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Services, Comparative Advantage and Agglomeration of Economic Activity: A Ricardo-Marshall Model

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Services, Comparative Advantage and Agglomeration of Economic Activity: A Ricardo-Marshall Model

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ABSTRACT

The last one and a half centuries have witnessed dramatic changes in the world economy. The service (tertiary) sector, which at the beginning of the 20th century was of little importance relative to agriculture and manufacturing, has become the dominant sector today, accounting for 80% and more of value added in advanced countries and around 70% and of employment. Innovations in transport technologies and in information and communications technologies have radically reduced the costs of trading goods and have also made an increasing share of services tradeable. We propose a tractable micro-founded Ricardo-Marshall model to study the implications of the rise of the service sector and its interaction with international trade and factor mobility for the location of economic activity. Our model highlights a tension between nontradeable services which exert an agglomerative force and trade costs and comparative advantage which act as dispersion forces.

JEL-Classification: F12, F22, R11, R12, R13

Keywords: services, comparative advantage, labor mobility, symmetry breaking, agglomeration structural change

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1 Introduction

The last one and a half centuries have witnessed dramatic changes in the world economy. The service (tertiary) sector, which at the beginning of the 20th century was of little importance relative to agriculture and manufacturing, has become the dominant sector today, accounting for 80% and more of value added in advanced countries (70% and more of employment). Innovations in transport technologies and in information and communications technologies have radically reduced the costs of trading goods and have made an increasing share of services tradeable. The latter development has stirred a big debate, notably in the United States, which has primarily focused on the labor market implications (see e.g. Blinder 2009 and Bhagwati and Blinder 2009). The rise of the tertiary sector, although hailed in the works of Clark, Fisher and Fourastié in the 20th century and, in (William) Petty's law even centuries ago, has, in our view, received (too) little attention in economic geography and regional economics in the last decades.

Our paper tries to fill this gap. We propose a tractable fully micro-founded Ricardo-Marshall model to study the implications of the rise of the service sector and its interaction with international trade and factor mobility for the location of economic activity. Our model highlights a tension between nontradeable services which exert an agglomerative force and trade costs and comparative advantage which act as dispersion forces. Four parameters are key in our model. The share of nontradeable local producer services and their substitutability give rise to an agglomerative tendency, whilst genuine comparative advantage and the costs of trading final goods and services tend to disperse economic activity.

Our paper is related to several strands of previous work. First, we build on the literature which has modified and generalized the canonical Ricardian model of Dornbusch, Fischer and Samuelson (1977) with a key theoretical contribution by Eaton and Kortum (2002) and a key methodological contribution by Dekle, Eaton and Kortum (2007) which has given rise to an evolving line of research dealing with new quantitative models of trade (see Costinot and

Rodriguez-Clare 2013). The service sector, that we highlight in our model, has received attention in a recent analysis on Matsuyama (2013) on which our analysis builds. Moreover, Stephen Redding (2012) has brought the new quantitative models in the realm of regional economics by highlighting the importance of factor mobility.

The structure of the rest of the paper is as follows. Section 2 sets up our model. Section 3 studies the baseline case without trade costs. Trade costs are brought in in section 4 which also contains a welfare analysis. Section 5 concludes.

2 The Model

General set-up. Our analysis builds on the Ricardian model of Dornbusch, Fischer and Samuelson (1977) with two regions, home and foreign, one factor of production, labor, and a continuum of final goods and services which are produced under perfect competition. We amend this model in three ways. First, following Matsuyama (2013), we assume that the production of *final goods and services* makes use of labor and a symmetric CES-composite of local non-tradeable *intermediate* producer services, each of which is produced with labor under increasing returns and monopolistic competition. It is important to notice here, that our model comprises both genuinely nontradeable intermediate services and potentially (at a cost) tradeable services which are final outputs for consumers. Second, to make our model tractable, we impose a specification of comparative advantage in final outputs as implied by Eaton and Kortum (2002).¹ The technologies to produce final goods are characterized by an exogenous parameter which governs the dispersion of productivity across products and which is identical across regions.² Hence, the distributions of technologies of the two regions are exact mirror images and comparative advantages are perfectly symmetric. Since we also assume that the two

¹ Eaton and Kortum (2002) derived their technology specification, the Fréchet-distribution, in order to render the case of many countries in the Dornbusch, Fischer, Samuelson model tractable. Eaton and Kortum also indicated how this distribution maps into the case two-country case (Eaton and Kortum 2002: 1747) and Dekle, Eaton and Kortum (2007) fruitfully made use of this case in their working paper.

