Tax arbitrage and global sourcing

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Abstract

Cross country differences in corporate tax rates mean that multinational firms can us strategic profit shifting to arbitrage away tax differences. Previous studies have documented this practice and explored its fiscal consequences. I show that heterogeneous taxation has real consequences, distorting two choices of the global firm: where to source, and whether to open an affiliate or purchase from an arm's length supplier. To study the extent to which taxation affects these two decisions, I build a parsimonious general equilibrium, multi-country trade model with heterogeneous firms. I show that a decrease in the statutory tax rate of a country induces more firms to locate to that country and to choose vertical integration over outsourcing. Using data on U.S. related party trade I present empirical evidence supporting this prediction. I then perform a comparative statics exercise, showing that global tax harmonization would generate a global increase in outsourcing relative to vertical integration, and induce more firms to source from the U.S.

JEL Classifications: F12, F23, H26

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1 Introduction

Corporate tax rates vary substantially across countries, ranging from 0% in Bermuda to 40% in the United States in 2016.[1] It is generally believed that such high heterogeneity has led to opportunistic behavior by multinational firms (MNFs) who shift taxable profits from high to low tax jurisdictions, or incorporate in tax havens to minimize their global tax burden. An obvious concern is that profit shifting hinders the provision of public goods due to the loss in government revenues in higher tax countries. Another concern is that it could distort firms' location of production or sourcing decisions. In this paper I explore how much the real resource allocation is affected by corporate tax heterogeneity.

In a world with homogeneous taxation, firms would decide how to organize production by weighting the costs and benefits of outsourcing at arm's length versus integrating suppliers of intermediate goods. The relative merits of these modes can vary across firms, reflecting firm specific core competencies. If the production location decision is coupled with the organizational mode decision, introducing tax heterogeneity could lead to some firms altering their decisions. More specifically, to the extent that vertical integration facilitates transfer pricing by substituting market transactions for opaque internal transactions, on the margin some firms will be induced to opt for an economically less efficient organization mode in lower tax locations. Transfer pricing is the price of MNFs' cross-border intra-company trade in goods and services. International accounting rules stipulate that transfer prices should not differ from arm's length prices, but reference prices are often missing. Coupled with infrequent auditing, this results in MNFs likely using transfer pricing to arbitrage away tax differences and lower their tax burden. Indeed, Heckemeyer and Overesch [2013], in a survey of empirical papers that document profit shifting report that 70% of the measured profit shifting is due to strategic transfer pricing. Bernard et al. [2006] also document the existence of a wedge between arm's length and related party prices, which increases in the tax rate of the affiliate.

This paper attempts to quantify the real resource costs associated with two channels through which corporate taxation distorts economic decisions: production location and organizational mode. To

[1] KPMG's Corporate Tax Rate Survey, 2016.

this end, I build a multi-country general equilibrium model of international production with both channels at work. I borrow from Melitz [2003] and Arkolakis et al. [2013] the features of heterogeneous firms that sell differentiated final goods in monopolistically competitive markets. The non-traded final goods are assembled using potentially internationally sourced intermediates. Unlike Melitz [2003], I have fixed entry in each country to be able to generate taxable equilibrium profits. In addition, firms differ in their organizational modes of production. Vertically integrating intermediates production enables strategic transfer pricing, whereas outsourcing does not. Core firm productivites across production locations and modes are independently drawn from an extreme value distribution.

I employ the model in two ways. First, using data on U.S. Census Related Party trade and statutory tax rates, I test the model's prediction that, all else equal, the lower the tax rate of a potential production location, the higher the share of related party trade. I confirm this relationship. Second, after calibrating the model, I conduct two exercises to illustrate the workings of the model a) harmonize taxes globally, and b) equalize the U.S. corporate tax rate to Germany's tax rate. In a small version of the world, with the U.S., Germany, and Denmark being the only countries trading with each other, I show that tax harmonization would lead to substantial change in the allocation of resources. Relative to the current tax regime, more firms choose to invest in the United States, and more firms opt for outsourcing. Furthermore, reducing the U.S. statutory tax rate to the German rate of 29.6 percent would increase U.S. real exports by approximately 3 percent.

