

Outsourcing and the Division of Labor between Firms : Evidence from Swedish Cities*

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Abstract

Firms increasingly engage in task outsourcing. This form of outsourcing has the potential to raise aggregate productivity by facilitating the division of labor between firms. In this paper, we develop a model of trade in tasks in which the task scope of manufacturers and providers is endogenous. In order to produce one unit of good, manufacturers have to perform a fixed range of tasks. However, they can outsource some tasks to providers, which do not produce any good and cannot outsource, but have the possibility to sell tasks to different manufacturers. Our key assumption is that the marginal cost of producing a given task is an increasing function of the number of tasks performed in-house both for manufacturers and providers. The manufacturer decision to outsource therefore results from a trade-off between the efficiency gains stemming from its specialization in terms of task scope and the cost of contracting with specialized providers in an imperfect contracting environment. The model generates gains from larger market size through a specialization effect: aggregate productivity rises, manufacturers are more specialized, providers are more specialized and their relative number increases. We then use detailed Swedish data on the number of occupations performed by workers to test these predictions. We find evidence that manufacturing firms and providers perform fewer tasks in-house in larger cities.

Keywords: service outsourcing, division of labor, productivity, specialization.

JEL codes: F10, F43, L24, R10.

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1 Introduction

There is by now large empirical evidence that firms outsource an increasing range of activities to independent suppliers, be they located in the domestic economy or abroad. However, the nature of outsourcing is changing. While it has long involved trade in intermediate inputs, it increasingly involves trade in tasks. Firms not only outsource the production of components to inputs providers but also the tasks related to human resources to recruitment companies, the development of software to external IT engineers, the after sales services to call-centers, and the cleaning of offices to cleaning companies. An important implication of this organizational change is that it reinforces firm's specialization. Firms perform in-house only a small range of all the activities actually involved in the sale of their finished product, outsourcing the remaining ones to suppliers. In turn suppliers become increasingly specialized and each performs a range of activities that they sell to different companies. For instance the competitors IBM and Compaq outsource the production, the delivery and the invoicing of their computers to the same company Ingram (Fontagné and Lorenzi, 2005).

Adam Smith (1776) argued that the *division of labor between workers* would generate greater efficiency in production:

“The greatest improvement in the productive powers of labor, and the greater part of the skill, dexterity, and judgment with which it is any where directed, or applied, seem to have been the effects of the division of labor.” (Book I, Chapter I)

In this paper, we argue that in modern economies, outsourcing facilitates the *division of labor between firms*. It induces firm specialization and has therefore the potential to generate large productivity gains.

The idea that outsourcing can enhance a firm productivity has already been highlighted. The business and management literature emphasizes that by outsourcing their non-core activities to external suppliers, firms can focus on their core activities and increase their productivity (see inter alia Quinn and Hilmer (1994)). In the economic literature, theoretical studies consider that the benefits in terms of firm productivity arising from running a smaller and more specialized organization are a key determinant of the make-or-buy decision (see in particular Grossman and Helpman (2002)). On the empirical side, a number of studies give evidence that outsourcing contributes to an increase in firm level productivity (Abramovsky and Griffith (2009), Amiti and Wei (2009)).

In this paper, we contribute to this literature by investigating the macroeconomic implications of this organizational change. We develop a model of trade in tasks in

which the scope of tasks performed by manufacturers and providers is endogenous. In order to produce one unit of a differentiated good, manufacturers have to perform a fixed range of tasks. However, manufacturers have the option to outsource some tasks to providers. Providers do not produce any good and cannot outsource, but perform tasks that they each sell to all manufacturers. The key assumption in the model is that the marginal cost of producing a given task increases in the number of tasks performed in-house, both for manufacturers and providers. The manufacturer decision to outsource therefore results from a trade-off between the efficiency gains stemming from its specialization in terms of task scope and the cost of contracting with different providers in an imperfect contracting environment, which implies that manufacturers have to share their revenue with the providers. As providers also become more efficient the narrower is their task scope, they also have an incentive to specialize in the performance of fewer tasks.

The model yields several new theoretical predictions. First, manufacturers and providers perform fewer tasks in-house in larger markets. Second, aggregate productivity rises as both manufacturers and providers become more specialized in terms of task scope. Indeed, when the size of the economy increases, manufacturers decrease the scope of tasks performed in-house and expand output per variety. This translates into a higher demand for outsourcing, this favors the entry of providers and they each become more specialized. The model therefore generates gains from trade or larger market size through a “specialization effect” rather than through the variety effect standard in models with CES preferences.

The main predictions of the model are tested using a Swedish dataset which contains detailed information on the occupation of all workers employed in the private sector at the plant level. This dataset enables us to construct a proxy of the number of tasks performed in-house in manufacturing plants (manufacturers) and service plants (providers). We also match the location of plants at the city level with the size of the cities (as proxied by population size). The results show that both types of plants tend to perform fewer tasks in-house in larger cities. We also find that the number of providers is higher in larger cities. As predicted by the model, firms are more specialized in terms of task scope in large cities.

Our theoretical framework is inspired by several literatures. A first body of the literature analyzes the determinants of the make-or-buy decision and highlights the existence of a trade-off between outsourcing and vertical integration. Outsourcing to specialists lowers production costs but is associated to costly search and contractual frictions, see in particular Grossman and Helpman (2002) and Antràs and Helpman (2004). These models mainly focus on the decision to outsource or not. The present

model examines the extent of outsourcing (how many tasks should be performed in-house). Furthermore the model focuses on task outsourcing rather than outsourcing of manufactured inputs. A second body of the literature has modeled international trade in tasks. In these models, trade in tasks can arise between countries which differ in factor endowments (Grossman and Rossi-Hansberg (2008b)), between countries which differ in size (Grossman and Rossi-Hansberg (2008a)), or in response to exogenous changes in the cost of moving goods and ideas (Baldwin and Robert-Nicoud (2010)). We build on these models by assuming that the production of a manufactured good requires the performance of a continuum of tasks. However, in our model, trade in tasks between manufacturers and providers arises in an autarky setting due to the efficiency gains stemming from adjustments in tasks scope. Finally our model, which assumes homogeneous firms, predicts that a larger market size or a trade liberalization leads to productivity gains at the aggregate level, as in the heterogeneous firm literature (Melitz (2003)). In this literature, this is due to reallocation of production across heterogeneous firms whose productivity is given. In the present model the reallocation of tasks across firms with homogeneous productivity generates productivity gains that are *internal* to the firm.

Our model predicts that larger markets are more efficient. The existence of a positive correlation between output per capita and city size has been largely documented in the empirical literature, see in particular (see Rosenthal and Strange (2004); Combes, Duranton, and Gobillon (2008)). Several channels have been proposed to explain this result. In our model, productivity is higher in large markets due to the division of labor between firms, and their deeper specialization. Our empirical strategy tests the effect of the market size on the degree of firms' specialization. We find suggestive evidence that the division of labor between firms is actually deeper in larger cities. Our paper therefore complements the study of Duranton and Jayet (2011) who find that the division of labor between workers is limited by the extent of the market.

The remainder of this paper is organized as follows. Section 2 describes the model we have developed. Section 3 presents the testable predictions and the data we use. Section 4 presents the results. Section 5 concludes.

2 A simple model

We begin by presenting our theoretical setting which is developed in an autarky framework. We then describe the equilibrium and the main predictions of the model.

2.1 Theoretical set up

The model depicts an economy with a primary production factor labor, L , which is used in all sectors. The economy includes three sectors: the agricultural sector which is a Walrasian, homogeneous-good sector, the manufacturing sector, which is characterized by Dixit-Stiglitz monopolistic competition and the provider sector, which consists of the providers to which manufacturing firms can outsource some of the tasks needed in the production of their final good. In this sector, providers do not produce any consumption good and cannot outsource, but instead perform tasks for manufacturing firms. All sectors have free entry and firms therefore make zero profit in equilibrium. All firms are assumed to be homogeneous in terms of productivity.

2.1.1 Demand

Consumers have two-tier utility functions with the upper tier (Cobb-Douglas) determining the consumer's allocation of expenditure among the two consumption goods and the lower tier (CES) dictating the consumer's preferences over the differentiated varieties the manufacturing composite good. More specifically, individuals have the following utility function

$$U = C_M^\mu C_A^{1-\mu}, \quad (1)$$

where $\mu \in [0, 1]$, C_A is the consumption of the homogeneous good and C_M is the consumption of the manufacturing composite good. The utility function stemming from the consumption of the manufacturing composite good is defined by

$$C_M = \left[\int_0^N c_M^{\frac{\sigma-1}{\sigma}} d_M \right]^{\frac{\sigma}{\sigma-1}}, \quad (2)$$

N being the mass of varieties consumed, c_M the amount of variety M consumed and $\sigma > 1$ the constant elasticity of substitution between varieties. Each consumer spends a share μ of his income on the composite manufacturing good, the demand for a variety M is therefore

$$q_M = \frac{p_M^{-\sigma}}{P^{1-\sigma}} \mu Y, \quad (3)$$

where p_M is the consumer price of variety M , Y is income and $P \equiv \left(\int_0^N p_M^{1-\sigma} d_M \right)^{\frac{1}{1-\sigma}}$ the price index of manufacturing varieties. For ease of notation, we rewrite it as $q_M = A p_M^{-\sigma}$ where $A \equiv \frac{\mu Y}{P^{1-\sigma}}$ is taken as given by each manufacturing firm.

2.1.2 Technologies

The agricultural sector

Starting with the agricultural sector, it is characterized by perfect competition and constant returns to scale. Producing one unit of the homogeneous good requires one unit of labor. Since it is chosen as the numeraire and labor is assumed to be perfectly mobile between sectors, this gives $p_A = w = 1$, w being the nominal wage of workers. This also means that $Y = L$, Y being the aggregate income and L the number of workers in the economy. As standard in such models, the agricultural sector is therefore introduced only to normalize nominal wages to unity.

The manufacturing sector

We now turn to the presentation of the technologies in the manufacturing sector. We assume that in order to produce one unit of a variety of a differentiated good, manufacturers have to perform a fixed range of tasks, indicated by j and ranging from 0 to 1, in fixed proportions. More specifically, we assume that the production function is of Leontief type and given by

$$q_M = \min_{j \in [0,1]} (q(j)). \quad (4)$$

where q_M is the output produced by a manufacturer and $q(j)$ is the quantity of each task $j \in [0, 1]$ required in the production of q_M . Cost minimization means that the demand for each task j given the output level is

$$q(j) = q_M \quad \forall j \in [0, 1] \quad (5)$$

This means that in equilibrium, the quantity demanded for each task $j \in [0, 1]$ is proportional to the output level of the manufactured good.

