and docu-

ments stylized facts about services outsourcing in Belgium. Building on these facts, in Section 3 we develop a simple model of trade in tasks. Section 4 describes the estimation procedure and the determinants of outsourcing. In Section 5, we use the estimates to conduct counterfactual analyses.

2 Data and stylized facts

2.1 Data and sample definition

Main data sources. Our panel of Belgian firms over the 2002-2014 period draws on several administrative data sources from Belgium, accessible only at the National Bank of Belgium. The first data source is the business-to-business transactions database (NBB B2B) that contains all domestic transactions between any pair of Belgian firms. By law, all Belgian firms are required to report annual sales to any Belgian firm if sales to that customer are worth 250EUR or more. Administrative sanctions for inaccurate or incomplete reporting guarantee a high quality of data collected (see Dhyne, Magerman, and Rubinova (2015) for more details). In the dataset, we observe the firm's identifier of both the seller and the buyer, allowing us to pinpoint any existing firm-to-firm linkage and its yearly value. This dataset enables us to characterize the sourcing strategy followed by a very large set of Belgian firms.[5] Compared to other existing data sources like those used in Ito and Saito (2020), Bernard, Moxnes, and Saito (2019), Lee et al. (2016), or Atalay et al. (2011), our dataset provides a full description of the B2B transactions made during a given year in Belgium. Its coverage and structure is more similar to the one used in Alfaro Urena, Manelici, and Vasquez (2019) for Costa-Rica or in Cosar et al. (2019) and Demir et al. (2020) for Turkey.

As buyers and sellers are identified with their unique VAT-identifier, the NBB B2B dataset can be merged with firm-level balance sheet data, firm-level international trade data and Crossroad Bank data. This provides us with firm-level information on both sellers and buyers such as number of employees, wages, stock of capital, total input consumption, location, exports and imports, whether the firm belongs to a domestic or an international group, etc.

Despite the richness of our dataset, we face several limitations. A first limitation is that we do not have any information on what is traded between two firms. The B2B transaction data does not provide us with the nature of the delivery, whether it is material inputs, services or capital goods. To work around this data limitation, we rely on the suppliers' main sector of activity, which is defined at a very disaggregated level (NACE Rev2 4-digit industry classification). We classify a transaction made with a supplier in a given sector of activity as a delivery of the corresponding type of services (f.e. a supplier classified in NACE 7430 "Translation and interpretation activities" is assumed to provide translation and interpretation support service). This assumption is arguably

[5] This data set has been used in other papers such as Magerman et al., 2016, Bernard et al., 2022, Dhyne et al., 2020, Kikkawa, Magerman, and Dhyne, 2020.

light in the context of this paper. Indeed, our main variable of interest is the number of services suppliers. Therefore, we simply require suppliers classified in the service sector to actually provide services.

While we observe the universe of domestic transactions, a second limitation of our data is that we do not observe all imports of services[6]. However, we consider this limitation is not too serious. Imports of services are restricted to a very small number of firms and imported values are relatively low compared to domestic expenditure on services.[7] Moreover, the services we are focusing on in this paper often require face-to-face communications (notably office administrative support, legal and accounting services, consultancy, publishing, advertising) or physical delivering (notably services to buildings, leasing activities, architectural and engineering activities, food and beverages services). This is the reason why firms usually outsource services from very close suppliers, as we will show in our stylized fact 2.

Services Definition. In this paper, services are defined as deliveries from firms classified in NACE 5510 to 8299. Table 2 in Appendix provides a full description of the 2-digits service categories covered by this definition, ranked by the number of sourcing firms. Office administrative, office support and other business support activities, and legal and accounting activities rank first and second, with more than 90% of firms sourcing these activities. Our definition of services does not cover wholesale and retail activities (NACE 45 to 47) because those activities are strongly related to products. Sales of wholesalers or retailers not only cover the services provided by the seller (which corresponds to the trade margin) but also the value of the products. For the same reason, we also exclude transportation services, postal and courier activities (NACE 49 to 53) as usually their bill includes the value of transported products.However, our results are not sensitive to the exclusion of these sectors.

Firm Definition. As with most firm-level data, one challenge associated with our dataset is that information is recorded at the level of the VAT-identifier and not at the establishment level. So we do not observe transactions between establishments within the same firm. However, we do observe the number of establishments. When appropriate, we control in our analysis for the multi-establishment status of firms. We also observe in our dataset whether a seller and a buyer are affiliates of the same Belgian or multinational group. Because these relations between affiliates might be considered as equivalent to within-firm transactions, we exclude them from our analysis. In our dataset, we therefore keep only transactions between non-related firms.

[6] From 2006 onwards, firm level imports of services are only available through a survey and therefore for a small set of firms (Ariu, 2016).

[7] In 2005, the last year for which we observe all firms that are importing services, around 4000 firms in our sample import services, which correponds to 4.2 percent of our sample size. Their import of categories of services corresponding to our definition, i.e. business travel (except expenditure by border workers), communications services, insurance and financial services, computer and information services, and business services (except services between affiliated enterprises), amount to 13.4 € billion according to Eurostat. Given that the expenditure on domestic services suppliers amount to 246 € billion in 2005 (see Table 4), import of services account for no more than 5 percent of total expenditure on services.

Table 2: Services sectors

Services sector	Number of sourcing firms (% of the total)	Within firm average number of suppliers
Office administrative, office support and other businesss support activities	95.1	1.8
Legal and accounting activities	93.5	2.2
Services to buildings and landscape activities	56.8	2.3
Activities auxiliary to financial services and insurance activities	56.1	1.5
Computer programming, consultancy and related activities	54.5	2.5
Rental and leasing activities	47.0	2.5
Financial service activities, except insurance and pension funding	46.8	1.9
Publishing activities	45.3	2.2
Activities of head offices; management consultancy activities	44.4	2.6
Architectural and engineering activities; technical testing and analysis	42.5	3.2
Advertising and market research	41.7	2.3
Food and beverage service activities	33.5	2.6
Employment activities	29.7	2.3
Telecommunications	26.8	1.4
Other professional. scientific and technical activities	24.8	2.0
Real estate activities	20.9	1.6
Security and investigation activities	19.7	1.4
Information service activities	15.7	1.5
Scientific research and development	12.4	1.2
Accomodation	11.6	2.3
Travel agency, tour operator reservation service and related activities	9.0	1.8
Motion picture, video and television programme production, sound recording and music publishing activities	8.5	2.1
Programming and broadcasting activities	4.0	1.4
Veterinary activities	2.1	2.1
Insurance, reinsurance and pension funding, except compulsory social security	1.0	1.1

Note : This table is on our sample of 104,535 firms in 2012.

Sample Selection. If our datasets cover the universe of Belgian firms, we restrict our sample to firms in the private and non-financial sector with at least one full-time-equivalent employee, positive output and positive value-added, tangible assets of more than 100 EUR and intemediate inputs of more than 100 EUR, following De Loecker, Fuss, and Van Biesebroeck (2014). The reason for not taking the whole population of firms is the need to estimate firm level TFP. Applying these criteria reduces the number of firms significantly. As shown in Table 3, roughly 105,000 firms met the above criteria in 2012, while the whole sample includes more than 750,000 firms. The large reduction in sample size is mostly driven by the exclusion of the self-employed. These firms, however, constitute a relatively small share in the total economy. Our selected sample provides good coverage of the entire economy, as it represents 70% of aggregate value added and 62% of aggregate employment of non financial corporations.

2.2 Summary statistics and stylized facts

We document four basic facts about firms' services sourcing behavior in the data, which will guide our theoretical framework in Section 3. All numbers refer to our sample of firms defined in Section 2.

Fact 1. Virtually all firms source from at least one services supplier, but there is substantial heterogeneity in the services sourcing of firms.

As shown in Table 1 in the Introduction, firms had on average 18 services suppliers in 2012. However, the number of services suppliers is very heterogeneous across firms, ranging from 1 to more than 120.

Fact 2. Firms purchase services mostly from arm's-length partners.