² Technologies in Eaton and Kortum (2002) exhibit another parameter, total factor productivity, which is country-specific. We abstract from this parameter of absolute advantage in order to have ex-ante identical regions.

regions have identical labor endowments, preferences and trade costs, there are no overall first-nature advantages in our model and the two regions can be considered to be identical, ex-ante. Third, we allow for the mobility of labor across regions and study the resulting spatial equilibrium.

We now turn to the detailed description of preferences and technologies from the point of view of the domestic region. Variables and parameters pertaining to foreign will be denoted by an asterisk (*).

Preferences. Preferences are defined over the consumption $c(z)$ of every final good $z \in [0,1]$ and are assumed to take the Cobb-Douglas form:

$$U\{c(z)\} = \exp\left[\int_0^1 \log c(z) dz\right] \quad (1)$$

The associated perfect price index is:

$$P = \exp\left[\int_0^1 \log p(z) dz\right] \quad (2)$$

where $p(z)$ is the consumer price of z , which may comprise trade costs of the iceberg-type $\tau \geq 1$ for goods that are imported from the other region. Due to perfect competition, producer prices of final goods reflect unit costs.

Technologies and prices. The technology to produce final good or service z is characterized by the constant-returns unit cost function:

$$\kappa(z) = a(z) w^{1-\beta} P_s^\beta, \quad P_s = \left(\int_0^n p_s^{1-\sigma} ds \right)^{\frac{1}{1-\sigma}} \quad (3)$$

where w is the domestic wage, P_s is the perfect price index for nontradeable domestic producer services, p_s is the price of a single service s , and σ is the constant elasticity of substitution between any two services. We assume $\sigma > 1$. The mass of services is given by n , which is

determined endogenously. The cost share of intermediate services is governed by the parameter $0 \leq \beta \leq 1$ which we assume to be equal across all final goods.³ Services are produced with labor, as described below in detail. The term $a(z)$ is an exogenous technology parameter which varies across final goods.⁴ The foreign analogue is represented by $a^*(z)$. To introduce (exogenous) comparative advantage in the spirit of Dornbusch, Fischer and Samuelson (1977), we assume that the final goods z can be ranked in descending order of $A(z) \equiv a^*(z)/a(z)$. Hence, home's (exogenous) relative technological superiority is highest for $z = 0$ and foreign's relative technological superiority is highest for $z = 1$. Furthermore, we assume that the distribution of domestic and foreign technology parameters is perfectly symmetric in the sense that labor coefficients are exact mirror images, i.e. $A(z = 0) = 1/A(z = 1)$ etc.

We assume that intermediate producer services are symmetric. Each intermediate service s is produced by a single firm under increasing returns and monopolistic competition. The labor input to produce quantity q_s of service s is given by $l_s = f + mq_s$, with f and m denoting the fixed and variable labor input, respectively. Total costs are $w(f + mq_s)$. It is well-known that with this Dixit-Stiglitz specification, the parameter σ is also the price elasticity of demand for services (from eq. (3)) and that monopolistic competitive service producers charge profit-maximizing producer prices

$$p_s = \frac{\sigma}{\sigma - 1} wm. \quad (4)$$

Profits of each service producer are $\pi_s = (p_s - wm)q_s - wf$ which, on substituting p_s from eq. (4), can be rewritten as $\pi_s = w[mq_s / (\sigma - 1) - f]$. In long-run zero-profit equilibrium we have

³ Here we deviate from Matsuyama (2013) who assumes that the cost share of services varies across sectors. This assumption is key for his research question, the endogenous derivation of comparative advantage. We pursue a different line of research, taking comparative advantage as exogenously given as will become clear in the following.

⁴ These coefficients coincide with the (exogenous) labor coefficients in Dornbusch, Fischer and Samuelson (1977) for $\beta = 1$.

$\pi_s = 0$. Hence, the level of output at which a service firm breaks even is given by:

$$q_s = \frac{f(\sigma-1)}{m}. \quad (5)$$

We can now make use of eq. (4) to rewrite unit costs to produce final good z as:

$$\kappa(z) = \left(\frac{\sigma m}{\sigma-1} \right)^\beta a(z) w n^{-\frac{\beta}{\sigma-1}}, \quad (6)$$

This equation reveals that unit costs rise with wages and the technology coefficient $a(z)$. Crucially, unit costs fall as the number of producer services increases. Hence, we have productivity gains associated with an increasing variety of services. This is one of Marshall's agglomeration forces which was originally formalized by Ethier (1982).