Regarding production costs, manufacturing firms face two costs, a fixed cost f_M and a variable production cost C . As manufacturers can outsource the production of some tasks to providers, the latter depends on the cost of performing tasks in-house and on the cost of tasks outsourced

$$C = w \overbrace{\int_0^1 \gamma(j) q(j) \tilde{\varphi}_M(j) dj}^{\text{Tasks performed in-house}} + \overbrace{\int_0^1 (1 - \gamma(j)) q(j) p_S(j) dj}^{\text{Outsourced tasks}} \quad (6)$$

where $\gamma(j) \in \{0, 1\}$, equals 1 if the firm performs the task j in-house and 0 if it is outsourced.

Regarding the production cost of tasks performed in-house, it depends on the wage w which is normalized to unity, on the number of task j performed in-house, on the

quantity of each task j performed in-house $q(j)$ and on the marginal cost of performing each task j , $\tilde{\varphi}_M(j)$. The key assumption is that this marginal cost increases in the average distance of task j to all other tasks j' performed within the firm

$$\tilde{\varphi}_M(j) = \frac{\int_0^1 (j' - j)^\delta \gamma(j') dj'}{\int_0^1 \gamma(j') dj'}. \quad (7)$$

where $\delta > 1$ to attain a convex relationship between task scope and marginal cost, where δ is restricted to the set of *even* numbers and where $\gamma(j') \in \{0, 1\}$.¹

The parameter δ is therefore key in the model. It measures how much more expensive it is to produce multiple tasks when they lie far from each other or, equivalently, how expensive it is for a firm to operate a wide task scope. The higher is δ , the higher the benefits from firm specialization in terms of task scope.

This assumption that the cost of performing a given task increases in a firm's task scope is founded upon our belief that it is more costly for firms to perform tasks of very different nature than to specialize in a narrower range of tasks. This is essentially how we capture Adam Smith's argument of the division of labor and apply it to firms. A firm that specializes in just a few tasks that are close to each other in nature will be more productive in the performance of each of these tasks than a firm that does a lot of different tasks. The intuition regarding the cost function is that if tasks are arranged along a line, tasks located close to each other are more similar in nature. Along the same argument, the further away two tasks are, the more different they are. Consider the following tasks: (i) hammering the pins so that they are completely straight, (ii) hammering the end of the pin so that it has a flat end, (iii) cleaning the factory floor and, (iv) disposing of waste created in the manufacturing process. This may be very stylized but tasks (i) and (ii) are likely to be more similar in nature than say (i) and (iii). This assumption about the marginal cost per task ensures first that it is less costly to perform tasks (i) and (iii) than all the four tasks, but more importantly, that it is less costly to perform tasks (i) and (ii) than tasks (i) and (iii).

The reduction in the marginal cost stemming from a reduction in task scope provides an incentive to outsource. A manufacturing firm can thus either perform a task and pay $w\tilde{\varphi}_M(j)$ per unit or procure it from a specialized provider at the price $p_S(j)$ per unit. As it will be clarified shortly, p_S represents a share of the manufacturer revenue

¹As it will be clarified shortly, the cost of performing each task j when a manufacturer performs t_M tasks in-house simplifies to $\varphi_M(t_M) = \lambda_1 t_M^\delta$ and is therefore an increasing function of a manufacturer task scope.

rather than a constant price. The manufacturing firm's total cost is therefore:

$$TC_M = f_M + w \overbrace{\int_0^1 \gamma(j) q(j) \tilde{\varphi}(j) dj}^{\text{Tasks performed in-house}} + \overbrace{\int_0^1 (1 - \gamma(j)) q(j) p_S(j) dj}^{\text{Outsourced tasks}}. \quad (8)$$

The provider sector

Now, regarding the provider sector, providers do not produce any good and cannot outsource. However they produce a set of tasks that they each sell to all manufacturers n_M . They face a similar cost structure as the one of the manufacturers. First they pay a fixed cost f_S . Second, they face a marginal cost per task, $\tilde{\varphi}_S(j)$, that increases in its average distance from all other tasks j' performed within the firm. The total cost of the provider S is therefore:

$$TC_S = f_S + wn_M \int_0^1 \gamma(j) q(j) \tilde{\varphi}_S(j) dj \quad (9)$$

where

$$\tilde{\varphi}_S(j) = \frac{\int_0^1 (j' - j)^\delta \gamma(j') dj'}{\int_0^1 \gamma(j') dj'}. \quad (10)$$

where w is the wage normalized to unity, n_M is the number of manufacturers and $\gamma(j') \in \{0, 1\}$. This cost structure provides an incentive to providers to specialize in the performance of some of the tasks outsourced by manufacturers that they each sell to all manufacturers. Modern examples of this type of “task outsourcing” refer, for instance, to the recent emergence of firms specialized in accounting or in the recruitment of workers. In each case, this company provides a service which is specific to a manufacturer but can still provide different services to different manufacturers.

2.2 Production structure of the economy

To sum up, the manufacturing production process of one unit of a final differentiated good involves two types of firms: manufacturers and providers. The production of each variety of consumer goods requires specific tasks. More precisely, in order to produce one unit of a differentiated good, manufacturers have to perform a fixed range of tasks which have to be customized for its needs. However, these tasks can be performed in-house or outsourced to providers. Indeed, the reduction in marginal cost stemming from a reduction in a manufacturer task scope provides an incentive to outsource the performance of some tasks to providers. Providers, on the other hand, specialize in the performance of some tasks. They perform specific task for each manufacturer but can perform them for different manufacturers. To illustrate it, let's take the exemple of a

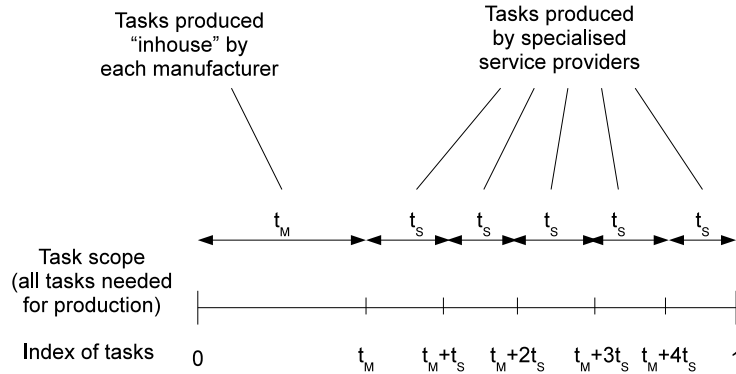


Figure 1: The structure of task production.

provider which does accounting for different companies. The provider writes specific reports for each manufacturer as the accounting report for one manufacturer has no relevance for another manufacturer. However, it can sell the same tasks of writing accounting reports to different manufacturers. In this simple framework, the provider can do specific accounting reports for each manufacturer without any costs and sell the tasks of writing reports to different manufacturers. However, the accounting report made for one manufacturer has no other value to other manufacturer. This setup is illustrated in figure 1. The line going from 0 to 1 describes all the tasks that have to be performed so that a manufacturer is able to produce one unit of a final differentiated good. Suppose that a manufacturer performs a range t_M of tasks in-house. Since in the model, firms have an incentive to perform tasks which are adjacent to each other, we can for simplicity assume that along the line, the manufacturer performs the tasks going from 0 to t_M in-house when its task scope is t_M . Providers produce therefore all the tasks $(1 - t_M)$ which are not performed by manufacturers and each is specialized in a different task scope t_S . As they are assumed to be homogeneous, they each produce a range of task t_S such that $(1 - t_M) \equiv n_S t_S$ where n_S denotes the number of service providers. In other words, each provider specializes in the performance of t_S tasks needed in the production of one unit of final good, where $t_S \equiv \frac{1-t_M}{n_S}$.

We therefore have to make assumptions about the trade structure between manufacturers and providers. Following Williamson (1975, 1985) and Grossman and Hart (1986), an important literature has highlighted the role of transaction costs, asset specificity and incomplete contracts in the make-or-buy decision. We follow the recent literature on outsourcing by considering an environment which is characterised by incomplete contracts and where all activities that providers undertake for manufacturers are relationship specific (see in particular Grossman and Helpman (2002), Acemoglu, Antràs, and Helpman (2007) and Antràs and Helpman (2004)).

In our model, the outsourcing decision is influenced by a trade-off between the benefits of specialization and the costs of outsourcing in an imperfect contracting environment.² In our setting, providers can sell tasks to different manufacturers but all tasks are relationship-specific, meaning that they are specialised such that they can only be used by the final good manufacturer for which they were intended. Moreover, we assume that once it is decided that the manufacturer should use a certain provider's inputs, it cannot use any other provider's inputs nor produce these inputs on its own. Turning to the contracting environment, it is assumed that some of the attributes of inputs produced by providers are not verifiable by third parties. In such an imperfect contracting environment, it is impossible for parties to write contracts *ex ante* on the quantity and price of inputs that is finally delivered *ex post*. This results in a hold-up problem. After the production of tasks has taken place, final good producers can theoretically choose not to accept the tasks delivered by providers unless the price is sufficiently low. However, if providers would choose not to deliver their tasks, final good producers would produce zero output. The payment to providers and the quantity they produce are therefore non-contractible and subject to *ex post* bargaining.

We therefore assume exogenously that manufacturers and providers are paid a share of the revenues generated by the sales of the final good which is equal to their respective share of the inputs used in the production of the final good.³ A manufacturer that produces a range t_M tasks inhouse and outsources $1 - t_M$ tasks is therefore paid a share t_M of revenues generated by the sales of the final good. A provider producing a range of t_S of the inputs for a final good producer is paid a share t_S of the revenues generated by the sales of this good.

Moreover, since the true quality cannot be verified by a court of law, providers can maximise profits by determining the quantity they deliver. Due to the production function described in equation (4), providers therefore also determine the quantity produced of the final good (which is similar to Grossman and Helpman (2002) and Antràs

²Grossman and Helpman (2002) develop a theoretical framework to examine an industrial structure in which vertical integration and outsourcing are treated as equilibrium phenomena. In modelling the determinants of the mode of organization, they highlight the existence of a trade-off between the costs of running a larger and less specialized organization and costs that arise from incomplete contracts and search frictions. They make two assumptions about search frictions. First, they assume constant returns to scale in search, introducing such search frictions should not change our main result. Then, they assume increasing returns to scale in search and their model predicts that outsourcing is more likely to be viable in larger markets, due to the benefits of having a thicker market. Adding such type of search frictions should strengthen our result about market size, outsourcing and firm specialization.