Firms tend to source services mostly from close suppliers (see Figure 2), with 13% of service sourcing relations taking place within a 5 km range and 90% within a 95 km range. The median distance of a service sourcing relation is 30 km, while it would be 57 km if the buyers and suppliers were randomly matched.

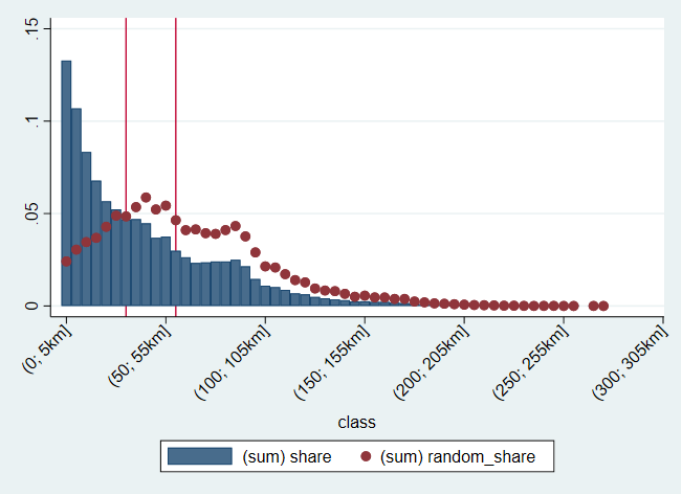
Fact 3. Even though increasing over time, the services input share remains modest

Table 3 shows that services expenditures as a share of total expenditure rose over the period under review by 5 percentage points on average. These inputs do not represent a large fraction of total expenditure, as they accounted for only 16% in 2014. While firms outsource these activities on very large scale, the transaction value is usually relatively small compared to expenditure on other suppliers such as wholesalers or manufacturing suppliers.

Fact 4. The extensive margin plays a large role in explaining both the aggregate trend and the firm-level fluctuations in services outsourcing growth

Table 4 shows aggregate trends in services outsourcing over time. The table decomposes the growth in services expenditure into a within-firm intensive margin and four different extensive margins: new firms, within-firm adding new services suppliers, firms ceasing trading and within-firm shedding of services suppliers. It is instructive to look at the average of these decompositions over all years, as reported in the last row. On average, services expenditure grew

Figure 2: Distribution of distance between firms and their services suppliers



Note: The distribution of distance is based on the observed links between our sample of 104,535 firms in 2012 and their service suppliers. The random distribution represents the theoretical distribution between our sampled firms if the connection was random. The solid red line shows the observed median distance. The dotted red line shows the median distance if links were random.

Table 3: Services expenditure as a share of total expenditure (in percentage)

Year	p10	p25	p50	p75	p90	Mean	Number of firms
2002	1.1	2.3	5.2	12.2	28.9	10.9	94,166
2003	1.3	2.8	6.0	14.0	32.1	12.2	94,977
2004	1.3	2.8	6.1	14.3	32.5	12.3	96,507
2005	1.5	3.0	6.6	15.6	35.1	13.2	97,931
2006	1.5	3.0	6.4	15.1	34.1	12.9	99,965
2007	1.5	3.0	6.0	15.5	34.6	13.1	102,162
2008	1.7	3.4	7.3	16.8	36.6	13.9	103,022
2009	1.6	3.2	6.8	16.1	36.5	13.6	102,690
2010	1.7	3.3	6.9	15.9	36.4	13.6	102,715
2011	1.7	3.3	7.1	16.6	38.2	14.2	103,834
2012	1.8	3.5	7.5	17.4	39.5	14.6	104,523
2013	1.9	3.8	7.9	18.3	40.7	15.1	102,944
2014	2.1	4.1	8.5	19.6	43.0	15.9	103,083
Total	1.6	3.2	6.8	16.0	36.2	13.5	/

by 3.2 percent per year. This growth can be decomposed into a within-firm intensive margin, which contributed 2.0 percentage points; growth on the two extensive margins (firms, suppliers), which contributed 16.1 percentage points; and decline on the two extensive margins, which contributed −14.9 percentage points. Among the extensive margins, firms adding new services suppliers were by far the biggest contributor (13.1 percentage points). The large magnitude of the extensive margin calls for an explicit model of the decision to add additional services suppliers. And the comparable magnitudes of the margins associated with adding and shedding services suppliers (13.1 and 10.8 percentage points) suggest that the decision to outsource services likely entails some fixed costs per-period . One of our goals in this paper is to examine the productivity implications of this outsourcing strategy and the associated increase in services expenditure.

3 A model of task outsourcing

Motivated by the stylized facts above, in this section, we build a static model of industry equilibrium in which firms rely both on in-house tasks and outsourced tasks for production. Our main objective is to guide the empirical section by providing the specification of a production function that can be brought to the data.

Production. Each firm i owns a blueprint to produce a single differentiated variety of final product. Production of final good i requires a continuum of measure one of tasks to be performed, assumed to be imperfectly substitutable with each other, with a constant and symmetric elasticity of substitution equal to ρ. The marginal cost of firm i is

$$c_i = \left(\int_0^1 z_i(t)^{1-\rho} \, dt \right)^{\frac{1}{(1-\rho)}} \tag{1}$$

where $z_i(t)$ is the price of an individual task t paid by firm i.

For simplicity, we assume that there is a unique factor of production, labor, and wage is the numeraire in this economy. Firms can produce all tasks with labor under constant-returns-to-scale technologies. We denote by $a_i(t)$ the labor requirement associated with the production of task $t \in [0,1]$ by firm i. We treat the (infinite-dimensional) vectors of tasks efficiencies $1/a_i(t)$ as the realization of an extreme value distribution. More specifically, the TFP of firm i in producing a task t is a realization of a random variable from the Frechet distribution $Pr(a_i(t) \geq a) = e^{-\varphi_i a^{\theta}}$. As in Eaton and Kortum (2002), θ determines the variability of productivity draws across tasks. These draws are assumed to be independent across firms and tasks. The firm's core TFP φ_i which scales the ability to produce tasks is the source of firm-level heterogeneity in our framework. For instance, following growing literature emphasizing the role of management in shaping the patterns of TFP distribution (Bloom, Sadun, and Van Reenen, 2012, Bloom et al., 2013, Bloom et al., 2020, Syverson, 2011), this

Table 4: Intensive and extensive margins of growth of services consumption

Year	Total expenditure on services (€ billions)	Growth (%)	Contribution (pp)				
			New firms	New suppliers	Stopping firms	Dropped suppliers	Intensive margin
2002	205.5						
2003	214.0	4.3	3.4	16.2	-3.3	-12.6	0.6
2004	225.0	5.1	3.8	14.0	-3.2	-15.3	5.8
2005	246.0	9.1	3.2	18.8	-2.9	-11.6	1.5
2006	261.0	6.3	3.3	14.1	-2.9	-13.4	5.2
2007	290.0	11.1	2.9	15.9	-2.5	-12.4	7.0
2008	285.0	-1.7	2.5	13.6	-7.5	-12.1	1.8
2009	249.0	-12.6	2.0	11.6	-5.3	-11.2	-9.7
2010	272.0	9.0	3.9	12.2	-4.3	-9.7	6.9
2011	299.0	10.2	3.1	14.2	-5.4	-8.1	6.5
2012	301.0	0.6	3.8	8.8	-4.2	-8.1	0.3
2013	291.0	-3.4	2.4	8.9	-3.9	-7.4	-3.4
2014	291.0	0.2	2.2	8.6	-4.2	-7.8	1.4
Average		3.2	3.0	13.1	-4.1	-10.8	2.0

parameter may reflect the managerial capabilities of the firm. But it could also reflect consumers' taste for firm i's product, as production ability is isomorphic to demand preferences in this model.