3 General Equilibrium

Short-run equilibrium and parameterization. We now turn to characterize the general equilibrium of the economy in the short-run, where labor is immobile across regions. Let L and L^* denote the size of the domestic and foreign labor force, respectively. Consumers buy goods and tradeable services from the minimum cost source and, hence, compare unit cost prices in home (eq. (6)) with those in foreign, which, by analogy, are given by

$$\kappa^*(z) = \left(\frac{\sigma m}{\sigma-1} \right)^\beta a^*(z) w^* n^{*\frac{\beta}{\sigma-1}}. \text{ Given the ranking of relative technology parameters } A(z)$$

there is a hypothetical cutoff \tilde{z} at which unit costs in home and foreign are identical:

$$\kappa(\tilde{z}) = \kappa^*(\tilde{z}) \Rightarrow A(\tilde{z}) = \left(\frac{w}{w^*} \right) \left(\frac{n}{n^*} \right)^{\frac{\beta}{1-\sigma}} \quad (7)$$

Goods and tradeable services in the range $z \in [0, \tilde{z}]$ are accordingly produced and sold to consumers in home and foreign by domestic producers, whilst goods and final services in the range $z \in [\tilde{z}, 1]$ are produced in foreign. To render our model tractable, we assume that the

technology parameters are distributed as in Eaton and Kortum (2002). This implies for the two-country case that $A(z) = ((1-z)/z)^{\frac{1}{\theta}}$ (see Eaton and Kortum 2002:1747). The parameter $\theta > 1$ is an inverse measure of the variability of technology parameters. Hence, comparative advantage is the stronger, the smaller the value of θ . Using this specification in eq. (7) we obtain:

$$\left(\frac{1-\tilde{z}}{\tilde{z}}\right)^{\frac{1}{\theta}} = \left(\frac{w}{w^*}\right) \left(\frac{n}{n^*}\right)^{\frac{\beta}{1-\sigma}} \quad (8)$$

To complete the short-run general equilibrium and in order to determine the (so-far) hypothetical cutoff \tilde{z} , we bring in market clearing conditions for intermediate services and final goods and services. Starting with the former, note first that the total revenue in the intermediate service sector in home, $np_s q_s$, has to equal the share β of domestic income, wL . Hence $np_s q_s = \beta wL$. By analogy $n^* p_s^* q_s^* = \beta w^* L^*$. Dividing these conditions and taking eqs. (4) and (5) for home and foreign into account, we immediately obtain that the relative masses of service firms are proportionate to the relative size of the labor force:

$$n/n^* = L/L^* \quad (9)$$

Putting this in eq. (8) and rearranging yields one schedule which links relative wages with \tilde{z} :

$$\frac{w}{w^*} = \left(\frac{L}{L^*}\right)^{\frac{\beta}{\sigma-1}} \left(\frac{1-\tilde{z}}{\tilde{z}}\right)^{\frac{1}{\theta}} \quad (10)$$

Turning to domestic labor markets, note that market clearing commands that the total value of domestic production, wL , equals the value of sales to domestic and foreign consumers $\tilde{z}(wL + w^*L^*)$. Rearranging, we obtain a second schedule linking relative wages with \tilde{z} :

$$\frac{w}{w^*} = \frac{\tilde{z}}{1-\tilde{z}} \frac{L^*}{L} \quad (11)$$

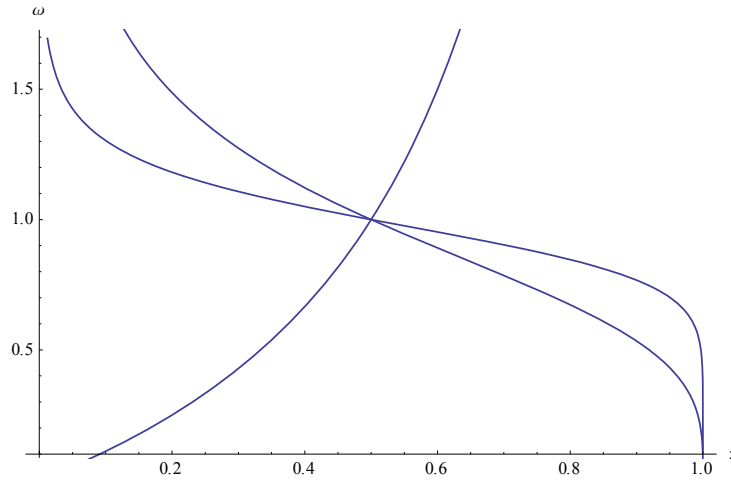
These two equations are immediately solved for the cutoff and for relative wages:

$$\frac{w}{w^*} = \left(\frac{L}{L^*} \right)^{\frac{\frac{\beta-1}{\sigma-1}}{\theta}} \quad (12)$$

$$\tilde{z} = \left(\frac{L}{L^*} \right)^{\frac{\frac{\beta-1}{\sigma-1}}{\theta}} / \left[1 + \left(\frac{L}{L^*} \right)^{\frac{\frac{\beta-1}{\sigma-1}}{\theta}} \right] \quad (13)$$