³Grossman and Helpman (2002) assume an exogenous bargaining power parameter for suppliers, but in our model each manufacturer bargains with multiple providers. A strict application of the Shapley value principle (see Shapley (1953)) if we assume that all intermediate products are produced before bargaining takes place, however, would give every party, including the manufacturer, $\frac{1}{n_S+1}p_M q_M$, since revenues are zero in all possible coalitions in which not all parties are included. We believe, however, that it is substantially more realistic to assume that each participant receives a share of the revenue which is proportional to its input contribution to the production of the final output.

and Helpman (2004)). The profit maximisation problem for final good producers is therefore to determine the optimal range of tasks which should be outsourced.⁴

The sequence of events in the economy is therefore as follows. Manufacturers and providers enter the market and pay the relevant entry costs. Manufacturers decide on their task scope t_M and describe their task requirements to providers. Providers position themselves on the range of tasks not produced by manufacturers and decide on the quantity q_S of each task they produce. Then, providers and producers adjust their production systems and after this point they cannot shift the source or destination of inputs. Production thereafter takes place of intermediate inputs and final goods and the bargaining causes the revenues from the sales of final goods to be distributed as described above. Manufacturers get a share t_M of their revenue and each provider gets a share t_S of each manufacturer's revenue. Finally, consumption takes place.

For completeness, the specific conditions used to close the model are:

1. *Consumers maximize utility through consumption given their income.*
2. *Manufacturers maximize their profits by determining their task scope, taking output as given since it is determined by the providers.*
3. *Service providers maximize their profits by determining the quantity of each task to produce taking their task scope as given. Due to the Leontief production function, they thereby determine the manufacturer output.*
4. *Manufacturers earn zero profits due to free entry.*
5. *Task providers earn zero profits due to free entry.*

Together, these conditions determine in equilibrium the output level of each final good and each task (q), the price of each final good (p), the task scope of manufacturers (t_M), the task scope of each provider (t_S), the number of manufacturers (n_M), the number of providers (n_S), the price index for manufacturing varieties (P), and welfare (W).

2.3 The autarky equilibrium

We start by computing the profits of a manufacturer. The total profit, π_M , of a manufacturer is:

$$\pi_M = p_M q_M - f_M - \overbrace{\int_0^1 \gamma(j) q_M(j) \tilde{\varphi}_j(j) dj}^{\text{Tasks performed in-house}} - \overbrace{\int_0^1 (1 - \gamma(j)) q_M(j) p_S(j) dj}^{\text{Tasks outsourced}}. \quad (11)$$

⁴While our setup is similar to Grossman and Helpman (2002) and Antràs and Helpman (2004), in their models the decision of final good producers is on the *extensive* margin, i.e. whether to outsource all production or none (which in our model is similar to setting t_M equal to 0 or 1). In our model, however, the final good producer sets t_M in the space $(0, 1)$ which means that its decision is on the *intensive* margin.

where

$$\tilde{\varphi}(j) = \frac{\int_0^1 (j' - j)^\delta \gamma(j) dj'}{\int_0^1 \gamma(j) dj}.$$

is the cost of performing tasks in-house. It depends on the number of tasks performed in-house and on the cost of performing each task. If the tasks are ordered on a line between 0 and 1, we can, for simplicity, assume that the tasks performed in-house are in the range between 0 and t_M , where t_M is determined endogenously. With this setup, the marginal cost of performing a specific task j when the manufacturer task scope is t_M is given by

$$\begin{aligned} \tilde{\varphi}(j) &= \frac{\int_0^1 (j' - j)^\delta \gamma(j) dj'}{\int_0^1 \gamma(j) dj} \\ &= \frac{\int_0^{t_M} (j' - j)^\delta dj'}{\int_0^{t_M} dj} \\ &= \frac{1}{t_M} \int_0^{t_M} (j' - j)^\delta dj' \\ &= \frac{1}{t_M(\delta + 1)} \left((t_M - j)^{\delta+1} - (-j)^{\delta+1} \right). \end{aligned} \quad (12)$$

This means that the average marginal cost for performing t_M tasks in-house is

$$\begin{aligned} \varphi_M(t_M) &= \frac{1}{t_M} \int_0^{t_M} \tilde{\varphi}_M(j) dj \\ &= \frac{1}{t_M^2(\delta + 1)} \int_0^{t_M} \left((t_M - j)^{\delta+1} - (-j)^{\delta+1} \right) dj \\ &= \lambda_1 t_M^\delta \end{aligned} \quad (13)$$

where $\lambda_1 \equiv \frac{2}{(\delta+1)(\delta+2)}$. This cost therefore more than increases in the scope of tasks that are performed in-house.

We now turn to the cost of outsourcing some tasks. Due to the competition structure described above, the manufacturer pays to the providers a share of its revenue which is equal to their contribution to the production of one unit of output. If the manufacturer performs t_M tasks in-house, this means that providers produce the rest of the $(1 - t_M)$ tasks that need to be performed to produce one unit of output. The cost for the manufacturer to buy tasks outsourced is therefore

$$(1 - t_M) p_M q_M.$$

The profit of a manufacturer can then be rewritten as:

$$\pi_M = p_M q_M - t_M \varphi_M(t_M) q_M - (1 - t_M) p_M q_M - f_M. \quad (14)$$

We now turn to the profit of a provider. It faces a cost structure similar to the one of a manufacturer. In order to produce, a provider faces a fixed entry cost f_S and a variable cost. Regarding the latter, the marginal cost of producing a given task increases with the scope of tasks it produces. The average marginal cost of performing t_S tasks in-house, where t_S is determined endogenously, is given by

$$\varphi_S(t_S) = \lambda_1 t_S^\delta. \quad (15)$$

A provider gets paid a fraction of the manufacturer revenue which is equal to its contribution to the production of one unit of output. A provider which performs t_S tasks therefore gets paid $t_S p_M q_M$ per manufacturer. However, as a provider produces each of these tasks for all manufacturers, a provider gets paid

$$n_M t_S p_M q_M.$$

Therefore, the profits of a provider are

$$\pi_S = n_M t_S p_M q_M - n_M t_S \varphi_S(t_S) q_S - f_S. \quad (16)$$

Since the provider has the same output of a task as the manufacturer has of its final good, due to the Leontief production function in (4), we denote hereafter output of both items simply as q where $q = q_M = q_S$.

We can now turn to the maximization problems of a provider and of a manufacturer. Starting with the provider, it produces t_S tasks, taking demand $q = A p_M^{-\sigma}$ and the task scope of manufacturers t_M as given and knowing that $\varphi_S(t_S) = \lambda_1 t_S^\delta$. At this point, it also takes its own scope, t_S , as given. It faces the problem of which quantity q of each task to produce. The provider maximization problem is therefore

$$\max_q \pi_S = n_M t_S A^{\frac{1}{\sigma}} q^{\frac{\sigma-1}{\sigma}} - n_M \lambda_1 t_S^{\delta+1} q - f_S \quad (17)$$

which gives the following first order condition:

$$q = \left(\frac{1}{\tilde{\sigma} \lambda_1 t_S^\delta} \right)^\sigma A \quad (18)$$

where $\tilde{\sigma} \equiv \frac{\sigma}{\sigma-1}$. This gives the optimal output for a provider given its own task scope

and the manufacturer's task scope. As expected, the output of a provider increases in demand A and a higher elasticity of substitution between manufacturing varieties makes output more sensitive to marginal costs. Finally the output of a provider decreases in its own task scope t_S as a higher task scope translates into a higher marginal cost.

We can now turn to the manufacturer maximization problem. As stated before, the manufacturer decides over its task scope, taking output chosen by the provider as given and knowing that the average cost of performing t_M tasks in-house is $\varphi_M(t_M) = \lambda_1 t_M^\delta$. A manufacturer maximization problem is therefore

$$\max_{t_M} \pi_M = A^{\frac{1}{\sigma}} q^{\frac{\sigma-1}{\sigma}} t_M - \lambda_1 t_M^{\delta+1} q - f_M, \quad (19)$$

which gives the following first order condition:

$$t_M = \left(\frac{1}{\lambda_1 (\delta + 1)} A^{\frac{1}{\sigma}} q^{-\frac{1}{\sigma}} \right)^{\frac{1}{\delta}}. \quad (20)$$

The solution for t_M above gives the solution for a manufacturer's optimal task scope given the quantity produced by each provider. We know the output of a provider from (18) and t_M can therefore be written as:

$$t_M = t_S \left(\frac{\tilde{\sigma}}{\delta + 1} \right)^{\frac{1}{\delta}} \quad (21)$$

This means that there is a monotonic and linear relationship between the task scope of a manufacturer and that of the service suppliers. The reason for this is simply that a higher task scope of providers, t_S , make them less specialized and therefore less efficient. Outsourcing is less attractive, manufacturer perform relatively more tasks in-house and t_M raises.

We now turn to the free entry condition in the manufacturing sector

$$\begin{aligned} \pi_M &= 0 \\ \Leftrightarrow A &= t_S^{\delta(\sigma-1)-1} \lambda_1^{\sigma-1} \tilde{\sigma}^{\sigma-1} \left(\frac{\delta + 1}{\tilde{\sigma}} \right)^{\frac{1}{\delta}} \left(\frac{\delta + 1}{\delta} \right) f_M \end{aligned} \quad (22)$$

which returns in a relationship between A , the demand per firm in the economy, t_S , the task scope of providers, and f_M , the fixed entry cost of manufacturers.

We now turn to the free entry condition for providers which will drive down their task

scope, t_S , such that they earn zero profits in equilibrium:

$$\begin{aligned} \pi_S &= 0 \\ \Leftrightarrow n_M &= \frac{f_S}{f_M} \frac{\tilde{\sigma}}{\tilde{\sigma} - 1} \frac{\delta}{\delta + 1} \left(\frac{\tilde{\sigma}}{\delta + 1} \right)^{\frac{1}{\delta}}. \end{aligned} \quad (23)$$

The free entry condition for providers yields a solution for the number of manufacturing firms, n_M which depends only on exogenous parameters. Note that the number of manufacturers is independent of population size. This absence of “variety effect” may appear counter intuitive in a model with CES preferences. However, the reason for n_M being fixed stems from the fact that all surplus profits coming from an expansion in market size are passed on to the provider side given this particular setting, as it will be clarified shortly.

Knowing this, we can use the expression for A to find the solution for the optimal provider task scope t_S

$$\begin{aligned} \frac{\mu L}{P^{1-\sigma}} &= t_S^{\delta(\sigma-1)-1} \lambda_1^{\sigma-1} \tilde{\sigma}^{\sigma-1} \left(\frac{\delta + 1}{\tilde{\sigma}} \right)^{\frac{1}{\delta}} \left(\frac{\delta + 1}{\delta} \right) f_M \\ \Leftrightarrow t_S &= \frac{f_S}{\mu L} \frac{\tilde{\sigma}}{\tilde{\sigma} - 1} = \frac{\sigma f_S}{\mu L} \end{aligned} \quad (24)$$

The task scope of a provider increases in the fixed entry costs of providers but more importantly decreases with the size of the economy. Providers are therefore more specialized in terms of task scope in larger economies.