Tasks are produced by a competitive fringe of services suppliers. But trade in tasks requires the payment of fixed and variable costs. To purchase a bundle of tasks from a particular supplier j, firm i must incur a fixed cost f_{ij} paid in terms of labor. This fixed cost may for instance represent the cost associated with the set-up of a specific contract between the two firms. Furthermore, trade in tasks is subject to iceberg trade costs τ_{ij}. This trade cost may capture transportation costs, coordination costs or any wedge in unit price between the seller and the buyer. So τ_{ij} might include the bilateral markup charged by the seller, as long as this markup is not variable. This model of trade in tasks is one of the simplest we can think of that can square with the facts. It enables us to disregard complex solvability issues, arising in any model of trade in goods due to double marginalization, although providing the rationale for trade in tasks.

A key feature of the equilibrium will be determining the number of task suppliers. Typically, the firm decides to concentrate on its core activities (i.e. the tasks for which it gets the better draws) and outsource the remaining tasks.

As a result, the price of an individual task t paid by the firm i is

$$z_i(t) = \min_{j \epsilon J_i} \{a_i(t), \tau_{ij} a_j(t)\} \tag{2}$$

where J_i is the set of firms for which firm i has paid the associated fixed cost of outsourcing f_{ij}.

Optimal sourcing strategy. We consider the sourcing strategy of firm i producing a final good. Using the properties of the Frechet distribution, one can show that firm i will source a positive number of tasks from each supplier in its sourcing strategy set J_i. Furthermore, the share of tasks sourced from any supplier j is simply given by

$$\chi_{ij} = \frac{\varphi_j (\tau_{ij})^{-\theta}}{\varphi_i + \Theta_i} \tag{3}$$

where following Antràs, Fort, and Tintelnot (2017) $\Theta_i = \sum_{k \epsilon J_i} \varphi_k (\tau_{ik})^{-\theta}$ is the sourcing capability of firm i and J_i the sourcing strategy of firm i. The overall marginal cost faced by firm i can be expressed as

$$c_i = \gamma (\varphi_i + \Theta_i)^{-1/\theta} \tag{4}$$

where $\gamma = \left[\Gamma\left(\frac{\theta+1-\rho}{\theta}\right)\right]^{1/(\rho-1)}$ and Γ is the gamma function.

Demand. Consumers value the consumption of differentiated varieties of products i in the set I according to a standard symmetric CES utility function[8]

[8] With a slight abuse of notation, subscript i refers both to firm and (its) product.

$$U = \left(\sum_{i \in I} q_i^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)} \tag{5}$$

with $\sigma > 1$. These preferences give rise to the following demand for firm i :

$$q_i = E_i P_i^{\sigma-1} p_i^{-\sigma} \tag{6}$$

where p_i is the price of variety produced by firm i, P_i is the standard ideal price index associated with (5), and E_i is aggregate spending in this economy. To close the model, we assume that L units of labor are inelastically supplied. Wage is the numeraire in this economy.

Production function with trade in tasks. As we assume that firms act as monopolistic competitors when selling their product to final consumers, they charge a constant mark-up over marginal cost. Using (6), (7) and the constant mark-up over marginal cost, total labor associated with the production of final goods i, denoted by $\widetilde{L}_i$,is given by

$$\widetilde{L}_i = \frac{(\varphi_i + \Theta_i)^{(\sigma-1)/\theta}}{\sum_{k \in I} (\varphi_k + \Theta_k)^{(\sigma-1)/\theta}} L \tag{7}$$

Labor demand in firm i is

$$L_i = \frac{\varphi_i}{(\varphi_i + \Theta_i)} \widetilde{L}_i$$

If firms are not allowed to outsource tasks, their marginal cost (4) only depends on their own core TFP φ_i. In this case, the labor force associated with the production of product i is totally located in firm i. The higher the core TFP, the lower the marginal cost and the larger the firm is. If instead we suppose that firms are able to outsource tasks, part of the labor force associated with production of firm i is now provided by its services suppliers. Outsourcing services allows firms to decrease their marginal cost, and market share now depends on the augmented TFP $\varphi_i + \Theta_i$. The production function of firm i is:

$$log q_i = log \widetilde{L}_i - log \gamma + f(n_i) + log (\varphi_i)^{1/\theta} \tag{8}$$

The first term on the right-hand side measures the contribution to firm i's output of labor, $\widetilde{L}_i$, which includes not only workers in firm i, L_i, but also workers active in its suppliers j and allocated to performing the tasks required by firm i. The second term is a demand shifter. The final term is the Hicks-neutral productivity shifter that positively depends on firm's own core TFP φ_i. The novelty in the equation is the third term, which represents the contribution of outsourcing services and depends on the number of services suppliers n_i as $f(n_i) = log (1 + \Theta_i/\varphi_i)^{1/\theta}$. The larger the set of services suppliers J_i, the higher the sourcing capability Θ_i and the more efficient the firm is.

Optimal choice of suppliers. Using (4), the properties of the Frechet distribution and the constant markup over marginal cost, the firm profit can be written as:

$$\pi_i = (\varphi_i + \Theta_i)^{(\sigma-1)/\theta} A_i - \sum_j f_{ij} \tag{9}$$

where $A_i = \frac{\gamma}{\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma} E_i P_i^{\sigma-1}$. The problem of maximizing (9) is not straightforward to solve because the decision to include a supplier j in the set J_i depends on the number and characteristics of the other suppliers in this set. When deciding whether to add a new supplier j to the set J_i, the firm trades off the reduction in costs associated with the inclusion of that supplier in the set J_i against the payment of the additional fixed cost f_{ij}. Using a first-order Taylor rule, this net gain of adding supplier j can be approximated by:

$$\Delta_{ij}(\Theta_i) = \frac{\sigma-1}{\theta}(\varphi_i + \Theta_i)^{\frac{\sigma-1-\theta}{\theta}} \varphi_j (\tau_{ij})^{-\theta} A_i - f_{ij} \tag{10}$$

The marginal gain from adding a supplier is higher for more productive firms whenever $\sigma - 1 > \theta$, which we henceforth assume. In this case, TFP and outsourcing display complementarities, which is consistent with Figure 1 in the Introduction. If, instead, $\sigma - 1 < \theta$, more efficient firms outsource fewer tasks as they find it more profitable to capitalize on their comparative advantage in producing tasks more efficiently. Interestingly, under the condition that $\sigma - 1 > \theta$, Equation (10) also exhibits complementarities between suppliers. A firm with a larger sourcing strategy will find more profitable to outsource tasks to one more supplier. This is more likely when consumer demand is elastic and TFP draws are heterogeneous.

Our model also puts us in a position to derive some testable predictions. From Equations (10) and (3), we can see that more efficient and less distant suppliers are more likely to be choosen. We also show that the share of tasks is rising with the supplier's productivity and declining both with the geographic distance between the supplier and the buyer and with the buyer's productivity. These predictions will be tested in the next section.

4 Estimation and results

4.1 Total factor productivity and sourcing strategy

We now take the model to the data. It is natural to interpret Eq (8) as a production function for output in which the firm's total factor productivity is given by $\omega_i = f(n_i) + log(\varphi_i)^{1/\theta}$, i.e., the sum of the productivity gains from selecting a large number of services suppliers and a "residual productivity" term. This interpretation is correct in the sense that variation in ω measures differences in output for the same amount of resources employed in the production process. To be able to estimate the impact of services outsourcing on productivity, we

will nevertheless disentangle the two terms, as in Eq (8). We therefore consider the following specification as a production function,

$$y_{it} = \beta_l \widetilde{l}_{it} + \beta_k \widetilde{k}_{it} + \beta_m \widetilde{m}_{it} + \beta_s n_{it} + log\varphi_{it} + \varepsilon_{it} \tag{11}$$

where y_{it} is the log of real sales of firm i, n_{it} is the inverse hyperbolic sine[9] of the number of services suppliers from which firm i sources, and φ_{it} is the core TFP of firm i in period t. The n_{it} term captures the gain of services outsourcing and is therefore our key variable of interest. The variables $\widetilde{l}_{it}$, $\widetilde{k}_{it}$, $\widetilde{m}_{it}$ are respectively the log of labor force, real capital stock and material inputs consumption augmented by the amount of outsourced labor / capital / materials provided to firm i by each services supplier in period t. To implement this, we assume that the amount of inputs (labor, capital or materials) provided by supplier j to firm i is given by the weighted amount of inputs used by supplier j, weighted by the share of firm i in supplier j's output[10]. Material inputs is defined as total input expenditure reduced by expenditure on services suppliers, deflated by sectoral input consumption deflators. Therefore, input variables in (11) are given by