This paper contributes to the literature studying how taxes affect multinational production and, to the best of my knowledge, it is the first attempt at quantifying the global resource misallocation resulting from heterogeneous taxation. The modern trade literature pays little attention to taxation issues. An exception is Fajgelbaum et al. [2016]. They build build a spatial general equilibrium model of economic activity across states in the U.S. and find that U.S. state tax dispersion leads to aggregate welfare losses in the absence of a high correlation between initial tax rates and state amenities or productivity. As helpful as their setup is in thinking about tax dispersion in general equilibrium, it does not allow for multi-state firms, thus no intrafirm trade and strategic transfer pricing. The rest of the literature is generally set in partial equilibrium, and focuses on environments where strategic transfer pricing partially offsets tax distortions, which is not the focus of our paper. For example, Keuschnigg and Devereux [2012] show that when investment in an affiliate requires external funds collateralized by the MNF's income, profit shifting allows the MNF to invest on a larger scale. In a model of horizontal integration, Amerighi and Peralta [2010] show that when individual profit maximization choice is single-plant but the welfare maximization organization is double-plant, profit shifting could be welfare improving. The work of Egger and Seidel [2013] is more closely related to my analysis. In a semi-general equilibrium model they argue that heterogeneous taxation induces firms to vertically integrate, leading to higher intra-firm trade. However, there is no location decision for the MNFs, which I believe is crucial to capture resource misallocation.

The rest of the paper is structured as follows. Section 2 develops the model and characterizes the equilibrium. Section 3 tests model hypotheses, calibrates the model and attempts to estimate the deep parameter η, which governs the strength of government enforcement of the arm's length principle. Section 4 presents the counterfactual exercises and Section 5 concludes.

2 Theoretical framework

2.1 Consumers

The world consists of N countries populated by mass L_i for $i = \{1, 2, \ldots, N\}$ of consumers who value differentiated goods aggregated as $Q = \left(\int_{\phi\in\Omega_i} q_i(\phi)^{\frac{\sigma-1}{\sigma}} d\phi\right)^{\frac{\sigma}{\sigma-1}}$, where $\sigma > 1$ is the and Ω_i represents the universe of varieties in country i. Consumers supply labor inelastically, for which they receive wage w_i, and own the firms headquartered in country i. Therefore, in each country, the representative consumer solves the problem:

$$\max_{q_i(\phi)} \log Q_i$$

$$s.t \int_{\phi\in\Omega_i} p_i(\phi) q_i(\phi) d\phi = w_i L_i + \text{Net}\Pi_i$$

where $\text{Net}\Pi_i$ represents the net profits of firms headquartered in country i, which are owned by consumers in country i. Optimization gives rise to the demand for each variety ϕ:

$$\begin{aligned} q_i(\phi) &= \frac{X_i}{\int_{\phi\in\Omega_i} p_i(\phi)^{1-\sigma} d\phi} p_i(\phi)^{-\sigma} \\ &= A_i p_i(\phi)^{-\sigma} \end{aligned}$$

where X_i is total expenditure in country i. Noting that the price index can be expressed as $P_i = \left(\int_{\phi\in\Omega_i} p_i(\phi)^{1-\sigma} d\phi\right)^{\frac{1}{1-\sigma}}$, I can rewrite demand as $q_i(\phi) = X_i P_i^{\sigma-1} p_i(\phi)^{-\sigma}$. By setting $B_i = A_i \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} \frac{1}{\sigma}$, the inverse demand can then be written as $p_i(q_i(\phi)) = q_i(\phi)^{-\frac{1}{\sigma}} B_i^{\frac{1}{\sigma}} \sigma (\sigma-1)^{-\frac{\sigma}{1-\sigma}}$.

2.2 Firms

Each country i has corporate tax rate t_i and is populated by a fixed mass of firms M_i. A firm is a blueprint for a unique variety and produces final goods by assembling an intermediate good sourced anywhere in the world using the technology $q_i(\phi) = m(\phi)$. All intermediate goods need to be shipped to the firm's headquarters for assembly. To simplify the analysis, I assume that there is no trade in final goods. Iceberg trade costs from i to j are τ_{ij}. A firm from country i can obtain inputs in country j by either outsourcing production, O, with a unit cost of $\frac{\tau_{ij} w_j}{\phi_j^O}$, or by opening an affiliate and vertically integrating, VI, with a unit cost $\frac{\tau_{ij} w_j}{\phi_j^{VI}}$. If O, a firm gets matched with workers in the country it is sourcing from via a competitive independent contractor. There are no matching frictions.