Using the result from (24), we can find a solution for the optimal task scope of a manufacturer t_M

$$\begin{aligned} t_M &= t_S \left(\frac{\tilde{\sigma}}{\delta + 1} \right)^{\frac{1}{\delta}} \\ &= \frac{\sigma f_S}{\mu L} \left(\frac{\sigma}{(\sigma - 1)(\delta + 1)} \right)^{\frac{1}{\delta}}. \end{aligned} \quad (25)$$

The tasks scope of a manufacturer therefore increases in the fixed costs of entry providers as it make them less specialized and therefore less efficient, making the benefits of outsourcing smaller. However, consistent with the previous result, the tasks scope of a manufacturer decreases with population size. Manufacturers are therefore also more specialized in larger economies.

We can use the results from (24) and (25) to find a solution for the number of providers

$$\begin{aligned} n_S &= \frac{1 - t_M}{t_S} \\ &= \frac{L - \lambda_2 \lambda_3}{\lambda_3}. \end{aligned} \quad (26)$$

where $\lambda_2 \equiv \left(\frac{\sigma}{(\sigma-1)(\delta+1)} \right)^{\frac{1}{\delta}}$ and $\lambda_3 \equiv \frac{\sigma \delta f_S}{\mu}$. In this model therefore, the number of providers increases in the size of the economy. This is because a higher demand for manufacturing goods translates into a higher demand for tasks. This leads to the entry of more providers, to a reduction in their task scope and to an increase in the quantity of each task produced by providers. Given the Leontief production function, this means that the quantity produced of each variety increases, holding the number of varieties available in the economy (n_M), constant. Both manufacturers and providers are more specialized in terms of task scope in larger economies and therefore more efficient.

Finally we can find solutions for the remaining variables of interest. A is given by

$$A = \left(\frac{1}{\mu L} \right)^{\delta(\sigma-1)-1} f_S^{\delta(\sigma-1)} \left(\frac{\tilde{\sigma}}{\tilde{\sigma}-1} \right)^{\delta(\sigma-1)-1} \lambda_1^{\sigma-1} \tilde{\sigma}^{\sigma-1} \left(\frac{\delta+1}{\tilde{\sigma}} \right)^{\frac{1}{\delta}} \left(\frac{\delta+1}{\delta} \right) \frac{f_M}{f_S}. \quad (27)$$

The general price index of the economy is:

$$P = \left(\frac{1}{\mu L} \right)^{\delta} f_S^{\delta} \left(\frac{\tilde{\sigma}}{\tilde{\sigma}-1} \right)^{\delta - \frac{1}{\sigma-1}} \lambda_1 \tilde{\sigma} \left(\frac{\delta+1}{\tilde{\sigma}} \right)^{\frac{1}{\delta(\sigma-1)}} \left(\frac{\delta+1}{\delta} \right)^{\frac{1}{\sigma-1}} \left(\frac{f_M}{f_S} \right)^{\frac{1}{\sigma-1}}. \quad (28)$$

The output per manufacturer is:

$$q = \mu L^{(\delta+1)} f_S^{-\delta} \left(\frac{\tilde{\sigma}-1}{\tilde{\sigma}} \right)^{(\delta+1)} \lambda_1^{-1} \tilde{\sigma}^{\sigma-1} \left(\frac{\delta+1}{\tilde{\sigma}} \right)^{\frac{1}{\delta}} \left(\frac{\delta+1}{\delta} \right) \frac{f_M}{f_S} \frac{1}{\tilde{\sigma}^{\sigma}}. \quad (29)$$

and the price per manufacturing good is :

$$p = \lambda_1 \left(\frac{\sigma}{\sigma-1} \right) \left(\frac{\sigma f_S}{\mu L} \right)^{\delta}. \quad (30)$$

Thus the output of a manufacturer increases in market size while the price per manufacturer and the general price index of the economy decrease in market size.

Finally, one might wonder how the welfare, given by the real wage $W = P^{-\mu}$, is influenced by market size. In order to do so we compute the elasticity of the price index P to market size L :

$$\frac{dP}{dL} \frac{L}{P} = \underbrace{-\delta}_{\text{“Specialization effect”}}. \quad (31)$$

This elasticity is negative and equal to $-\delta$, where δ is a key parameter in the model as it measures the cost to perform tasks which lie far from each other within the firm, or, equivalently, how much firms can benefit from specialization. The model therefore predicts that in larger markets the general price index of the economy decreases due to the benefits from firm specialization in terms of task scope. It generates therefore a new gain from trade or larger market size through a specialization effect. These gains are moreover higher the higher the decrease in marginal cost stemming from a reduction in task scope.

Theorem 1 *Larger economies are associated with more specialization in terms of task scope, higher productivity and higher welfare. The elasticity of these relationships is greater the higher is the cost for firms to engage in many tasks simultaneously.*

The model generates gains from larger market size through a specialization effect rather than through the usual variety effect generated by models building Dixit Stiglitz utility structures such as in Krugman (1980).⁵ In standard new trade theory models, firms maximize profits by setting an optimal price which is a constant markup over marginal costs. The marginal cost being constant, both the optimal price and the optimal output per firm are constant in equilibrium. Therefore, the only adjustment margin when the size of the economy rises, is through the entry of new firms. As consumers access more varieties, the general price index decreases and welfare increases. In this paper, we modify the standard model by assuming that manufacturers can outsource the performance of some of the tasks needed in their production process to specialized suppliers, leading to a decrease in their marginal costs. A key assumption in the model is that both manufacturers and providers become more efficient when they specialize in terms of task scope. This affects the profit maximization behavior of firms. Manufacturers maximize profits by choosing their task scope and providers maximize profits by choosing the optimal quantity per task they perform, which, given the Leontief production assumption, determines the manufacturer's level of output. The optimal price and the output per manufacturer are no longer constant as they depend on market size. Thus, when the size of the market increases, the optimal price decreases as both manufacturers and providers reduce their task scope, the output per firm rises and there is entry on the providers market, holding the number of manufacturers constant in equilibrium. Welfare still increases as consumers access the same number of varieties but at a lower price. Welfare increases therefore in larger economies in this model due to a specialization effect.

⁵If it is assumed that trade liberalization can be proxied by an increase in population size, the model also predicts that trade liberalization leads to higher specialization of firms, higher productivity and higher welfare.

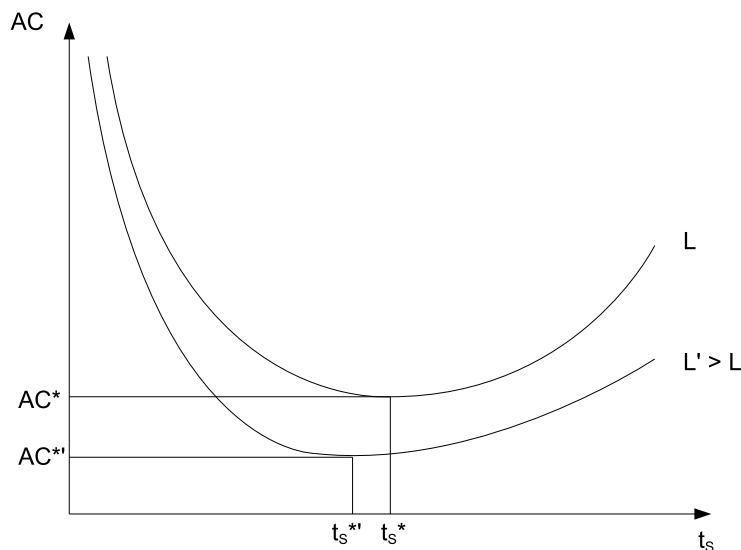


Figure 2: Average cost and task scope of providers when population size increases.

The key intuition behind the increase in specialisation that we observe is that a larger market also means a larger demand for each task. Every variety of consumption goods needs each task in its production so, regardless of whether a market size increase causes the number of varieties to expand or the quantity of each variety to rise (as in our model), a larger demand for manufacturing goods translates into increased demand for each task. This means that the average cost curve of providers falls when the size of the market increases. This can be seen from equation (9) and is illustrated in figure 2. Here, AC denotes the average cost curve and t_S the task scope of providers. Free entry in the provider market ensures that each firm operates at a minimum average cost which takes place at the point t_S^* . When the population size increases from L to L' , the average cost curve moves downwards and the new minimum average cost is attained at point $t_S^{*'} < t_S^*$. More specialised providers means that their marginal cost is lower which makes them produce a higher quantity since their prices are lower. In the aggregate, this lowers manufacturing prices and increases the quantity produced of each variety.

This gain from specialization is in line with Adam Smith's theory of the benefit of the division of labor. Smith (1776) argued that the division of labor *between workers* could generate a great increase in production as workers would specialize more. He also highlighted that larger markets would allow for a deeper division of labor

“There are some sorts of industry, even of the lowest kind, which can be carried on nowhere but in a great town. A porter, for example, can find employment and subsistence in no other place. A village is by much too

narrow a sphere for him;” (Book I, Chapter III)

Our model highlights, how in modern economies, outsourcing facilitates a division of labor *between firms*, and that its intensity is limited by the extent of the market.

3 Empirical strategy

The aim of this section is to verify if the main predictions of the models are corroborated by empirical evidence.

3.1 Main predictions

As stated above, the model predicts that in larger economies, aggregate productivity is higher because larger economies allow a deeper division of labor between firms. Indeed, in larger economies the demand for tasks outsourced by manufacturers is sufficiently high to favor the entry of providers which specialize in the performance of some tasks that they provide to all manufacturers. As the size of the economy grows, the number of providers increases and providers become more specialized, outsourcing becomes cheaper, both manufacturers and providers become more specialized and therefore more efficient. The model has thus three main predictions: (1) larger economies are more efficient, (2) manufacturers are more specialized in larger economies, (3) providers are more specialized in larger economies, and their number increases with the size of the economy. A number of precisions regarding our empirical strategy have to be made.

First, the model predicts that larger economies are more efficient. Given that our model is developed in the autarky case, we will carry out our empirical analysis at the national level and use the size of a city in Sweden as a source of variation in the size of the market. The first key prediction of the model, that firms are more efficient in larger cities, is perfectly consistent with the empirical evidence in the literature of a positive correlation between output per worker and city size. Research shows that a doubling in city size is associated with a 2 to 8% increase in productivity (see Rosenthal and Strange (2004); Combes, Duranton, and Gobillon (2008)).⁶ However there are several factors which are likely to positively influence the correlation between output per worker and city size, other than the division of labor between firms highlighted in this model. This can occur because more talented individuals sort into large cities, because large cities

⁶Rosenthal and Strange (2004) provide a comprehensive survey and conclude that a doubling in city size leads to an increase in productivity by an amount that ranges roughly from 3-8%. Combes, Duranton, and Gobillon (2008) go further in the analysis and control for skilled worker heterogeneity. They find, using French data, that the elasticity of wage with respect to local employment density is 2%.

select more productive entrepreneurs and firms, or because of agglomeration economies (Behrens, Duranton, and Robert-Nicoud, 2010). It can also occur because large cities allow a deeper division of labor between workers. Duranton and Jayet (2011) provide empirical evidence that specialists' occupations are overrepresented in larger cities in France. This implies that investigating empirically prediction (1) (larger economies are more efficient) would not allow us to validate our model given the existence of a number of potential alternative mechanisms for this result. We will therefore only test predictions (2) and (3), which are specific to our model.

