Economics Bulletin

Volume 35, Issue 1

A gravity model for foreign re-investment

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Abstract

This paper broadens the scope of Foreign Direct Investment (FDI) models by deriving a gravity equation for foreign re-investment. Re-investments in foreign subsidiaries are an equally frequent and unstudied phenomenon in international economics. However, previous empirical studies estimate a negative effect of distance. Our framework sets the theoretical ground for this finding and extends gravity's reach within FDI.

Citation: Jordi Paniagua, (2015) "A gravity model for foreign re-investment", *Economics Bulletin*, Volume 35, Issue 1, pages 627-632
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Submitted: September 23, 2014. **Published:** March 22, 2015.

1 Introduction

The gravity equation is the most popular tool to estimate international economic flows. Similarly to Newton's Universal Law of Gravitation, the gravity equation is a natural way to analyze the determinants of international trade. Nobel laureate Jan Tinbergen (1962) realized that the extent of trade between country pairs is directly proportional to their economic mass (i.e., gross domestic product, GDP) and decreases with distance, a proxy for freight costs. These explicatory variables are still being used today.

The gravity equation explains successfully a variety of spatial economic interactions, such as trade, FDI, financial equities, migration, tourism, employment or commodity flows (Anderson, 2011; Bergstrand and Egger, 2011; Griffith, 2007; Paniagua and Sapena, 2015). Robust empirical results have led the way towards a theoretical framework built on general equilibrium conditions. This setup, however, does not fully encompass re-investment in foreign affiliates, which account for a substantial amount of the world's FDI 2013 (UNCTAD, 2013, p. 24). This paper develops a theoretical model that explains re-investment of foreign firms in a gravity context and adds theoretical substance to previous empirical finds. Hence, we broaden the scope the gravity literature and refine or understanding of investment that crosses borders.

This paper is not exception in the gravity literature, where empirics come first and theory later. The first empirical gravity estimates of bilateral trade lacked a solid theoretical background. Anderson's (1979) model is generally credited as the first approach to give theoretical substance to Tinbergen's empirical findings. Since then, several authors refined our understanding of the theoretical mechanism behind gravity (Anderson and Van Wincoop, 2003; Bergstrand, 1985).

FDI gravity models find a sound theoretical structure only recently. Initially, the application of the gravity equation to FDI was done by just substituting trade by FDI. Further gravity models, however, rest on a general equilibrium of national, multinational and trading companies (Helpman, Melitz, and Yeaple, 2004; Helpman et al., 2004; Markusen, 2002; Markusen and Venables, 1998). Under these premises, some studies explain several FDI varieties in a gravity setup: greenfield (Nocke and Yeaple, 2007); mergers (Horn and Persson, 2001; Portes and Rey, 2005), acquisitions (Davies and Kristjánsdóttir, 2010; Head and Ries, 2008), foreign affiliate sales (Bergstrand and Egger, 2007; Kleinert and Toubal, 2010), and partial ownership (Fatica, 2010; Van Assche and Schwartz, 2013).

However, the theoretical container of foreign re-investment has escaped the academic scrutiny. According to the World Investment Report (UNCTAD, 2013, p. 24), more than half of the world's total FDI is the result of re-investment in foreign subsidiaries. Moreover,

policy-makers devote substantial amounts of public resources to after-care FDI for settled multinationals enterprises MNE (Loewendahl, 2001). These foreign subsidiaries require different services since they possess a knowledge asset through their foreign subsidiary which new-comers lack. MNE internalize some production costs, providing them with locational and organizational advantages, which are partially unknown to new investors. Therefore, new entrants should be more productive, since they pay on average, a higher entry price (Arkolakis, 2011).

These facts have attracted only a handful of scholars to study certain aspects of foreign re-investment (Chiţu, Eichengreen, and Mehl, 2014; Gil-Pareja, Llorca-Vivero, and Paniagua, 2013; Paniagua and Sapena, 2013; Wren and Jones, 2009). These empirical studies show that the gravity equation fits well foreign re-investment bilateral data. That is, the amount of foreign re-investment between country pairs decreases with distance and increases with GDP. The usual gravity suspects (e.g., common language, colony, legal links) have a significant effect on the expansion of foreign firms. Apparently, these findings stand on theoretical quicksand without an adequate model. This paper fills this gap.

2 The model

As it is usual in FDI gravity models (e.g., Kleinert and Toubal, 2010), the initial setup starts with the assumption of a Cobb-Douglas utility function for consumers in the host country,

$$U_j = X_{Aj}^{\mu} X_{Bj}^{1-\mu}, \tag{1}$$

for a two sector economy with goods A and B, where μ is a sector wide parameter which describes the intensity of the consumption of each good $0 < \mu < 1$. The aggregate consumption of a good $X_j \equiv X_{Bj}$ is a CES sub-utility function in the form of:

$$X_j = \left[\int_i \int_k {x_{kij}}^{(\sigma-1)/\sigma} dk di \right]^{(\sigma/(\sigma-1)}, \tag{2}$$

where the host country j consumption the good B produced by a firm k from home country i is denoted as x_{kij}. The constant elasticity of substitution is $\sigma > 1$ and equal for any product pair.

Under the assumption of monopolistic competition with symmetric producers and varieties, the consumption of a good is simplified as:

$$X_j = n_i x_{ij}^{(\sigma-1)/\sigma}, \tag{3}$$

where n_i is the number of firms in equilibrium in country i. The price index in country j, is assumed to be a CES function:

$$P_j = \left[\int_i n_i {p_{ij}}^{1-\sigma} \right]^{1/(1-\sigma)}, \tag{4}$$

where p_{ij} is the good's price in country j.