Firms draw a vector Φ of $2N$ core productivities associated with each country and each mode of sourcing. These draws reflect heterogeneity in firms' abilities to operate a plant in a given county, as well as in their ability to match with low cost suppliers in other countries. They chose location and mode of sourcing by maximizing over the $2N$ location-mode expected profits. All elements of Φ are independently drawn from the Frechet distribution $F\left(\phi_j^k \leq \phi\right) = e^{-T_j^k \phi^{-\theta}}$ where $\theta > (\sigma-1)$, $T_j > 0$ for $k = \{VI, O\}$ and $j = \{1, 2, \ldots, N\}$. θ is the dispersion parameter and T_j^k is the location parameter that varies by country and mode of serving the country.

I assume that all tax revenues are lost.

2.2.1 Outsourcing profit:

A firm outsourcing production of intermediate goods to producer with productivity ϕ, chooses intermediate good level m to maximize expected profits. After substituting for optimal demand obtained from the consumers optimization problem, optimal after-tax profits would be:

$$\Pi_{ij}^{O}(\phi) = (1 - t_i)\, B_i \left(\tau_{ij} w_j\right)^{1-\sigma} \phi_j^{O\sigma-1} = (1 - t_i)\, B_i c_{ij}^{O1-\sigma} \tag{1}$$

I assume that the price paid to the contractor is $\frac{\tau_{ij} w_j}{\phi_j^O}$, reflecting perfect competition in the market. Spending on imports from country j in O mode is

$$m_{ij}^{O}(\phi) = (\sigma - 1) B_i \left(\tau_{ij} w_j\right)^{1-\sigma} \phi_j^{O\sigma-1} = (\sigma - 1) B_i c_{ij}^{O1-\sigma}$$

2.2.2 Integration profit:

There is an advantage to opening an affiliate: Firms use transfer pricing to shift profits between locations to arbitrage away tax differences and lower their global tax burden. I assume that at the end of the period the profits are always repatriated without penalty. That is, consumers located in the headquarter country get all after-tax global profits. The after tax profits of a firm located in country i that sources in VI mode from country j, are:

$$\begin{aligned} \Pi_{ij}^{VI} &= \left((1 - t_i)^{\eta_{ij}} (1 - t_j)^{1-\eta_{ij}}\right) B_i (\tau_{ij} w_j)^{1-\sigma} \phi_j^{VI\sigma-1} \\ &= \gamma_{ij} B_i c_{ij}^{VI1-\sigma} \end{aligned} \tag{2}$$

Since transfer pricing is used when affiliate taxes are lower than headquarter taxes, I set $0 < \eta_{ij} = \eta_i \leq 1$ if $t_i \geq t_j$ and $\eta_{ij} = 1$ if $t_i < t_j$. Here η_{ij} represents the strength of government enforcement of the arms' length principle. I provide a microfoundation for the after tax optimal profit in the appendix. Spending on imports from j in VI mode is $m_{ij}^{VI}(\phi) = (\sigma - 1)\, B_i(\tau_{ij} w_j)^{1-\sigma} \phi_j^{VI\sigma-1} = (\sigma - 1)\, B_i c_{ij}^{VI1-\sigma}$.

2.3 Aggregation

To find the share of country i imports from country j that come from IV or O I follow these steps: First, I find the probability that country j in mode IV/O is the maximum profit. Second, I aggregate over individual choices using the density obtained in step 1.

Using the properties of the Frechet distribution, I find the probability that country l is the minimum cost location in modes VI and O, is, respectively:

$$
\begin{aligned}
&Pr(\Pi_{i1}^{VI} \leq \pi, \Pi_{i1}^{O} \leq \pi, \ldots, \Pi_{il}^{VI} = \pi, \ldots, \Pi_{iN}^{VI} \leq \pi, \Pi_{iN}^{O} \leq \pi) = \\
&= \frac{\theta}{\sigma - 1} \pi^{\frac{-\theta}{\sigma-1} - 1} B_i^{\frac{\theta}{\sigma-1}} \gamma_{il}{}^{\frac{\theta}{\sigma-1}} T_l^{VI} \psi_{il} \Psi_i \exp -\{B_i^{\frac{\theta}{\sigma-1}} \Psi_i \pi^{\frac{-\theta}{\sigma-1}}\}
\end{aligned} \tag{3}
$$

and

$$
\begin{aligned}
&Pr(\Pi_{i1}^{VI} \leq \pi, \Pi_{i1}^{O} \leq \pi, \ldots, \Pi_{il}^{O} = \pi, \ldots, \Pi_{iN}^{VI} \leq \pi, \Pi_{iN}^{O} \leq \pi) = \\
&= \frac{\theta}{\sigma - 1} \pi^{\frac{-\theta}{\sigma-1} - 1} (1 - t_i)^{\frac{\theta}{\sigma-1}}\, B_i^{\frac{\theta}{\sigma-1}} T_l^{O} \psi_{il} \Psi_i \exp -\{B_i^{\frac{\theta}{\sigma-1}} \Psi_i \pi^{\frac{-\theta}{\sigma-1}}\},
\end{aligned} \tag{4}
$$