$$\widetilde{l}_{it} = log\left(\widetilde{L}_{it}\right) = log\left(L_{it} + \sum_{j \in J_{it}} L_{jt} \frac{sales_{jit}}{sales_{jt}}\right)$$

$$\widetilde{k}_{it} = log\left(\widetilde{K}_{it}\right) = log\left(K_{it} + \sum_{j \in J_{it}} K_{jt} \frac{sales_{jit}}{sales_{jt}}\right)$$

$$\widetilde{m}_{it} = log\left(\widetilde{M}_{it}\right) = log\left(M_{it} + \sum_{j \in J_{it}} M_{jt} \frac{sales_{jit}}{sales_{jt}}\right)$$

where $sales_{jit}$ is supplier j's sales to firm i and $sales_{jt}$ is supplier j's total sales. With these equations, it is straightforward to see that supplier j's inputs are allocated to its customers proportionally to their revenue share.

As stated in the model, changes in n will not only capture the fact that changes in firm's i own core TFP allows it to outsource more, but also that changes in TFP in the service sector (the core TFP of the suppliers) make outsourcing more attractive to any given firm.

The estimation of this production function is subject to the well established endogeneity issue between TFP and inputs. In this paper, we use standard estimation procedures based on the control function approach, like the Levinsohn-Petrin or the Wooldridge estimation procedures, assuming that the number

[9] We use the inverse hyperbolic sine instead of the log function to allow for 0 services supplier in the production function. This is only useful for a very low number of firms.

[10] Capital and materials are always strictly positive in our data. Labor may not. If a service supplier j has no employee, it is assumed to be a self employed so that the number of FTE is assumed to be equal to 1.

Table 5: Production function controlling for firm i's sourcing strategy

dependent variable : y_{it}

	OLS	LP	Wooldridge
$\widetilde{l}_{it}$	0.269^{***}	0.240^{***}	0.237^{***}
	(0.001)	(0.001)	(0.001)
$\widetilde{k}_{it}$	0.035^{***}	0.023^{*}	0.013^{***}
	(0.000)	(0.014)	(0.001)
$\widetilde{m}_{it}$	0.644^{***}	0.522^{***}	0.638^{***}
	(0.000)	(0.010)	(0.008)
n_{it}	0.033^{***}	0.059^{***}	0.045^{***}
	(0.001)	(0.001)	(0.001)
Observations	$1,349,253$	$1,349,253$	$939,776$

Note:y_{it}, $\widetilde{l}_{it}$,$\widetilde{k}_{it}$ and $\widetilde{m}_{it}$are the log of respectively the total sales of firm i at time t, its labor force, its capital stock and its material input consumption increased by the amount of the inputs supplied by its services suppliers. $n_{it}$is the inverse hyperbolic sine of the number of domestic suppliers active in the services sector (NACE REV2. 55 to 82) over the period 2002-2012. Production functions estimated using the Prodest ado file in Stata. The equation includes year and NACE 2 digit fixed effects. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

of service suppliers, employment and material inputs are set after the occurance of the TFP shock and should be properly instrumented, while the total capital stock is set by firm i and its suppliers in response to their respective productivity shock in period $t-1$ but before it happened in t. Lagged material inputs are used in the control function in the Levinsohn-Petrin and Wooldridge estimations. Instrumenting the number of service suppliers by its lagged value captures the endogenous character of the sourcing strategy.

The results presented in Table 5 indicate that the services sourcing is an important and significant way to raising production at the firm level. Based on equation (11), one can compute two alternative measures of TFP : the total factor productivity implied by the sourcing strategy (ω_{it} in our model), given by $y_{it} - \beta_l \widetilde{l}_{it} - \beta_k \widetilde{k}_{it} - \beta_m \widetilde{m}_{it}$, and, what we call the core TFP, $log\varphi_{it} = y_{it} - \beta_l \widetilde{l}_{it} - \beta_k \widetilde{k}_{it} - \beta_m \widetilde{m}_{it} - \beta_s n_{it}$. Based on our "Wooldridge" estimates, we find that expanding the number of services providers between two consecutive years improves on average the total factor productivity of individual firms in our sample by 0,2% ($\beta_n (n_{it} - n_{it-1})$). Over a 10 years period, the productivity gains induced by the increasing use of outsourcing of services ($\beta_n (n_{it} - n_{it-10})$) represented on average a 1.6% increase of TFP. This may be modest but only captures a small fraction of the benefit of the sourcing of services, by neglecting the fact that even at the begining of our sample period, firms were already sourcing part of their service activities. In our sample, the sourcing strategy of firms improves the TFP of the firm by 16% compared its core TFP.

Our measure of productivity gains due to the extensive margin of services outsourcing is robust to alternative specifications. For example, we considered as a robustness check a standard Cobb-Douglass value added based production

function augmented by the number of service suppliers, even though this is not consistent with our framework.

In addition to the standard problem of endogeneity of inputs in production function estimates, we potentially face an additional problem. As TFP developments in the service sector can naturally influence the sourcing strategy of individual firms, in order to evaluate a potential omitted variable bias on β_n, we have also estimated the same specification as in Table5 augmented with service sectors $\times$ year dummies for all NACE 2 digit service sectors from which an individual firm has sourced at least once during the sample period. All robustness checks are presented in Appendix 6. Still, as we want to capture the impact of outsourcing of services on productivity not only through the extensive margins but also through the specific TFP development of the service sector, as in our theoretical model, we consider that the omitted variable bias on in our baseline regression is not an important issue and, for the remaining sections, we will consider the TFP estimate based on the Wooldridge estimations presented in Table 5.

4.2 The determinants of services sourcing

Next, we explore the determinants of services outsourcing. Based on our model, the selection of a specific trading partner relies on both geographical (for instance, the distance between the firm and a potential supplier) and economic (the level of economic performance of both trading partners) factors. In this section, we rely on the estimation of an equation characterizing the decision of firm i to source inputs from firm j to test the empirical predictions of our model. To do this, we use our estimates of core TFP in combination with the NBB B2B dataset described in section 2. As mentioned above, this dataset provides the researcher with a complete description of all the business relationships managed by Belgian firms. For every registered corporation in Belgium, we therefore have a complete view of its domestic suppliers. Simultaneously, we know which Belgian firms were not choosen by a firm as a supplying partner.

In our model, firms that trade domestically may face some trade costs. Geography, as illustrated in Figure 2 shapes the structure of the Belgian production networks. So geographical distance is definitely a determinant. Moreover, Belgium is a multilingual country. The country is made up of three Regions, with Dutch-speaking Flanders, French-speaking Wallonia and bilingual Brussels. Therefore, even if there is no formal border or any tariff barriers to trade within Belgium, there can be sizeable costs for trade between a firms located in Flanders and a firm located in Wallonia.

Following our modeling strategy and equation (10), we assume that the probability that j belongs to the set of suppliers of firm i is given by a linear probability model

$$P\left[I\left(Sales_{j\to i,t}>0\right)\mid X_{ijt}\right] = \beta_0+\beta_1 dist_{ij}+\beta_2 \neq language_{ij}+\beta_3 log\varphi_{i,t-1}+ \beta_4 log\varphi_{jt}+additional\ controls$$

As a robustness check, we also test a Probit specification with the same explanatory variables

$$P\left[I\left(Sales_{j\to i,t}>0\right)!X_{ijt}\right]=\Phi\ \left(\beta_0+\beta_1 dist_{ij}+\beta_2\neq Regions_{ij}+\beta_3 log\varphi_{i,t-1}+\beta_4 log\varphi_{jt}+additional\ controls\right)$$

where :

- $dist_{ij}$ is the log distance between firm i and supplier j ;
- $\neq language_{ij}$ is a binary variable indicating wether firm i and supplier j do not share a common language ;
- $log\varphi_{i,t-1}$ is the log core TFP of firm i. As a reminder, this measure of productivity is purged from the contribution of its services sourcing strategy. We use this variable in period $t-1$, in order to capture the core ability of firm i before it takes its sourcing decision in time t. This measure reflects the φ_i parameter in our model and it represents the ex-ante ability of the firm to combine all the tasks needed for its production ;
- $log\varphi_{jt}$ is the log core TFP of supplier j ;

And we also introduce a number of control variables that arguably may influence the probability of a relationship. These variables serve as a proxy for both the iceberg trade cost τ_{ij} and the fixed cost f_{ij} in equation (10).