Our model predicts that larger economies are more efficient because manufacturers and providers are more specialized in terms of task scope. We should therefore observe a positive relationship between a firm's degree of specialization (in terms of task scope) and city size. To our knowledge, this theoretical result is specific to our model and such an empirical relationship has not been investigated so far. A first challenge is to measure firm specialization. Our approach consists in measuring a firm's specialization by the number of different occupations workers are performing in-house, the underlying idea being that if manufacturers outsource some activities, the number of different occupations performed by workers should decrease, making the firm more specialized in terms of task (occupations) scope. However, a second challenge is that, in the model, both manufacturers and providers become more specialized when the size of the city grows, but for two different reasons. Regarding manufacturers, this is because they can outsource more. Regarding providers, this is because more providers can enter in larger markets and they each become more specialized. It seems therefore more appropriate to analyze empirically the case of manufacturers and providers separately. Given that our model of firm specialization bears on the idea that manufacturers increasingly outsource tasks related to service outsourcing (such as accounting, finance, human resources, IT services), in the empirical analysis, the manufacturing sector will be used as a proxy for the outsourcing sector and a selected number of service sectors will be used as a proxy for the provider sector.⁷

A last but important question remains about the geographical scale of the analysis. For the city to be the appropriate unit for the division of labor between firms to take place, it is required that there are costs in moving goods and outsourcing tasks between cities. This is obviously a strong assumption given that today, firms have access to markets that go way beyond their city boundaries, as shown by the importance of international trade and international outsourcing.⁸ The city might therefore not be

⁷In the case of Sweden, the intermediate use in service input by manufacturers has risen from 12% in 1975 to 25% in 2005, while the intermediate usage of goods in manufacturing output has remained stable (around 44%), according to the National Board of Trade (2010), who provides these numbers based on input-output tables from Statistics Sweden.

⁸According to the Swedish Trade National Board (2010), based on the input output tables, 17% of service input used by manufacturing firms in 2005 is imported while 83% remain domestic.

the appropriate unit for the division of labor to take place. We will therefore also try to construct a better proxy of the size of the market.

3.2 Data

Our aim is to verify whether, as predicted by the model, manufacturers and providers are more specialized in terms of task scope, i.e. perform a lower number of different occupations in-house, in larger cities than in smaller cities. We use data from the 2005 census of Statistics Sweden, the most recent year available. For our purpose, a cross-sectional approach is superior to using a panel estimation as city size changes only slowly over time. The initial dataset contains information on 2,563,771 individuals, including all individuals employed in the private sector in Sweden in 2005. Valuable for our purpose, this dataset contains information on the occupation for each employee. In Sweden, occupations are classified and coded according to The Swedish Standard Classification of Occupations 1996 (SSYK 96), which is a national adaptation of the International Standard Classification of Occupations (ISCO-88) published in 1990 by the International Labor Office, Geneva. The Swedish Standard Classification organizes occupations in a hierarchical framework. They are based on two main concepts: the concept of kind of work performed, defined as a set of tasks or duties designed to be executed by one person, and the concept of skill. The concept of skill takes into account the skill level (the degree of complexity of constituent tasks) and the skill specialization (the field of knowledge required for competent performance of the constituent tasks). This classification comprises 114 occupations at the 3-digit level and 355 occupations at the 4-digit level. In the former case, the classification is such that it is possible to know if an employee is a specialist manager, a business professional, a physical and engineering science technician, an industrial robot operator, a client information clerk or an helper and cleaner. At the 4-digit level, it is possible to know further if the manager is a finance and administration manager or a sales and marketing manager, if the business professional is an accountant or an organizational analyst and if the client information clerk is a receptionist or a telephone switchboard operator.

We are interested in the relationship between city size and the range of tasks performed within the firm. In the empirical analysis we proxy tasks by occupations. This level of classification of occupation does not describe all the different specific tasks involved in one occupation. However, the type of outsourcing described in the model is more related to occupations rather than to specific tasks, and this nomenclature of occupations is thus sufficiently high to capture the range of activities which are likely to be outsourced in the model.⁹ We then define the task scope of a firm, which will

⁹An important literature has investigated which tasks are more likely to be offshored (see in particular Blinder (2009)). In this literature, an occupation involves in itself a wide range of task

Table 1: Descriptive statistics

<i>Manufacturing Sample</i>						
Variables	Obs.	Mean	Stand. Dev.	Min	Max	Median
Number of Employees per plant	22,052	29.6	143.5	2	7311	7
Task scope / plant (# of 3-digit occupations)	22,052	5.8	5.7	1	61	4
Task scope / plant (# of 4-digit occupations)	22,052	6.2	7.1	1	96	4
Number of plants per city	289	76.3	120.8	13	1553	109
<i>Service Sample</i>						
Variables	Obs.	Mean	Stand. Dev.	Min	Max	Median
Number of Employees per plant	37,613	12.5	41.2	2	2257	4
Task scope / plant (# of 3-digit occupations)	37,613	3.7	3.4	1	53	3
Task scope / plant (# of 4-digit occupations)	37,613	3.9	4	1	85	3
Number of plants per city	289	130.1	514.3	4	7836	446

be our dependent variable, as a count of the number of different occupations which are performed by workers within a plant. This variable will be computed once at the 3-digit and once at the 4-digit level of occupations. We prefer to work at the plant-level rather than at the firm level as we consider that if a vertically integrated firm separates the location of tasks in two different plants, this can lead to benefits from specialization which are in line with our model. Multi-plants firms represent nevertheless a very small fraction of the final sample.

Turning to explanatory variables, we use the size of a plant (in terms of number of employees) in order to potentially control for plant heterogeneity. Finally and most importantly for our analysis, we define the location of each plant at the municipality level. Sweden is divided in 21 counties and each county is further divided into municipalities, ranging from only one (in Gotland County) to forty-nine (in Västra Götaland County). The total number of municipalities in Sweden is 289. In the empirical analysis, in line with the existing urban economic literature, the size of a municipality, referred hereafter as the size of a city, is proxied by its population.

Finally, for the reasons outline above, we limit our analysis to plants belonging to the manufacturing sector and to some service sectors more likely to encompass service outsourced by manufacturers, based on information regarding the main sector of activity of each plant (as defined by the NACE classification)¹⁰. Note that we lose many firms because of missing information on workers occupations (about 10% at

contents. However, when a firm decides to outsource some activities, such as accounting, it is likely to outsource all tasks needed to perform accounting. This is why occupations are a better proxy for measuring firms' task scope than tasks in their traditional definition.

¹⁰Based on the Statistical Classification of Economic Activities in the European Union (NACE), the service sectors included in the analysis are: Supporting and auxiliary transport services; Post and telecommunication services; Financial intermediation services, except insurance and pension funding services; Insurance and pension funding services, except compulsory social security services; Services auxiliary to financial intermediation; Real estate services; Renting services of machinery and equipment without operator and of personal and household goods; Computer and related services; Research and development services; and Other business services.

the 3-digit level and around 15% at the 4-digit level). We also drop all plants which comprise only one employee for two reasons. First it is unlikely that the mechanisms highlighted in the model lead to the extreme case of a one worker specialized firm. Second, and more importantly, self-employed firms are a way to get tax reductions in Sweden. Our final dataset consists of 22,052 plants in the manufacturing sector and 37,613 plants in the service sector. Table 1 reports some descriptive statistics about the main plant characteristics relevant for the empirical analysis.

4 Empirical analysis

4.1 City size and the specialization of manufacturers

4.1.1 City size and average industry plant task scope

The model predicts that manufacturing firms should be more specialized in terms of task scope in larger cities. We now describe a number of methodologies to test this prediction. We derive our first basic specification directly from equation (25) of the model. Firms being assumed symmetric in the model, this equation predicts that the average task scope of firms in a given industry decreases in the market size and increases in the fixed cost of entry for service providers. After a logarithmic transformation, this yields:

$$\log t_{M_{lc}} = \beta_0 + \beta_1 \log L_c + \beta_1 \log f_{S_l} + \varepsilon_{lc} \quad (32)$$

where $t_{M_{lc}}$ is the average number of occupations manufacturing plants have in sector l and city c , $\beta_0 \equiv \log \frac{\sigma}{\mu} \left(\frac{\sigma}{(\sigma-1)(\delta+1)} \right)^{\left(\frac{1}{\delta}\right)}$, L_c denotes the population size of city c and f_{S_l} is the fixed cost of entry of providers to which the manufacturing sector l outsources some tasks.

However, this specification has to be refined. First, the average degree of plant specialization is likely to differ across sectors l as the range of tasks needed to perform one unit of output is likely to vary across industries. Second, f_{S_l} , the cost of entry of providers to which the manufacturing industry l outsources is not observable. But as this fixed entry cost affects the cost of outsourcing in industry l , it also affects the degree of specialization in l . Finally, there might be other unobservable characteristics specific to an industry that affect the average task scope of a given industry in a city. We therefore modify equation (32) to control for industry fixed effects η_l and estimate:

$$\log t_{M_{lc}} = \beta_0 + \beta_1 \log L_c + \eta_l + \varepsilon_{lc} \quad (33)$$

Table 2 presents the results of the estimation of this basic specification. Here, the dependent variable, $t_{M_{lc}}$, is defined as the average the number of different occupations

Table 2: City size and average industry plant task scope in manufacturing sectors

	Log plant average task scope in sector l and city c (3-digit level of occupations)					
	computed at:	2-digit industry level			3-digit	4-digit
	(1)	(2)	(3)	(4)	(5)	(6)
City size	0.0277** (0.0124)	-0.0352*** (0.00601)	-0.0416*** (0.00579)	-0.0431*** (0.00596)	-0.0230*** (0.00490)	-0.0205*** (0.00432)
City-sector plant size _{2-digits}		0.478*** (0.00553)	0.478*** (0.00556)	0.481*** (0.00615)		
City-sector plant size _{3-digits}					0.531*** (0.00463)	
City-sector plant size _{4-digits}						0.547*** (0.00453)
Industry fixed effects	2-digits	2-digits	2-digits	No	No	No
Region fixed effects	No	No	Yes	No	No	No
Industry-region fixed effects	No	No	No	2-digits	3-digits	4-digits
Observations	3,851	3,851	3,851	3,851	7,860	10,145
R^2	0.145	0.769	0.772	0.803	0.829	0.847

Robust standard errors clustered at the municipality level in parentheses.