where $\Psi_i = \sum_{j=1}^{N} (\tau_{ij} w_j)^{-\theta} \left[T_j^{VI} \gamma_{ij}{}^{\frac{\theta}{\sigma-1}} + T_j^{O} (1 - t_i)^{\frac{\theta}{\sigma-1}} \right]$, $\psi_{il} = \frac{(\tau_{il} w_l)^{-\theta}}{\Psi_i}$.

Note that integrating over all possible values of π, the probability that a firm from i sources from country l in mode VI can be written as:

$$
\psi_{il}^{VI} = T_l^{VI} \psi_{il} \gamma_{il}{}^{\frac{\theta}{\sigma-1}} \tag{5}
$$

And the probability that that a firm from i sources from country l in mode O is:

$$\psi_{il}^{O} = T_l^O \psi_{il} \left(1 - t_i\right)^{\frac{\theta}{\sigma-1}} \tag{6}$$

The equations in (3) and (4) multiplied by M_i also represent the measure of country i firms that source from l in mode VI and O, respectively. It is easy to show that, $\frac{\partial \psi_{il}^{VI}}{\partial t_l} < 0$, $\frac{\partial \psi_{il}^{O}}{\partial t_l} > 0$, if $t_i \leq t_l$.

I calculate the amount of intrafirm imports in country i that come from country j by aggregating over individual firms' import spending. Noting that $m_{ij}^{VI} = \frac{\sigma-1}{\gamma_{ij}} \Pi_{ij}^{VI}$ and using the density in (3):

$$Imp_{ij}^{VI} = M_i(\sigma-1)\gamma_{ij}^{\frac{\theta}{\sigma-1}-1} T_j^{VI} \psi_{ij} \Psi_i^{\frac{\sigma-1}{\theta}} B_i \Gamma\left(1 - \frac{\sigma-1}{\theta}\right)$$

where$\Gamma\left(1 - \frac{\sigma-1}{\theta}\right)$ is the Gamma function. For imports to be defined, $\theta > \sigma - 1$ is required. Total sales of country i firms that import from j:

$$X_{ij}^{VI} = \frac{\sigma}{\sigma-1} Imp_{ij}^{VI} = \sigma M_i \gamma_{ij}^{\frac{\theta}{\sigma-1}-1} T_j^{VI} \psi_{ij} \Psi_i^{\frac{\sigma-1}{\theta}} B_i \Gamma\left(1 - \frac{\sigma-1}{\theta}\right) \tag{7}$$

Similarly, sales of country i firms that import from j in O mode:

$$X_{ij}^{O} = \frac{\sigma}{\sigma-1} Imp_{ij}^{O} = \sigma M_i \left(1 - t_i\right)^{\frac{\theta}{\sigma-1}-1} T_j^{O} \psi_{ij} \Psi_i^{\frac{\sigma-1}{\theta}} B_i \Gamma\left(1 - \frac{\sigma-1}{\theta}\right) \tag{8}$$

Total sales of country i firms that import from j:

$$X_{ij} = \sigma M_i \psi_{ij} \Psi_i^{\frac{\sigma-1}{\theta}} B_i \Gamma\left(1 - \frac{\sigma-1}{\theta}\right)\left(T_j^{VI} \gamma_{ij}^{\frac{\theta}{\sigma-1}-1} + T_j^{O}\left(1 - t_i\right)^{\frac{\theta}{\sigma-1}-1}\right) \tag{9}$$

Intrafirm import spending as a share of spending on imports from country j would then be:

$$\chi_{ij}^{VI} = \frac{T_j^{VI} \gamma_{il}^{\frac{\theta}{\sigma-1}-1}}{T_j^{VI} \gamma_{ij}^{\frac{\theta}{\sigma-1}-1} + T_j^{O} \left(1 - t_i\right)^{\frac{\theta}{\sigma-1}-1}} \tag{10}$$

Note that $\frac{\partial \chi_{ij}^{VI}}{\partial t_j} = -\frac{T_j^{VI}\left(\frac{\theta}{\sigma-1}-1\right)(1-\eta_{ij})\gamma_{ij}^{\frac{\theta}{\sigma-1}}(1-t_j)^{-1}}{T_j^{VI}\gamma_{ij}^{\frac{\theta}{\sigma-1}-1}+T_j^{O}(1-t_i)^{\frac{\theta}{\sigma-1}-1}}\left(1-\frac{T_j^{VI}\gamma_{ij}^{\frac{\theta}{\sigma-1}-1}}{T_j^{VI}\gamma_{ij}^{\frac{\theta}{\sigma-1}-1}+T_j^{O}(1-t_i)^{\frac{\theta}{\sigma-1}-1}}\right) < 0$ if $t_i \geq t_j$. This is a prediction of the model that I test in the data.