- $l_{i,t-1}$ and l_{jt} are respectively the log employment of firm i and supplier j, to account for the importance of size;
- Dummies indicating the international trade status of i and j (exporter, importer, MNE) ;
- 2-digit sectoral dummies of i and j, and in addition a dummy indicating whether i and j belong to the same 2-digit sector;
- Dummies characterizing the location of i and j (district code), to account for possible geographical differences, in terms of accessibility for example;
- Dummies indicating whether i and j are multi-plant, to account for increased accessibility of multi-plant firms;
- Year fixed effect to account for change in cost over time.

Results are summarized in Table 6 (see Appendix 6 for more details on the estimation procedure). In addition to the estimated coefficients, we also present, for the Probit specification, the estimated average elasticity of the probability

Table 6: Services sourcing choice of firm i : dependent variable : $I\left(Sales_{j\to i,t}>0\right)$

	Linear probability model	Probit	
	Est. coef.	Est. coef.	Avg. elast (in 2012)
$dist_{ij}$	-0.0007^{***}	-0.2473^{***}	-0.9992^{***}
	(0.0000)	(0.0004)	(0.0016)
$\neq Region_{ij}$	-0.0001^{***}	-0.3120^{***}	-0.7194^{***}
	(0.0000)	(0.0007)	(0.0009)
$log\varphi_{i,t-1}$	0.0001^{***}	0.0231^{***}	0.0935^{***}
	(0.0000)	(0.0007)	(0.0026)
$log\varphi_{jt}$	0.0001^{***}	0.0609^{***}	0.2460^{***}
	(0.0000)	(0.0005)	(0.0022)
$l_{i,t-1}$	0.0002^{***}	0.1425^{***}	0.5761^{***}
	(0.0000)	(0.0003)	(0.0010)
l_{jt}	0.0004^{***}	0.1511^{***}	0.6106^{***}
	(0.0000)	(0.0003)	(0.0082)
Year f.e	Yes		
i and j district f.e	Yes		
i and j sector f.e	Yes		
Additional controls	Yes		
Replications	100		

Note: Mean estimates and their standard errors computed using 100 random samples that includes all B2B transactions supplemented by 100 random transactions for each buyer, for the 2003-2012 period. Weighted likelihood is used in order to control for the fact that "1"s are over-represented in our sample. $I(sales_{ijt}>0)$ is a binary variable that indicates whether firm i sources inputs from firm j at time t. $dist_{ij}$ is the log of the "as the crow flies" distance in km. $\neq language_{ij}$ is a binary variable indicating that firms i and j are located in two different regions that do not share a common language. $_{log\varphi}$ is the log of total factor productivity estimates purged from the contribution of the service sourcing strategy followed by the firm (using the Wooldridge-LP estimator). l is the log of number of employees, in FTE. Additional controls include dummies for the degree of internationalization of i or j (exporter, importer, MNE), dummies indicating whether i or j are multiplant firms, 2-digit sectoral fixed effects of i and j, a binary variable indicating whether i and j belong to the same 2-digit sector, district fixed effect for i and j, year fixed effects. Average elasticities are computed considering all potential pairs (i,j) for all firms i and all suppliers j sampled in 2012. Standard errors of the estimated coefficients are clustered at the sourcing firm level. Significance levels: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

of a transaction with respect to our set of explanatory variables, computed considering all potential supplier-buyer pairs in 2012.[11] The results obtained using both methods are in line with the predictions of our model. Most productive firms tend to source from more suppliers, and better suppliers are more likely to be selected. Distance is also a key determinant of the likelihood of a business relationship. Considering the Probit estimates, we quantify the average elasticity to outsource services with regard to distance to close to 1, implying a cost of distance in the case of domestic services close to the traditional gravity estimates obtained in the international trade literature. Our results are also consistent with the fact that trade costs may embody cultural barriers to trade as a common language increases the probability of trading. In the case of services supply, these cultural barriers may reflect the fact that personal contacts are an important component of a service transaction.

Results in Table 6 can be benchmarked against results presented in the Appendix where all suppliers are included, not only services suppliers, or where only manufacturing suppliers are included. Even if our model of trade in task is not appropriate for modeling business relations with providers of intermediate inputs, estimations results using a sample of potential business relations implying firms active in all the Belgian economy (Table 11 in Appendix A4) or in the manufacturing sector only (Table 12 in Appendix A4) suggest that the cost of distance and the language barrier are relatively high for provision of services.

Next, to confront our model with our transaction-level dataset, we exploit the value of the transaction to analyse how firms and geographic characteristics affect the amount supplied by j to firm i. We therefore estimate an Eaton-Kortum Tobit equation of the amount traded between i and j, censoring our dependent variable to the minimum amount delivered by supplier j to any firm in the Belgian network. The dependent variable is the expenditure on supplier j, as a share of total expenditure of firm i, in log. Results are presented in Table 13 in Appendix 6.

The results obtained are in line with Equation (3) of our model. When firms source from remote locations, they tend to trade less because of rising variable costs. Similarly, variable costs are associated with the cultural barriers. As a share of their total expenditure, firms naturally source more tasks to more efficient suppliers. As predicted by our model, the firm's own core TFP reduces the expenditure share on its suppliers This reflects two phenomena. First, as more efficient firms source from more suppliers, each of them represents a smaller share of firm i's total expenditure. Second, as firm i is more intrinsically efficient, it's own contribution to the value of production is larger. When we benchmark these results against those obtained with all suppliers, and not only services suppliers, or manufacturing suppliers, this again suggests that trade cost and language barriers are higher for services (see Appendix A5), so, for services, both

[11] As LPM estimates does not garantee that the estimated probability will be between 0 and 1 and as the unconditional probability of a transaction is very low, a large fraction of estimated probabilies based on the LPM are negative and close to '0'. This implies that the elasticity of the probability w.r.t. any explanatory variable becomes highly volatile. The average elasticity becomes meaningless in that setting.

the extensive and intensive margins seem to be affected by higher sensitivity to trade costs.

5 Changes in trade costs and productivity gains

In this section, we simulate structural shocks in a static partial equilibrium economy based on the transaction-level data and our estimates. Firms behave as in our theoretical model, with parameters given by the coefficients using the LPM specification in the first column of Table 6. Moreover, we use our production function estimates with reference to the Wooldridge estimator, which disciplines the elasticity of production to the number of services suppliers (in that case estimated at 0.08). Based on this estimation, a counterfactual level of apparent productivity is computed and compared with the current productivity level. It is worthnoting that we assign to each firm its actual "augmented" level of capital, labor an materials and keep them constant througout the whole exercise. The goal here is to investigate how firms would change the organization of their production, in terms of how many services subcontractors they are using. This can be seen as a long-run effect after the reallocation of inputs among firms and their suppliers.

5.1 Cost of distance and language barriers

Using the results of our LPM estimates, we are able to compute firm-specific responses to changes in trade costs or in language trade barriers and to identify the effects of these reductions in trade frictions on the number of services suppliers that can serve any given firm in our sample. Using those heterogenous responses, we can then evaluate the impact of several scenarios on the number of services suppliers managed by a specific firm. More specifically, we want to investigate how many services suppliers are added or dropped in response to shoks. The implied change in the number of services suppliers can then be used to evaluate the change in observed TFP.