* significant at 10%, ** significant at 5%, *** significant at 1%.

performed within manufacturing plants in city c and sector l , where occupations are at the 3-digit level of occupations. Since the model predicts that specialization should increase with city size, the average industry plant task scope should decrease with city size, we therefore expect the coefficient associated with city size to be negative.¹¹ However, an industry can be defined at a broad level (2 digit), or at a more detailed level (3 digit or 4 digit). Throughout this paper, we will look at different levels of aggregation, to see whether results hold when the definition of an industry change. The first column of Table 2 presents the results of this basic specification when the average industry plants task scope is computed at the 2 digit industry level. There seems to be no negative correlation between the average task scope at the industry level and city size.

However, an important limit with equation (33) is that all sectors are not represented equally in all cities, see for example Mori, Nishikimi, and Smith (2005). If a given industry is larger in a city, the scale of plants and therefore their task scope are also likely to be larger. Though these scale effects are not embodied in our theoretical framework for sake of simplicity, they have to be taken into account, as other things being equal, one cannot attribute the same degree of specialization to two plants which largely differ in size. We therefore augment equation (33) and control for the average size of plants in industry l in city c , E_{lc} and estimate:

$$\log t_{M_{jc}} = \beta_0 + \beta_1 \log L_c + \beta_2 \log E_{lc} + \eta_l + \varepsilon_{jc} \quad (34)$$

¹¹According to the model, the coefficient on city size, β_1 , should be equal to -1.

Column (2) presents the results of this estimation. The results show that once we control for the average size of plant in a given industry and city, as proxied by the number of employees, the coefficient associated with city size is negative and significant. This confirms, as expected, that plants are more specialized, i.e. perform a lower number of occupations in-house, in larger cities. Nevertheless, there might remain some unobservable characteristics which affect the average task scope of plants in a given industry and city that are specific to a region, or specific to an industry in a given region. We therefore augment our specification to control for region fixed (κ_r) and industry-region fixed effects (ν_{lr}) and estimate respectively:

$$\log t_{M_{lc}} = \beta_0 + \beta_1 \log L_c + \beta_2 \log E_{lc} + \eta_l + \kappa_r + \varepsilon_{lc} \quad (35)$$

$$\log t_{M_{lc}} = \beta_0 + \beta_1 \log L_c + \beta_2 \log E_{lc} + \nu_{lr} + \varepsilon_{lc} \quad (36)$$

Results are presented in column (3) and (4), respectively. The coefficient associated with city size remains negative and significant and confirms that for a given industry, plants have in average a lower task scope in larger cities. Finally, in order to check the robustness of the results to different level of industry aggregation, we repeat the analysis at the 3-digit level and 4-digit level of industries (see columns (5) and (6)). For this, we reconstructed our dependent variable, $t_{M_{lc}}$, at the appropriate industry level. The regressions contain also industry fixed effect at the corresponding level. Even though we see a decrease in the magnitude of the effect, in all equations, the impact of the size of the city remains negative and significant. This confirms that, as predicted by our model, that the average task scope of plants in a given industry is lower in larger cities.

Finally, in order to check further the robustness of our results to the occupation classification, we reproduce the same analysis but with the average plant task scope of the industry computed using the number of occupations at the 4-digit level. The results, which are reported in table 3 are qualitatively and quantitatively similar.

Overall, these preliminary regressions give support for the main prediction of our model. Manufacturers seem to be more specialized, in terms of number of different occupations performed by workers in-house, in larger markets. A doubling in city size is associated with a decrease in the average industry plant task scope ranging from 2% to 4.3%. However, these basic specifications can be refined further.

4.1.2 City size and plant task scope

The results presented previously might be influenced by the way specialization has been measured so far. In this section, we verify whether our results hold if specialization is

Table 3: City size and average industry plant task scope in manufacturing sectors

Log plant average task scope in sector l and city c (4-digit level of occupations) computed at :	2-digit industry level			3-digit	4-digit	
	(1)	(2)	(3)	(4)	(5)	(6)
City size	0.0428*** (0.0112)	-0.0262*** (0.00655)	-0.0364*** (0.00580)	-0.0361*** (0.00595)	-0.0179*** (0.00493)	-0.0138*** (0.00438)
City-sector plant size _{2-digits}		0.526 *** (0.00567)	0.527*** (0.00571)	0.529*** (0.00618)		
City-sector plant size _{3-digit}					0.579*** (0.00477)	
City-sector plant size _{4-digits}						0.592*** (0.00444)
Industry fixed effects	2-digits	2-digits	2-digits	No	No	No
Region fixed effects	No	No	Yes	No	No	No
Industry-region fixed effects	No	No	No	2-digits	3-digits	4-digits
Observations	3,808	3,808	3,808	3,808	7,739	9,965
R^2	0.155	0.794	0.798	0.826	0.846	0.861

Robust standard errors clustered at the municipality level in parentheses.

* significant at 10%, ** significant at 5%, *** significant at 1%.

measured at the plant level. A limit with our specification in (36) is that the dependent variable is computed as the average plant task scope at the industry level. It therefore aggregates all plants and divides them by their number. First, this means that the results could be driven by industries in which there are fewer plants. Second, this means that the same average degree of specialization could be observed in an industry and city in which plants differ substantially in task scope as to an industry in which plants have the same degree of specialization. Thirdly plants are likely to differ in size and therefore in terms of task scope for other reasons than the ones outline in our model. And everything else being equal, one cannot attribute the same degree of specialization to two plants with the same number of occupations but with a different

Table 4: City size and plant task scope in manufacturing sectors

	Log Plant task scope					
	occupation code 3-digit			occupation code 4-digit		
	(1)	(2)	(3)	(4)	(5)	(6)
City Size	-0.00944*** (0.00296)	-0.00549* (0.00307)	-0.00600** (0.00298)	-0.00716** (0.00316)	-0.00356 (0.00332)	-0.00402 (0.00312)
Plant Size	0.562*** (0.00286)	0.569*** (0.00324)	0.570*** (0.00367)	0.608*** (0.00273)	0.613*** (0.00301)	0.615*** (0.00317)
Industry-region fixed effect	2-digit	3-digit	4-digit	2-digit	3-digit	4-digit
Observations	22,052	22,052	22,052	21,916	21,916	21,916
R^2	0.757	0.777	0.792	0.770	0.790	0.805

Robust standard errors clustered at the municipality level in parentheses.

* significant at 10%, ** significant at 5%, *** significant at 1%.

number of employees. A solution for this is to take the analysis at the plant level and to estimate the following equation:

$$\log t_{M_{ilc}} = \beta_0 + \beta_1 \log L_c + \beta_2 \log E_{ilc} + \nu_{lr} + \varepsilon_{ilc} \quad (37)$$

where the dependent variable is the log task scope of plant i in industry l and city c and E_{ilc} is the size of plant i pertaining to industry l in city c , as measured by the number of employees in the plant, and where ν_{lr} are industry-region fixed effects.

We present the results of the estimation of this equation in table 4. In columns (1) to (3), the dependent variable is computed as the log of the number of occupations in plant i pertaining to industry l and city c at the 3-digit level of occupations codes. Region-industry fixed effects are introduced respectively at the 2-digit, 3-digit and 4-digit industry level, in order to be sure that the results are not influenced by the classification of an industry. As expected, larger plants tend to have a larger task scope. This is expected as larger plants are likely to have more occupations simply because they are of a larger magnitude. Note that a limit with controlling for plant size is that if a firm outsources more, its number of occupations but also its number of employees is likely to decrease. However, the coefficient on city size, which is our variable of interest is negative and significant in all three columns. In line with our previous findings, the results confirm that in larger cities, workers perform overall fewer occupations in-house than in smaller cities. A doubling in city size is associated with a decrease in plant task scope ranging from 0.5% to 0.9%.

In columns (3) to (6), the dependent variable is constructed at the 4-digit level of occupation codes. The results are still in line with our expectations, though the level of significance of the coefficients is weaker. While these results still remain overall in favor of the main prediction of our model, there might be some limits in the way plant specialization has been computed so far.

4.1.3 Alternative measure of specialization

Results might be still influenced by the way specialization has been computed so far. In this section, we propose an alternative measure of plant specialization. Until now, the degree of specialization of plants is measured by a count of the number of different occupations performed by workers within the plant. This proxy has one important limit. In the model, firms become more efficient because outsourcing allows them to reduce their task scope and to focus on a range of tasks which are more similar in nature. Our measure of specialization in equation (37) does not take into account the distance between occupations performed within the plant. Indeed, for a given number of occupations, a firm could perform either occupations which are similar in nature,

or occupations which are totally different. An appropriate measure of specialization should allow us to consider the former firm as more specialized than the latter.¹² In order to deal with this issue, we propose an alternative measure of specialization in which distance between tasks is based on the Swedish International Standard Classification of Occupations. Indeed, given that occupation categories are created according to the kind of work performed and the skill requirements for the work, this classification tends to regroup together occupations which are more similar in nature. We therefore simply assume that two occupations at the 4-digit level of occupation code which belong to the same 3-digit occupation code are more similar than two occupations at the 3-digit level which belong to two different 3-digit codes of occupation.¹³ We then construct a Herfindahl index of the concentration of occupations in a given plant. This Herfindahl index aims at measuring how much occupations within a plant are concentrated in the same occupation category. It is defined as:

$$Herfindahl_i = \sum_{d=1}^N (s_{i_d})^2 \quad (38)$$

where $s_{i_d} = \frac{\text{number of occupations at (d+1) digit pertaining to the same (d) digit in plant } i}{\text{total number of occupations at the (d+1) digit in plant } i}$

This measure still has some limits as some categories of occupations are more disaggregated than others (some occupations at the 3 digit level are disaggregated in more 4 digit occupations than others). This could bias upward the results if the less disaggregated occupation categories are over-represented in larger cities. In order to partially limit this issue, we construct two different Herfindahl indices at different levels of occupation categories and estimate the following regressions:

$$Herf_{ilc(3)} = \beta_0 + \beta_1 \log L_c + \beta_2 \log E_{ilc} + \nu_{lr} + \varepsilon_{ilc} \quad (39)$$

$$Herf_{ilc(4)} = \beta_0 + \beta_1 \log L_c + \beta_2 \log E_{ilc} + \nu_{lr} + \varepsilon_{ilc} \quad (40)$$

Table 5 presents the results of such estimations. In the first three columns, the Herfindahl index is based on the share of the number of 3-digit occupations in the same 2-digit occupations categories over the total number of 3-digit occupation categories in plant i . Note that in this case, a higher Herfindahl index means that occupations within the plant are more concentrated within a given category and therefore that the

¹²While this criticism is valid both when we compute the number of task at the 3 and 4 digits levels, the bias becomes higher the more disaggregated is the task scope in terms of categories of occupations, as the number of potential different occupations performed by workers is likely to be higher at the 4-digit than at the 3-digit level of occupations.