We assume heterogeneous productivities that split the market between domestic, exporting and investing firms (Helpman et al., 2004; Melitz, 2003). Different firm productivity results in different marginal costs, different prices and different quantities for each firm k. The firm's marginal information costs is denoted by a_{kij} with $\rho_a > 0$ and therefore the productivity is proportional to $1/a_{kij}$. Profit maximization will bring a fixed markup over the marginal costs a_k.

The sales of a firm the foreign market, x_{kij}, are defined as:

$$x_{kij} = p_{ij}^{1-\sigma}(1-\mu)a_{kij}^{\rho_a}(1-\mu)Y_j P_j^{\sigma-1}, \tag{5}$$

where Y_j is the market size. Moreover, the prices of the goods produced in county i and exported to country j depend on the prince index in the source country, P_i, and the iceberg-type transaction (i.e. distance) costs τ_{ij}, thus the standard price equation for exporters $p_{ij}^{Ex} = P_i \tau_{ij}$. Therefore, dynamic firm-specific prices for a firm located in i and exporting to j yield firm specific quantities sold in j:

$$p_{ij}^{Ex} x_{kij}^{Ex} = P_i^{1-\sigma} a_{kij}^{\rho_a(1-\sigma)} \tau_{ij}^{1-\sigma}(1-\mu)Y_j P_j^{\sigma-1}. \tag{6}$$

Firms can either export goods to foreign market j or produce them on site, facing the following dilemma on trade or FDI:

$$\pi_i^{FDI} - \pi_i^{Ex} = (1-\rho)\left[p_{ij}^{FDI} x_{kij}^{FDI} - p_{ij}^{Ex} x_{kij}^{Ex}\right] > (1-\delta_{ijk})f, \tag{7}$$

where $\rho = \sigma/(\sigma-1)$; f stands for the fixed costs of establishing an additional producing plant in j and $0 < \delta_{ijk} \leq 1$ are the firms specific "headquarter services", which alleviate the sunk costs of off-shoring. Antràs and Helpman (2004) explain that through these services, firms may internalize foreign costs and engage in FDI. In a scenario featuring firm heterogeneity and fixed costs to modes of international organization, firms may invest even when the fixed costs would advise otherwise.

Headquarter services is a key insight of the model. The firm internalizes some of the foreign production costs and therefore alleviate the sunk costs of offshore subsidiaries. With

headquarters services, the subsidiary remains active in the foreign market even when sales are significantly lower than fixed costs. In return, the residual rights of control over the affiliate's operations are shifted towards headquarters (Antràs, 2003). In this scenario, the headquarter gains ownership power over the affiliate and may re-invest to keep foreign alive. Hence, we interpret re-investments as the outcome of a triple equilibrium between sales, costs and headquarter services transfer. Therefore, firms produce abroad in if the profits of doing so are higher than exporting:

$$\pi_i^{FDI} - \pi_i^{Ex} \Longleftrightarrow (1-\rho)\left[p_{ij}^{FDI} x_{kij}^{FDI} + (1-\delta_{ijk})f/(1-\rho) - p_{ij}^{Ex} x_{kij}^{Ex}\right] > 0. \tag{8}$$

The entry mode into a foreign market depends on the firm productivity and the extent of "headquarter services". The equilibrium is then characterized by the coexistence of exporting, investing and local firms. In this tier productivity system, investors are the most productive and domestic the less, re-investors lie in the middle. Substituting equation (6) in equation (8), re-investment is characterized by the equilibrium condition:

$$p_{ij}^{FDI} x_{kij}^{FDI} + (1-\delta_{ijk})f/(1-\rho) = P_i^{1-\sigma} a_{kij}^{\rho_a(1-\sigma)} \tau_{ij}^{1-\sigma} (1-\mu) Y_j P_j^{\sigma-1}. \tag{9}$$

Turning to standard gravity notation, we define home country *supply capacity* as $s_i = n_i P_i^{1-\sigma}$; host country *demand capacity* as $m_j = (1-\mu) Y_j P_j^{\sigma-1}$; distance costs as $\tau_{ij} = D_{ij}^{\rho_d} e^{\vartheta_{ij}}$; where D_{ij} is the physical distance between home and host countries with $\rho_d > 1$; and ϑ_{ij} are unmeasured cost frictions. Rearranging (9) we define foreign direct re-investment $FDrI_{kij}$ as the interplay of affiliate sales, foreign costs and headquarter transfers:

$$FDrI_{kij} = \left(s_i m_j D_{ij}^{\rho_d} a_{kij}^{\rho_a} e^{\vartheta_{ij}}\right)^{1-\sigma}. \tag{10}$$

Equation (10) reads: Foreign reinvestment is proportional to the supply and demand capacities (i.e., Gross Domestic Product, GDP) and inversely proportional to distance costs, allowing for firm specific productivity. The gravity equation (10) adds a new variety of FDI to the gravity family, foreign re-investment.

3 Conclusions

This paper broadens the framework for gravity models of FDI. We model foreign re-investment in settled subsidiaries, which has received less attention in the theoretical literature than other forms of FDI. This paper adds theoretical backup to previous empirical findings that related foreign re-investment with distance, GDP and transaction costs. Hence,

we contribute to refine and extend our knowledge on investment across borders. A fourth type of firm arises naturally in our framework. Not only domestic, exporters and foreign investors coexist, but a fourth type: re-investors. This note opens a path for new research, for example the study of the different productivity levels thresholds.

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