A reduction in the cost of distance could be achieved by ICT developments (such as a more intensive use of virtual meeting tools, high-speed mobile internet), less traffic congestion, or an improvement in transport infrastructure. A reduction in language barriers may be achieved by learning the other national languages and more generally by a better cultural knowledge of the other Region. As mentioned above, we consider the long term effect of those new transactions assuming that the total amount of labour required for production by a given firm i is fixed.

In each scenario, we simulate at the firm-level what the number of services suppliers might be if the coefficient of our variable of interest were lower, by 10%, 50% or even completely removed (the extreme case of zero cost).

The findings are presented in Table 7 (see also the comparable results obtained using the Probit specification in Table 15in the Appendix). Reductions of trade costs by 10 or 50% lead respectively to average productivity gains by

Table 7: Counterfactual experiments: cost of distance and language barrier

	Average change in observed TFP		
	Scenario 1 : no cost ($\bar{\beta}_k = 0$)	Scenario 2: reduction of cost by 50% ($\bar{\beta}_k = .5\hat{\beta}_k$)	Scenario 3: reduction of cost by 10% ($\bar{\beta}_k = .9\hat{\beta}_k$)
Coefficient on $dist_{ij}(\beta_1)$	0.093 [0.04 ; 0.15]	0.068 [0.02 ; 0.12]	0.026 [0.01 ; 0.05]
Coefficient on $\neq Lang_{ij}(\beta_2)$	0.005 [0.00 ; 0.02]	0.001 [0.00 ; 0.008]	0.000

{Note: using the LPM estimates as baseline. [p5-p95] range in brackets.}

3% and 7%. Removing the geographical trade cost completely ($\bar{\beta}_1 = 0$) would lead to a large average productivity gains of 9%. The impact is unevenly distributed. As shown in the whole distribution depicted in Figure 3, the impact on some firms is twice as large as this average. Interestingly, the average order of magnitude is broadly comparable to the average productivity gains implied by current level of sourcing compared to a no sourcing scenario, though it is a bit lower. This suggests that there are still potential productivity gains from increasing outsourcing of services, in a country where this process is already well developed.

Removing language barriers has a much smaller impact. On average, a complete removal of language barriers between Flanders and Wallonia would lead to a very modest average productivity gain of 0.5%. Thel distribution of the impact of such a scenario is provided in Figure 4 in the Appendix. Still this average impact for Belgium hides large regional discrepancies. In fact, the removal of language barrier would mostly benefit to firms located in the smallest Region, Wallonia, which on average could benefit from a 1% increase in TFP through easier trade with their Flemish counterparts. Firms located in Flanders, on the other hand, would increase their productivity only marginally, on average by 0.4%. This is due to a much denser economic fabric in Flanders compared to Wallonia. The complete removal of cultural trade barriers between the two regions would enable Walloon firms to potentially source from a much larger pool of suppliers, while this effect is much smaller for Flemish firms.

5.2 Unconditional fixed costs

As a final exercise, and using a similar procedure to that described in the previous section, we considered the impact of a permanent increase in unconditional fixed costs on productivity. Considering for example a world in which the COVID-19 virus would permanently hamper the ability to establish trade relation between firms, by imposing social distancing or restricting global mobility of people. We consider two scenarios here, respectively with a reduction of 25% or 50% of the current average unconditional probability of a transaction. In

Table 8: Counterfactual experiments: unconditional probability of a transaction

Average change in observed TFP	
Scenario 1: reduction of the unconditionnal probability of a transaction by 25%	Scenario 2: reduction of the unconditionnal probability of a transaction by 50%
-0.013	-0.029
$[-0.04\,;\,-0.002]$	$[-0.09\,;\,-0.00]$

{Note: [p5-p95] range in brackets.}

the case of the linear probability model, the drop in the number of suppliers is typically the same across firms. It would be equal to 2 in the first scenario and 4 in the second scenario, which corresponds to a drop of respectively 20% and 40% of the number of services suppliers for the median firm.[12] This relatively small reduction in the number of services suppliers would still have sizeable effects on productivity. In the first scenario, the decline in firm-level TFP would on average be estimated at 1.3%. In the 50% reduction scenario, the average loss in TFP at the firm level would amount to 3% (see Table 8, or Table 16 in the Appendix for a robustness check with the Probit model).

6 Conclusion

This paper examines how outsourcing services affects firms' TFP. Using an exhaustive dataset on firms' buyer-seller linkages in Belgium, we document a set of facts about the services sourcing behavior of individual firms. We have shown that virtually all firms source from at least one services supplier, but there is substantial heterogeneity in the services sourcing of firms. Geographic proximity plays a key role for the matching of services suppliers and customers as firms mostly connect with services suppliers at a distance of no more than 35 km. Finally, the extensive margin goes a long way to explaining both the aggregate trend and the firm-level fluctuations in services outsourcing growth.

Guided by these facts, we have developed a simple model in which firms can outsource tasks and search for services suppliers based on their geography and their core TFP. Our model implies a firm-level production function in which output depends on capital, labor, materials, augmented by the amount of outsourced capital, labor and materials provided by each services supplier, and a novel term related to the number of services suppliers. This model can be brought to the microdata. We find compelling evidence that the number of services suppliers matters for firm performance.

Perhaps the main caveat to our analysis is that, in the absence of exogenous variation, we need to use with full force the restrictions imposed by our structural framework. However, a benefit of our structural framework is that it

[12] If a firm has less than 2 or 4 service suppliers in the baseline, the number of suppliers in the alternative scenarios is bounded at 0

enables an explicit counterfactual analysis. Our results show that the productivity gains from outsourcing services are substantial. Our estimates imply that trade costs reductions would lead to significant productivity gains. Removing variable trade costs in services outsourcing completely would lead to a productivity gain of 11 percent. Reductions of variable trade costs by 10 or 50% lead respectively to average productivity gains of 3% and 7%. On the other hand, a 25% reduction in the probability of a transaction , due for example to a permanent increase in unconditional fixed costs, would lead to an average 1.3% TFP decline at the firm level.

The numbers obtained should naturally be viewed with caution as they are based on very stylized counterfactual exercises. However, they are still indicative of potential significant TFP gains related to the reduction in the costs of outsourcing. Reducing the costs associated with the sourcing of services can be achieved in many ways, ranging from digitalization of the economy, improving electronic communication to reducing congestion, but also in the Belgian context and more broadly in the European context, by reducing cultural barriers that may bring local discontinuities into an otherwise well integrated Single Market.

It is difficult to know what is driving the increase in services outsourcing. Our evidence suggests that TFP gains is part of the motivation, but there might be other reasons that are likely important, such as exclusion from rent sharing (Goldschmidt and Schmieder, 2017), or the development of new technologies that facilitate contracting out services. Understanding this is beyond the scope of this project but a fruitful area for future research.

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Appendix A1

As a robustness check of Table 5, this Appendix shows the estimates of a standard Cobb-Douglas value added production function.