A graphical illustration of the short-run equilibrium is given in fig.1 which depicts eq. (11), an upward-sloping schedule (as in Dornbusch-Fischer-Samuelson 1977) and eq. (10), a downward-sloping schedule. The latter is drawn for two values of θ . The steeper (negative) curves which exhibits the greater dispersion of technology parameters obtains for a smaller value of θ . Since we have assumed that the labor force in the domestic and foreign region is equal a symmetrical equilibrium obtains.

Figure 1: Short-run equilibrium



Long-Run General equilibrium. Workers are mobile in the long-run and normalize the labor endowment to 1 such that λ and $\lambda^* = 1 - \lambda$ are the domestic and foreign shares of overall labor, respectively. We assume that there are no mobility costs, so workers are attracted to the location which offers the highest indirect utility (real wage). In our model, indirect utilities correspond to

real wages $V = w/P$ and $V^* = w^*/P^*$ for a domestic and foreign household, respectively. Since we assume that there are no trade costs for final outputs in this section (they are taken up in section 5 below), the ratio of indirect utilities is given by:

$$\frac{V}{V^*} = \frac{w}{w^*} = \left(\frac{\lambda}{1-\lambda} \right)^{\frac{\beta-1}{1+\frac{1}{\theta}}} \quad (14)$$

Due to construction, symmetry ($\lambda = 1/2$) is always an equilibrium in our model. However, due to the agglomerative force exerted by intermediate nontradeable services this equilibrium is not necessarily stable. Performing a standard analysis of symmetry breaking one can easily show:

Proposition 1: *Assume that final goods and services are traded without costs. Then the economy exhibits dispersion iff $\frac{\beta}{\sigma-1} < \frac{1}{\theta}$ and agglomeration otherwise. The break point and the sustain point of agglomeration in terms in any of these parameters correspond to each other.*

Proposition 1 brings out the fundamental tension in our model. Comparative advantage acts as a dispersion force. The parameter θ governs the strength of this force. The lower θ , the stronger comparative advantage and, hence, the more likely is dispersion. The agglomeration exerted by the productivity effect of local services is governed by the importance of services as captured by β and by the parameter σ which is an inverse measure of average relative to marginal costs in the service sector (and hence can be interpreted to be a measure of increasing returns in the service sector). The term $\beta/(\sigma-1)$ is thus an overall measure of the agglomerative associated with the service sector. An important conclusion of our analysis is thus that the rise of the service sector that we have witnessed over the last one and a half decades may have contributed to the agglomeration of economic activities.

To make more specific predictions and to highlight the fact that we have witnessed a dramatic decline costs for trading costs of final goods and services due to dramatic innovations in transport technologies and in information and communications technologies we now bring in trade costs into the analysis.

4 Trade Costs

Short-Run General Equilibrium. Trade costs have already been considered in the basic model of Dornbusch, Fischer and Samuelson (1977). Introducing them into our modified framework is straightforward. As in the previous sections, consumers in each region buy from the minimum cost source, where now trade costs have to be taken into account. This leads to two cutoff thresholds which are embedded in the three conditions for the general equilibrium which now obtain:

$$\kappa(z) = \tau \kappa^*(z_H) \quad (15)$$

$$\kappa^*(z) = \tau \kappa(z_F) \quad (16)$$

$$\frac{w}{w^*} = \frac{z_F}{1 - z_H} \frac{L}{L^*} \quad (17)$$

Eq. (15) expresses that domestic production is the minimum cost source for domestic consumers for the range $z \in [0, z_H]$ of goods. By implication, domestic consumers import the range $z \in [z_H, 1]$ of goods from the foreign region. Eq. (16) implies that foreign production is the minimum cost source for foreign consumers for $z \in [z_F, 1]$. The range of goods imported by foreign is accordingly given by $z \in [0, z_F]$. Eq. (17) is derived from the condition that the value of domestic production, wL , has to equal the sales to domestic consumers $z_H wL$ plus the sales to foreign consumers $z_F L$. These three conditions now implicitly define the equilibrium values of z_H , z_F and w/w^* . Using the specifications $a(z) = z^{\frac{1}{\theta}}$ and $a^*(z) = (1-z)^{\frac{1}{\theta}}$ which are

consistent with our specification of $A(z)$ (see Dekle, Eaton and Kortum 2007), the price levels in home and foreign are straightforwardly calculated.