¹³For instance, following the standard classification, this amounts to assuming that an electrical engineering technician has an occupation which is more similar to the one of a mechanical engineering technician than to the one of a computer assistant.

Table 5: City size and plant specialization in manufacturing sectors

	Herfindahl index of occupation concentration based on:					
	Number of 3-digit in same 2-digit			Number of 4-digit in same 3-digit		
	(1)	(2)	(3)	(4)	(5)	(6)
City Size	0.00339*** (0.00128)	0.00239* (0.00134)	0.00255* (0.00133)	0.00426*** (0.00142)	0.00284* (0.00151)	0.00318** (0.00147)
Plant Size	-0.142*** (0.00123)	-0.144*** (0.00127)	-0.146*** (0.00146)	-0.157*** (0.00138)	-0.159*** (0.00138)	-0.161*** (0.00155)
Industry-region fixed effects	2-digit	3-digit	4-digit	2-digit	3-digit	4-digit
Observations	22,052	22,052	22,052	21,916	21,916	21,916
R^2	0.457	0.494	0.524	0.485	0.522	0.552

Robust standard errors clustered at the municipality level in parentheses.

* significant at 10%, ** significant at 5%, ***significant at 1%.

plant is more specialized. We thus expect a positive sign on city size and a negative sign on plant size. In columns (1), (2) and (3), we control for industry fixed effects at the 2-digit, 3-digit and 4-digit level respectively. Consistently with previous estimates, larger plants in terms of number of employees are less specialized in terms of task scope. As predicted by our model, the coefficient on city size is positive and significant. In the last three columns of Table 5, we reproduce the same analysis but when the Herfindahl index is computed using the share of the number of 3-digits occupations belonging to the same number of 4-digits occupations in the total number of 4-digit occupations categories within the plant. In columns (4), (5) and (6), we introduce industry fixed effect respectively at the 2-digit, 3-digit and 4-digit industry level. The coefficient on city size is positive and significant confirming that plants are more specialized in terms of task scope in larger cities.¹⁴ Overall, the results confirm that manufacturers are more specialized in terms of task scope in larger cities.

4.1.4 Alternative measure of market size

A further concern about our empirical strategy so far is the use city size as the only source of variation for the size of the market. However, in the presence of low costs for transporting goods and outsourcing tasks between cities, the city might not be the appropriate geographical scale for the division of labor to take place. Firms from a small city located near Stockholm for instance may have access to a much larger market than suggested by the size of the city. Along the same argument, the demand for outsourced task faced by provider in a small city located near Stockholm might be much larger than suggested by the size of the firm's city. As a consequence, plants could be more specialized in a small city than suggested by the city's population size. Though using

¹⁴Note that we reproduced the same analysis with the dependent variable expressed as the log Herfindahl index, this does not affect our results.

Table 6: Market Potential and plant specialization in manufacturing sectors

	Log Task scope (Inverse of plant specialization)			Herfindahl index (Plant specialization)		
	(1)	(2)	(3)	(4)	(5)	(6)
Market Potential	-0.0151*** (0.00563)	-0.00984* (0.00588)	-0.0116** (0.00572)	0.00599** (0.00256)	0.00466* (0.00268)	0.00524* (0.00266)
Plant Size	0.560*** (0.00297)	0.567*** (0.00336)	0.569*** (0.00398)	-0.141*** (0.00125)	-0.143*** (0.00130)	-0.145*** (0.00153)
Industry-region region fixed effect	2-digit	3-digit	4-digit	2-digit	3-digit	4-digit
Observations	19,176	19,176	19,176	19,176	19,176	19,176
R-squared	0.759	781 0.	0.797	0.459	0.500	0.533

Robust standard errors clustered at the municipality level in parentheses.

* significant at 10%, ** significant at 5%, ***significant at 1%.

city size as a measure of market size is likely to bias our results downward, we try to compute a better measure of market size.

In order to do so, we compute a “market potential” measure of the size of a city. This market potential takes into account the size of the city c but also the size of all other Swedish cities c' weighted by the bilateral distance between cities c and c' .¹⁵ With such a measure, the market potential of a small city located near Stockholm is therefore much higher than suggested by the local city size.

Results of estimations including market potential as a measure of market size are presented in Table 6. In columns (1) to (3), we present results when the dependent variable is the log of the plant task scope computed at the 3-digit level of occupations. The results confirm our expectations. The coefficient associated with the market potential is negative and significant and larger in magnitude than our previous estimates on market size. These results confirm that workers tend to perform fewer tasks in-house in larger markets.

In column (4) to (6), we present results using as dependent variable the Herfindahl concentration index of occupations. Here we use the index based on the number of 3-digit occupations belonging to the same 2-digit occupation category. For this measure, we expect a positive sign on market size. Again, results confirm our expectations, plants are more specialized in larger markets than in smaller markets.

Overall, this empirical analysis confirms that, as predicted by the model, manufacturers are more specialized in larger cities than in smaller cities. However, the model also predicts that providers should be more specialized in larger cities, and that the number of providers relative to the number of manufacturers should increase with the

¹⁵For the computation of the market potential measure, we first have to calculate the bilateral distance between the different Swedish cities. This is done using information on the latitude and longitude that we obtained for 240 Swedish cities. Bilateral distance is then computed as great circle distances.

size of the city. The aim of the next section is to verify the empirical relevance of these two predictions.

4.2 City size, specialization and number of service providers

4.2.1 City size and average plant task scope of service providers

We now turn to the analysis of the service provider sector. The model presented in section 2 predicts that providers should have a smaller task scope in larger cities, albeit for a different theoretical reason than manufacturers. In the model, providers cannot outsource, but in larger markets they face a higher demand per task. Since providers can sell more of each task, this favors the entry of more providers and each provider becomes more specialized and therefore more efficient. We derive our first basic specification directly from equation (24) of the model. Since firms are assumed to be symmetric in the model, this equation predicts that the average task scope of providers in a given industry and city decreases in city size and increases in the fixed cost of entry of service providers. After a logarithmic transformation, this gives:

$$\log t_{S_{lc}} = \beta_0 + \beta_1 \log L_c + \beta_2 \log f_{S_l} + \varepsilon_{lc} \quad (41)$$

where $t_{S_{lc}}$ denotes the average number of occupations providers have in sector l and city c , $\beta_0 \equiv \log \frac{\sigma}{\mu}$, L_c denotes the population size of city c and f_{S_l} denotes the fixed cost of entry of providers in sector l .

However, as for the manufacturing sector, this specification has to be refined. First, the degree of firm specialization is likely to differ across service sectors l . Second, f_{S_l} the fixed cost of entry of service providers in industry l is not observable. As it affects the number of providers it also affects their task scope. Third, it is likely that all sectors are not represented equally in all cities. If a given industry is larger in some cities, the scale of plants and therefore their task scope is also likely to be larger. Finally, there might remain some unobservable specific to an industry and a region which also affect the plant average task scope of industry l in city c . We therefore augment equation (41) to control for the average plant size of industry l in city c , E_{lc} and to control for industry-region fixed effects ν_{lr} . We therefore estimate:

$$\log t_{S_{lc}} = \beta_0 + \beta_1 \log L_c + \beta_2 \log E_{lc} + \nu_{lr} + \varepsilon_{lc} \quad (42)$$

Estimation results are presented in Table 7. In the first three columns, the dependent variable is the log of the average plant tasks scope in industry l and city c , measured by the average number of different occupations (at the 3-digit level of occupations) performed in a plant in a given industry and city. In column (1) to (3) we

Table 7: City size and average plant task scope in service sectors

	Log task scope in sector l and city c					
	Task scope (3-digit occupations)			Task scope (4-digit occupations)		
	2-digit	3-digit	4-digit	2-digit	3-digit	4-digit
	(1)	(2)	(3)	(4)	(5)	(6)
City size	0.00831 (0.00885)	-0.00793 (0.00722)	-0.0198*** (0.00583)	0.0179* (0.00950)	-0.00140 (0.00750)	-0.0147** (0.00617)
City-sector plant size _{2-digit}	0.452*** (0.0119)			0.483*** (0.0131)		
City-sector plant size _{3-digit}		0.478*** (0.00879)			0.505*** (0.00917)	
City-sector plant size _{4-digit}			0.503*** (0.00772)			0.531*** (0.00793)
Industry-region fixed effects	2-digit	3-digit	4-digit	2-digit	3-digit	4-digit
Observations	1,803	4,486	5,777	1,783	4,417	5,669
R^2	0.657	0.688	0.719	0.677	0.706	0.734

Robust standard errors clustered at the municipality level in parentheses.

* significant at 10%, ** significant at 5%, *** significant at 1%.

computed this variable at the 2-digit, 3-digit and 4-digit industry level respectively. The model predicts that the average plant task scope should decrease with city size. We therefore expect a negative coefficient on city size. Results are however mixed and seem to depend on the industry level classification. The coefficient on city size is negative and significant only at the 4-digit industry level (column 3).

In columns (4) to (6), we reproduce the same analysis but with the number of occupations per plant computed at the 4-digit level of occupations. Again the coefficient associated with city size is negative and significant only when the 4-digit industry classification is considered (column 6). The evidence that plants are more specialized in larger city seems therefore to be weaker regarding the service sectors. However, this might be linked to the way firm specialization is measured.

4.2.2 Alternatives measures of specialization

As noted earlier, there might in be some limits in the way plant specialization is measured at the industry level. We therefore use two alternatives measures of specialization.

First, we repeat the analysis with the same measure of specialization but by working directly at the plant-level and estimate:

$$\log t_{S_{ilc}} = \beta_0 + \beta_1 \log L_c + \beta_2 \log E_{ilc} + \nu lr + \varepsilon_{ilc} \quad (43)$$

where $\log t_{S_{ilc}}$ is the number of different occupations (at the 3-digit level of occupation) performed by workers in plant i belonging to industry l and located in city c , where L_c

Table 8: City size and plant specialization in service sectors

	Log Task scope (Inverse of Plant Specialization)			Herfindahl (Plant Specialization)		
	(1)	(2)	(3)	(4)	(5)	(6)
City Size	0.00558*** (0.00191)	-0.00235 (0.00215)	-0.00625*** (0.00196)	0.000590 (0.00172)	0.00605*** (0.00193)	0.00866*** (0.00185)
Plant Size	0.506*** (0.00759)	0.514*** (0.00632)	0.518*** (0.00563)	-0.385*** (0.00332)	-0.392*** (0.00286)	-0.393*** (0.00286)
Industry-region fixed effects	2-digit	3-digit	4-digit	2-digit	3-digit	4-digit
Observations	37,613	37,613	37,613	37,613	37,613	37,613
R^2	0.580	0.612	0.626	0.482	0.508	0.522

Robust standard errors clustered at the municipality level in parentheses.