Table 9: Value added production function controlling for firm i's sourcing strategy

dependent variable : va_{it}			
	OLS	LP	Wooldridge
l_{it}	0.765^{***}	0.661^{***}	0.727^{***}
	(0.001)	(0.001)	(0.001)
k_{it}	0.136^{***}	0.081^{**}	0.098^{***}
	(0.000)	(0.033)	(0.001)
n_{it}	0.224^{***}	0.058^{***}	0.106^{***}
	(0.001)	(0.002)	(0.001)
Observations	1,402,494	1,402,494	1,172,009

Note:va_{it}, l_{it} and $k_{it}$are the log of respectively the value added created by i at time t, its labor force and its capital stock. $n_{it}$is the inverse hyperbolic sine of the number of domestic suppliers active in the service sector (NACE REV2. 55 to 82) over the period 2002-2012. Production functions estimated using the Prodest ado file in Stata. The equation includes year and NACE 2 digit fixed effects. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 10: Revenue production function controlling for firm i's sourcing strategy and aggregate developments in service sectors

dependent variable : y_{it}			
	OLS	LP	Wooldridge
l_{it}	0.262^{***}	0.239^{***}	0.236^{***}
	(0.001)	(0.001)	(0.001)
k_{it}	0.033^{***}	0.047^{**}	0.013^{***}
	(0.000)	(0.000)	(0.001)
m_{it}	0.641^{***}	0.655^{***}	0.631^{***}
	(0.000)	(0.000)	(0.009)
n_{it}	0.032^{***}	0.044^{***}	0.035^{***}
	(0.001)	(0.001)	(0.001)
Observations	1,349,253	1,349,253	939,776

Note:va_{it}, l_{it} and $k_{it}$are the log of respectively the value added created by i at time t, its labor force and its capital stock. $n_{it}$is the inverse hyperbolic sine of the number of domestic suppliers active in the service sector (NACE REV2. 55 to 82) over the period 2002-2012. Production functions estimated using the Prodest ado file in Stata. The equation includes year and NACE 2 digit fixed effects. Sector x year fixed effects for each service sectors from which firm i sourced at least once during the observation period are also included to capture common shocks affecting service providers. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Appendix A2

Figures in this Appendix show the distribution of observed TFP changes associated with a zero-distance-cost scenario (Figure 3), and with a no-language-barrier scenario (Figure 4).

Figure 3: Distribution of TFP gains associated with removing the cost of distance

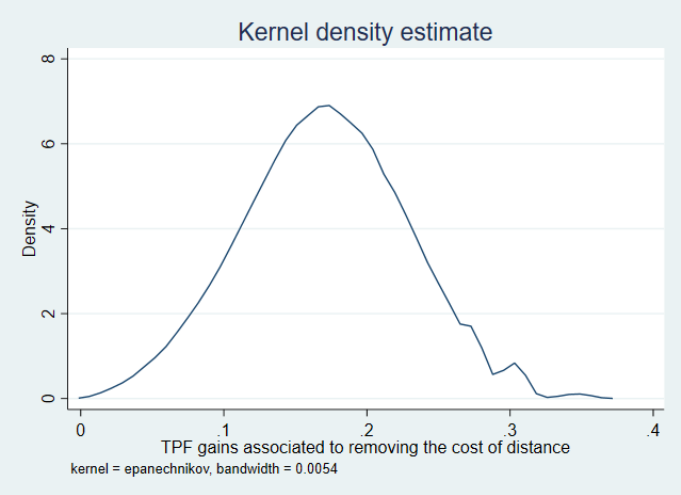
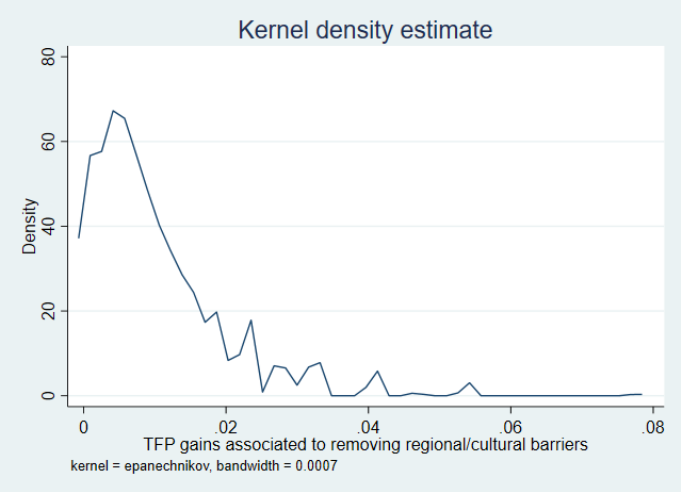


Figure 4: Distribution of TFP gains associated with removing the cost of language barrier



Appendix A3

In order to estimate a linear probability model or a Probit, one needs both "0"s and "1"s. If our transaction dataset provides us with all the "1"s in a given year, we need to sample the "0"s. To perform our estimation, we randomly selected a given number of potential transactions (effective or not) for any Belgian firm in our dataset. We have built three samples for the estimation of our baseline regression.

First, we considered all firms included in our sample for which we observe location, employment and an estimate of their total factor productivity, at least for one year in our estimation period running from 2003 to 2012 either as a buyer or as a potential supplier. This sample covers all sectors of activity, from manufacturing to services including wholesalers and retailers and network industries. In addition to the observed transactions, we considered 100 randomly selected potential suppliers for every firms. "1"s are naturally over-represented in our three samples. Therefore, we estimated weighted LPM and Probit equations that correct for this feature of our datasets.

This procedure has been replicated 100 times to estimates both coefficients and standard errors.

Appendix A4

Table 11 presents the results for all suppliers, and not only services suppliers as in Table 6. Table 12 gives the results for manufacturing suppliers. As we want to exclude firms that purchase manufacturing goods for resale (such as wholesalers or retailers), we restrict the set of buyers to manufacturing firms.

Table 11: Sourcing choice of firm i - All suppliers : dependent variable : $I\left(Sales_{j\to i,t} > 0\right)$

	Linear probability model	Probit	
	Est. coef.	Est. coef.	Avg. elast (in 2012)
$dist_{ij}$	-0.0007^{***}	-0.2304^{***}	-0.9192^{***}
	(0.0000)	(0.0001)	(0.0004)
$\neq Region_{ij}$	-0.0001^{***}	-0.2354^{***}	-0.6110^{***}
	(0.0000)	(0.0002)	(0.0004)
$log\varphi_{i,t-1}$	0.0001^{***}	0.0257^{***}	0.1026^{***}
	(0.0000)	(0.0002)	(0.0009)
$log\varphi_{jt}$	0.0002^{***}	0.1124^{***}	0.4484^{***}
	(0.0000)	(0.0003)	(0.0009)
$l_{i,t-1}$	0.0002^{***}	0.1223^{***}	0.4881^{***}
	(0.0000)	(0.0001)	(0.0003)
l_{jt}	0.0002^{***}	0.1331^{***}	0.5313^{***}
	(0.0000)	(0.0001)	(0.0004)
Year f.e	Yes		
i and j district f.e	Yes		
i and j sector f.e	Yes		
Additional controls	Yes		
Replications	100		

Note: Mean estimates and their standard errors computed using 100 random samples that includes all B2B transactions supplemented by 100 random transactions for each buyer, for the 2003-2012 period.. Weighted likelihood is used in order to control for the fact that "1"s are over-represented in our sample. $I(sales_{ijt} > 0)$ is a binary variable that indicates whether firm i sources inputs from firm j at time t. $dist_{ij}$ is the log of the "as the crow fly" distance in km. $\neq Region_{ij}$ is a binary variable indicating that firms i and j are located in two different regions that do not share a common language. $log\varphi$ is the log of total factor productivity estimates purged from the contribution of the service sourcing strategy followed by the firm (at the NACE 2-digit level using the Wooldridge-LP estimator). l is the log of number of employees, in FTE. Additional controls include dummies for the degree of internationalization of i or j (exporter, importer, MNE) or if i or j are multiplant firms. Average elasticities are computed considering all potential pairs (i,j) for all firms i and all suppliers j sampled in 2012. Standard errors of the estimated coefficients are clustered at the sourcing firm level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 12: Sourcing choice of firm i - Manufacturing buyers and sellers only : dependent variable : $I\left(Sales_{j\to i,t}>0\right)$

	Linear probability model	Probit	
	Est. coef.	Est. coef.	Avg. elast (in 2012)
$dist_{ij}$	-0.0013^{***}	-0.1827^{***}	-0.6667^{***}
	(0.0000)	(0.0006)	(0.0022)
$\neq Region_{ij}$	-0.0004^{***}	-0.2038^{***}	-0.5257^{***}
	(0.0000)	(0.0015)	(0.0026)
$log\varphi_{i,t-1}$	0.0001^{***}	-0.0100^{***}	-0.0366^{***}
	(0.0000)	(0.0018)	(0.0064)
$log\varphi_{jt}$	0.0004^{***}	0.1034^{***}	0.3771^{***}
	(0.0000)	(0.0018)	(0.0064)
$l_{i,t-1}$	0.0006^{***}	0.1346^{***}	0.4909^{***}
	(0.0000)	(0.0006)	(0.0022)
l_{jt}	0.0003^{***}	0.0696^{***}	0.2540^{***}
	(0.0000)	(0.0006)	(0.0022)
Year f.e	Yes		
i and j district f.e	Yes		
i and j sector f.e	Yes		
Additional controls	Yes		
Replications	100		