Long-Run General Equilibrium. Labor is mobile in long-run general equilibrium, as in the previous section. The ratio of indirect utilities to be considered is now given by:

$$\frac{V}{V^*} = \frac{w}{w^*} \frac{P^*}{P} \quad (18)$$

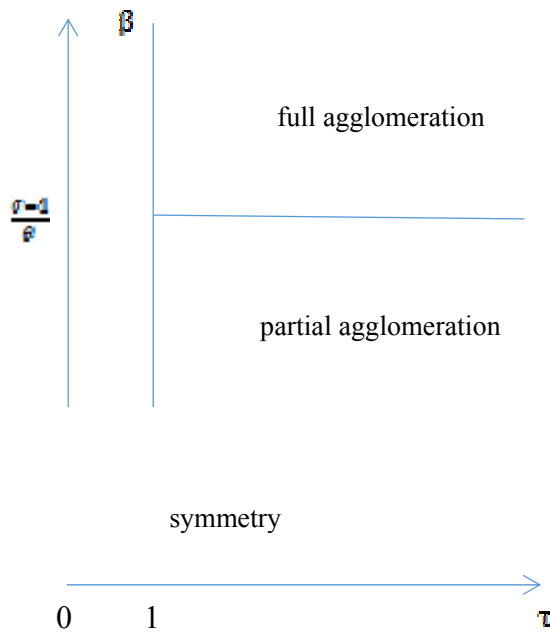
Making use of the wage ratios and the price levels as calculated in the short-run equilibrium, we can perform the standard analysis of symmetry breaking. This yields:

Proposition 2: *Let $\beta_{break} = \frac{2(\sigma-1)}{(2\theta+1)\tau^\theta - 1}$ and $\beta_{sustain} = \frac{\sigma-1}{\theta}$. Then three cases may arise: (i)*

The symmetric equilibrium prevails for $\beta < \beta_{break}$. (ii) The partially agglomerated equilibrium prevails for $\beta_{sustain} < \beta < \beta_{break}$. (iii) The fully agglomerated equilibrium prevails for $\beta > \beta_{break}$.

Proposition 2 is illustrated in fig. 2 below. It neatly comprises proposition 1. The break and sustain points in terms of the cost share of services coincide when $\tau = 1$. As soon as trade costs are positive, break and sustain points deviate. Moreover, as soon as trade costs are positive, partial rather than full agglomeration prevails if the agglomeration forces associated with the service sector are strong enough. The intuition of this result is that trade costs reinforce the dispersion force associated with comparative advantage. The stark locational implications which obtain when trade costs are absent – a bang-bang solution – become softened when costs of trading final goods and services are taken into account. Now, agglomeration, if it occurs, obtains only partially. However, the model also implies that agglomeration rises as trade costs are lowered. Hence, both the secular rise in the importance of the service sector and the secular fall in trade costs induce more agglomeration. Comparative advantage plays a crucial role too, however.

Fig. 2: Locational equilibria



Welfare analysis. We finally ask whether it is possible to reallocate labor across locations in such a way that the (potential) winners can compensate the (potential) losers so that the welfare of all individuals is raised. Such a second-best optimum can be implemented through a lump-sum tax-transfer mechanism across the two regions where the national government (a ‘benevolent social planner’) transfers lump-sum income (say T) from the domestic to the foreign region to equalize indirect utilities and then chooses the allocation of labor (λ) to maximize the (common) level of indirect utility. Note that such a scheme encompasses potential Pareto improvements, too. Performing this analysis we obtain:

Proposition 3: *The market and the social optimum coincide when the trade of final goods and services is completely free (i.e. for $\tau = 1$). For any positive level of trade costs, the market equilibrium exhibits too little agglomeration*

5 Conclusion

This paper has proposed a simple tractable yet fully micro-founded Ricard-Marshall agglomeration model in order to analyze the important structural changes that the world economy has witnessed in the last one and a half centuries. Agglomeration forces are strengthened and dispersion forces weakened with key changes in the last century, the rise of the service sector and the dramatic fall in trade costs. The tractability and full micro-foundation of our model should make it a useful tool for generalizations (e.g. to many regions), policy analysis and empirical work. These are the lines we envision for future work.

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