* significant at 10%, ** significant at 5%, *** significant at 1%.

is the population size of city c and where E_{ilc} is the employment size of plant i .

Results of such estimations are presented in the first three columns of Table 8. Again the results give weak support to the prediction according to which service provider task scope is lower in larger cities. The results depend largely of the industry classification and the coefficient associated with city size is negative and significant only at the 4-digit industry level. These results give weak support to the prediction according to which service provider are more specialized in larger cities.

As this measure of specialization does not take into account the degree of similarity of occupations performed within a plant, we instead use an Herfindahl concentration index of occupations as a dependent variable, which measures how much occupations at the 3-digit level are concentrated in the same 2-digit occupation category in a given plant. We therefore estimate:

$$Herf_{ilc(3)} = \beta_0 + \beta_1 \log L_c + \beta_2 \log E_{ilc} + \nu_{lr} + \varepsilon_{ilc} \quad (44)$$

Results of such estimation are presented in the second part of Table 8. In this case, the coefficient associated with city size is positive and significant when region-industry fixed effects are introduced at the 3 and 4 digit level respectively. Overall, these results tend to support the idea that service providers are more specialized in larger cities, though the evidence is weaker than for the manufacture sector.

4.2.3 Alternative measure of market size

Finally, as before, we also verify the robustness of our results to an alternative measure of market size. We reproduce the analysis using market potential rather than city size for defining the size of the market (as described in subsection 4.1.3).

Results are presented in Table 9. In columns (1) to (3), the dependent variable

Table 9: Market potential and plant specialization in service sectors

	Log Task scope (Inverse of Plant Specialization)			Herfindahl (Plant Specialization)		
	(1)	(2)	(3)	(4)	(5)	(6)
Market size	0.0106** (0.00414)	-0.00158 (0.00453)	-0.00916** (0.00454)	0.000349 (0.00168)	0.00388** (0.00180)	0.00603*** (0.00181)
Plant size	0.505*** (0.00873)	0.514*** (0.00730)	0.517*** (0.00657)	-0.151*** (0.00121)	-0.155*** (0.00127)	-0.156*** (0.00151)
Industry-region fixed effects	2-digit	3-digit	4-digit	2-digit	3-digit	4-digit
Observations	33,162	33,162	33,162	33,162	33,162	33,162
R^2	0.579	0.612	0.626	0.327	0.351	0.365

Robust standard errors clustered at the municipality level in parentheses.

* significant at 10%, ** significant at 5%, ***significant at 1%.

is the log of a plant task scope (at the 3-digit level of occupations). In line with our previous results for the service sector, only in column (3) the coefficient associated with market potential is of the expected sign, indicating that firms have a lower task scope in large cities.

In column (4) to (6), the dependent variable is the Herfindahl concentration index of occupations in a given plant. In this case, the coefficient of market potential is positive and significant in columns (5) and (6), confirming that service providers tend to be more specialized in larger cities.

Overall, the results of the empirical analysis give evidence that service providers tend to be more specialized in terms of task scope in larger cities. However, the results are highly dependent of the industry classification. The evidence is thus more mixed than for the manufacturing sector. One explanation for this might be that while we selected service sectors which are most likely to encompass service outsourcing, it is not possible to verify how much output of these sectors is actually used by manufacturers. The absence of input-output linkages is undoubtedly an important limit of the present analysis. With this caveat in mind, we finally turn to the verification of the empirical relevance of the third prediction of our model.

4.2.4 City size and the relative number of providers

The third important prediction of the model is that the number of service providers relative to the number of manufacturers should increase with city size, as shown by equations (26) and (23) of the model. This is because in larger markets, the demand per task is higher and therefore sufficient to sustain the entry of more providers. In order to test this prediction, we estimate the following regression:

$$\log(n_{Sc}/n_{Mc}) = \alpha + \beta \log L_c + \gamma \log(L_{Sc}/L_{Mc}) + \nu_r + \varepsilon_c \quad (45)$$

Table 10: Number of service plants and city size

	Dependent variable: Log ratio (n_S/n_M)			
	City size		Market Potential	
	(1)	(2)	(3)	(4)
Market size	0.396*** (0.0274)	0.220*** (0.0235)	0.779*** (0.0611)	0.436*** (0.0526)
Service/manufacturing employment		0.345*** (0.0233)		0.340*** (0.0258)
Region fixed effects	Yes	Yes	Yes	Yes
Observations	289	289	241	241
R^2	0.658	0.813	0.618	0.787

Standard errors in parentheses.

* significant at 10%, ** significant at 5%, *** significant at 1%.

where n_{Sc}/n_{Mc} denotes the ratio of the number of service plants over the number of manufacturing plants in city c , and (L_{Sc}/L_{Mc}) denotes the ratio of service employment over manufacturing employment in city c .

In columns (1) and (2) of Table 10, market size is measured by city size. As predicted by the model, the coefficient on city size is positive and significant, confirming that the number of service providers relative to the number of manufacturers increases with city size. In column (2), we control for the size of the service industry relative to the size of the manufacturing industry in the city as it is also likely to affect the relative number of providers and the coefficient associated with city size remains positive and significant. In columns (3) and (4), we also verify whether the results hold if market size is measured by market potential. The coefficient associated with city size remains positive and significant and of higher magnitude. As predicted by the model, the number of service providers relative to the number of manufacturers tends to be larger in larger market.

Globally, the main predictions of the model seem to be validated empirically. In larger markets, manufacturers tend to be more specialized in terms of the occupations performed inhouse. We also find that providers are more specialized and more numerous in larger markets. However, these results have to be interpreted with caution. First, it would be more rigorous to interpret them in terms of correlation rather than in terms of causality. Second while, these results seem to be in line with the idea that larger markets facilitate a greater division of labor between firms, outsourcing might not be the only explanation for the greater specialization of firms in larger cities.

5 Conclusion

In this paper, we develop a model of task outsourcing in which the scope of tasks performed by manufacturers and providers is endogenously determined. Our key assumption is that the marginal cost of producing a given task is an increasing function of the number of tasks performed in-house, both for manufacturers and providers. The manufacturer decision to outsource therefore results from a trade-off between the efficiency gains stemming from its specialization in terms of task scope and the cost of contracting with specialized providers in an imperfect contracting environment. The model generates gains from larger market size through a specialization effect: aggregate productivity rises, manufacturers are more specialized, providers are more specialized and their relative number increases.

We use a detailed data set on Swedish firms, which gather occupation information on all employees in the private sector, to test the last two predictions of the model. We actually find that manufacturers and service providers have a smaller task scope in larger cities. We also find that the number of service providers increases with city size. This suggests that, in larger markets, outsourcing generates a larger division of labor between firms. However, in the absence of information about input-output linkages at the firm level, these results have to be interpreted with caution. Moreover, assessing, as predicted by the model, how the division of labor between firms contributes the greater efficiency of large cities is left for future research.

References

- ABRAMOVSKY, L., AND R. GRIFFITH (2009): “ICT, Corporate Restructuring and Productivity,” IFS Working Papers W09/10, Institute for Fiscal Studies.
- ACEMOGLU, D., P. ANTRÀS, AND E. HELPMAN (2007): “Contracts and Technology Adoption,” *American Economic Review*, 97(3), 916–943.
- AMITI, M., AND S.-J. WEI (2009): “Service Offshoring and Productivity: Evidence from the US,” *The World Economy*, 32(2), 203–220.
- ANTRÀS, P., AND E. HELPMAN (2004): “Global Sourcing,” *Journal of Political Economy*, 112(3), 552–580.
- BALDWIN, R., AND F. ROBERT-NICOUD (2010): “Trade-in-goods and trade-in-tasks: An Integrating Framework,” *NBER working paper 15882*.
- BEHRENS, K., G. DURANTON, AND F. ROBERT-NICOUD (2010): “Productive cities: Sorting, selection and agglomeration,” *CEPR Discussion Paper 7922*.
- BLINDER, A. S. (2009): “How Many US Jobs Might be Offshorable?,” *World Economics*, 10(2), 41–78.
- COMBES, P., G. DURANTON, AND L. GOBILLON (2008): “Spatial wage disparities: Sorting matters!,” *Journal of Urban Economics*, 63, 723–742.
- DURANTON, G., AND H. JAYET (2011): “Is the Division of Labour Limited by the Extent of the Market? Evidence from French Cities ,” *Journal of Urban Economics*, 69(1), 56–71.
- FONTAGNÉ, L., AND J.-H. LORENZI (2005): “Désindustrialisation, délocalisations,” Les Rapports du Conseil d’analyse économique 55, La Documentation française.
- GROSSMAN, G., AND E. HELPMAN (2002): “Integration Versus Outsourcing in Industry Equilibrium,” *Quarterly Journal of Economics*, 117(1), 85–120.
- GROSSMAN, G. M., AND E. ROSSI-HANSBERG (2008a): “Task Trade Between Similar Countries,” *NBER Working Paper 14554*.
- (2008b): “Trading Tasks: A Simple Theory of Offshoring,” *American Economic Review*, 98(5), 1978–1997.
- GROSSMAN, S. J., AND O. D. HART (1986): “The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration,” *Journal of Political Economy*, 94(4), 691–719.

- KRUGMAN, P. R. (1980): “Scale Economies, Product Differentiation, and the Pattern of Trade,” *American Economic Review*, 70(5), 950–959.
- MELITZ, M. J. (2003): “The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity,” *Econometrica*, 71(6), 1695–1725.
- MORI, T., K. NISHIKIMI, AND T. SMITH (2005): “A divergence statistic for industrial localization,” *Review of Economics and Statistics*, 87(4), 635–651.
- QUINN, J. B., AND F. G. HILMER (1994): “Strategic Outsourcing,” *Sloan Management Review*, Summer, 43–55.
- ROSENTHAL, S., AND W. STRANGE (2004): *Handbook of Regional and Urban Economics (volume 4)* chap. Evidence on the nature and sources of agglomeration economies, pp. 2119–2171. North-Holland, Amsterdam.
- SHAPLEY, L. S. (1953): *Contributions to the Theory of Games* chap. A Value for n-person Games, pp. 307–317. Princeton University Press.
- SMITH, A. (1776): *An Inquiry into the Nature and Causes of the Wealth of Nations*. W. Strahan and T. Cadell, London.
- WILLIAMSON, O. E. (1975): *Markets and Hierarchies: Analysis and Antitrust Implications*. New York, NY, Free Press.
- (1985): *The Economic Institutions of Capitalism*. New York, NY, Free Press.