Note: Mean estimates and their standard errors computed using 100 random samples that includes all B2B transactions supplemented by 100 random transactions for each buyer, for the 2003-2012 period. Weighted likelihood is used in order to control for the fact that "1"s are over-represented in our sample. $I(sales_{ijt}>0)$ is a binary variable that indicates whether firm i sources inputs from firm j at time t. $dist_{ij}$ is the log of the "as the crow fly" distance in km. $\neq Region_{ij}$ is a binary variable indicating that firms i and j are located in two different regions that do not share a common language. $log\varphi$ is the log of total factor productivity estimates purged from the contribution of the service sourcing strategy followed by the firm (at the NACE 2-digit level using the Wooldridge-LP estimator). l is the log of number of employees, in FTE. Additional controls include dummies for the degree of internationalization of i or j (exporter, importer, MNE) or if i or j are multiplant firms. Average elasticities are computed considering all potential pairs (i,j) for all firms i and all suppliers j sampled in 2012. Standard errors of the estimated coefficients are clustered at the sourcing firm level. Significance levels: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Appendix A5

Table 13: Contribution of firm j to firm i's total sales: dep. var. : $\ln \frac{sales_{ijt}}{sales_{it}}$

	Services suppliers / All fims
$dist_{ij}$	-1.5501^{***}
	(0.0025)
$\neq Region_{ij}$	-1.9586^{***}
	(0.0053)
$log\varphi_{i,t-1}$	-0.5243^{***}
	(0.0046)
$log\varphi_{jt}$	0.6952^{***}
	(0.0045)
$l_{i,t-1}$	0.1172^{***}
	(0.0016)
l_{jt}	08210^{***}
	(0.0019)
Year f.e.	Yes
i and j district f.e.	Yes
i and j sector fe.	Yes
Additional controls	Yes
Replications	100

Note: Mean estimates and their standard errors computed using 100 random samples that includes all B2B transactions supplemented by 100 random transactions for each buyer, for the 2003-2012 period. The explained variable is the log of the ratio of $sales_{ijt}$, the amount in EUR of tasks / inputs sourced by firm i from firm j at time t and the total sales of firm i. $dist_{ij}$ is the log of the "as the crow flies" distance in km. $\neq Lang_{ij}$ is a binary variable indicating that firms i and j do not share a common language. $_{log\varphi}$ is the log of total factor productivity estimates purged from the contribution of the sourcing strategy followed by the firm (at the NACE 2-digit level using the Wooldridge-LP estimator). l is the log of number of employees, in FTE. Additional controls include dummies for the degree of internationalization of i or j (exporter, importer, MNE) or if i or j are multiplant firms. Standard errors of the estimated coefficients are clustered at the sourcing firm level. Standard errors of the estimated coefficients are clustered at the sourcing firm level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 14: Contribution of firm j to firm i's total sales: dep. var. : $\ln \frac{sales_{ijt}}{sales_{it}}$

	All suppliers / All fims	Manufacturing suppliers / Manufacturing firms
$dist_{ij}$	-1.5479^{***}	-1.3471^{***}
	(0.0006)	(0.0042)
$\neq Region_{ij}$	-1.6041^{***}	-1.5091^{***}
	(0.0017)	(0.0110)
$log\varphi_{i,t-1}$	-0.5590^{***}	-1.1519^{***}
	(0.0019)	(0.0183)
$log\varphi_{jt}$	1.1210^{***}	1.2436^{***}
	(0.0019)	(0.0166)
$l_{i,t-1}$	0.0563^{***}	0.2413^{***}
	(0.0006)	(0.0044)
l_{jt}	0.8122^{***}	0.4806^{***}
	(0.0006)	(0.0044)
Year f.e.	Yes	
i and j district f.e.	Yes	
i and j sector fe.	Yes	
Additional controls	Yes	
Replications	100	100

Note: Mean estimates and their standard errors computed using 100 random samples that includes all B2B transactions supplemented by 100 random transactions for each buyer, for the 2003-2012 period. The explained variable is the log of the ratio of $sales_{ijt}$, the amount in EUR of tasks / inputs sourced by firm i from firm j at time t and the total sales of firm i. $dist_{ij}$ is the log of the "as the crow flies" distance in km. $\neq Lang_{ij}$ is a binary variable indicating that firms i and j do not share a common language. $_{log\varphi}$ is the log of total factor productivity estimates purged from the contribution of the sourcing strategy followed by the firm (at the NACE 2-digit level using the Wooldridge-LP estimator). l is the log of number of employees, in FTE. Additional controls include dummies for the degree of internationalization of i or j (exporter, importer, MNE) or if i or j are multiplant firms. Standard errors of the estimated coefficients are clustered at the sourcing firm level. Standard errors of the estimated coefficients are clustered at the sourcing firm level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Appendix A6

To conduct our counterfactual exercise in Section 5, we follow the procedure below :

1. We start out from the sample of 83,456 firms in 2012 for which we estimate core TFP in 2011 and 2012, employment in 2011 and 2012 and their location. Starting from that sample, we estimated, for every firm, their probability of outsourcing services from each of the 26,443 services providers sampled, considering our estimated LPM. At this stage, we therefore estimate 2,206,827,008 individual probabilities of transactions, P_{ij0}. These are our baseline estimates.

2. For each of the counterfactual scenarios, we estimated alternative probabilities of transactions, $P_{ij,alt}$, and for each sample firm we estimate the average increase in probability induced by the change in trade costs. Based on these average increases in probability, given by $dP_{ij} = \frac{1}{26,443} \sum_{j=1}^{26,443} (P_{ij,alt} - P_{ij0})$, we estimate the number of new transaction in firm i implied by each scenario as, $new\,transactions_i = 26,443 * dP_{ij} = \sum_{j=1}^{26,443} (P_{ij,alt} - P_{ij0})$. In the case of a LPM, these new transactions are simply given by $\sum_{j=1}^{26,443} \left(\bar{\beta}_1 - \widehat{\beta}_1\right) dist_{ij}$ for the number of new transactions implied by changes in the cost of distance and by $\sum_{j=1}^{26,443} \left(\bar{\beta}_2 - \hat{\beta}_2\right) \neq language_{ij}$ for those implied by changes in the language barriers.

3. Finally, using the number of new transactions estimated for each firm at stage 2, we compute the estimated increase in production implied by the greater diversification of suppliers, keeping the volume of inputs constant. We label that increase in production as TFP gains implied by the different scenarios.

Table 15: Counterfactual exercises - Average productivity gains implied by changes in trade costs and/or regional barriers using the Probit estimates as baseline
[p5-p95] range in brackets

	Implied TFP gains	
	$dist_{ij}$	$\neq Lang_{ij}$
$\beta_k = 0$	0.101 [0.06 ; 0.15]	0.004 [0.00 ; 0.02]
$\beta_k = .5\hat{\beta}_k$	0.045 [0.02 ; 0.08]	0.001 [0.00 ; 0.01]
$\beta_k = .9\hat{\beta}_k$	0.008 [0.00 ; 0.02]	0.000 [0.00 ; 0.00]

Table 16: Counterfactual exercises - Average number of suppliers lost and average productivity losses implied by increases in fixed costs of transaction using the Probit estimates as baseline

[p5-p95] range in brackets

Scenario 1: 25% reduction in the unconditionnal probability of a transaction	Scenario 2: 50% reduction in the unconditionnal probability of a transaction
TFP	TFP
-0.007	-0.016
$[-0.02\,;\,-0.00]$	$[-0.04\,;\,-0.00]$

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Governor of the National Bank of Belgium

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