Spending on final goods assembled with VI and O imports from country j as a share of total spending in country i are, respectively:

$$\begin{aligned} \lambda_{ij}^{VI} &= \frac{\gamma_{ij}^{\frac{\theta}{\sigma-1}-1} T_j^{VI} (\tau_{ij} w_j)^{-\theta}}{\sum_{k=1}^{N} (\tau_{ik} w_k)^{-\theta} \left(T_k^{VI} \gamma_{ik}^{\frac{\theta}{\sigma-1}-1} + T_k^{O} \left(1 - t_i\right)^{\frac{\theta}{\sigma-1}-1}\right)} \\ \lambda_{ij}^{O} &= \frac{(1-t_i)^{\frac{\theta}{\sigma-1}-1} T_j^{O} (\tau_{ij} w_j)^{-\theta}}{\sum_{k=1}^{N} (\tau_{ik} w_k)^{-\theta} \left(T_k^{VI} \gamma_{ik}^{\frac{\theta}{\sigma-1}-1} + T_k^{O} \left(1 - t_i\right)^{\frac{\theta}{\sigma-1}-1}\right)} \end{aligned} \tag{11}$$

Equation (11) resembles a gravity equation, which can easily be seen when rewritten as:

$$\begin{aligned} \lambda_{ij}^{VI} = & \underbrace{\frac{(1-t_i)^{\eta(\frac{\theta}{\sigma-1}-1)}}{\sum_{k=1}^{N} (\tau_{ik} w_k)^{-\theta} \left(T_k^{VI} \gamma_{ik}^{\frac{\theta}{\sigma-1}-1} + T_k^{O} \left(1 - t_i\right)^{\frac{\theta}{\sigma-1}-1}\right)}}_{Importer \quad fixed \quad effect} \times_{Source} \underbrace{T_j^{VI} w_j^{-\theta}}_{characteristics} \times \\ & \times_{Bilateral} \underbrace{\tau_{ij}^{-\theta}}_{trade} {}_{barriers} \times \underbrace{(1-t_j)^{(1-\eta)(\frac{\theta}{\sigma-1}-1)}}_{Source \quad taxes} \end{aligned} \tag{12}$$

If bilateral intrafirm import data were available for a few countries, using various measures of τ_{ij}, data on statutory tax rates t_j, data on wages, and proxies for T_j^{VI} I would be able to estimate two elasticities of trade flows: θ, the elasticity of intrafirm trade flows with respect to bilateral trade barriers, and $(1-\eta)(\frac{\theta}{\sigma-1}-1)$, the elasticity of intrafirm trade flows with respect to the host country tax rate. With data available for the U.S. only, I can estimate $(1-\eta)(\frac{\theta}{\sigma-1}-1)$, but not θ.

Spending on final goods assembled with country j intermediates as a share of country i's total spending:

$$\lambda_{ij} = \frac{(\tau_{ij}w_j)^{-\theta}\Big(T_j^{VI}\gamma_{ij}{}^{\frac{\theta}{\sigma-1}-1} + T_j^{O}\left(1-t_i\right)^{\frac{\theta}{\sigma-1}-1}\Big)}{\sum_{k=1}^{N}(\tau_{ik}w_k)^{-\theta}\Big(T_k^{VI}\gamma_{ik}{}^{\frac{\theta}{\sigma-1}-1} + T_k^{O}\left(1-t_i\right)^{\frac{\theta}{\sigma-1}-1}\Big)} \tag{13}$$

The ratio of intrafirm to outsourcing spending on imports from country j would be:

$$Ratio_{ij}^{\frac{VI}{O}} = \frac{T_j^{VI}}{T_j^{O}}\left(\frac{\gamma_{ij}}{1-t_i}\right)^{\frac{\theta}{\sigma-1}-1} \tag{14}$$

I use equation (14) to inform the choice of the parameter η, which I discuss at length in Section 3.2.

2.4 Equilibrium

The mass of firms in each country is fixed at M_i. An equilibrium consists of $\{X_i\}_i$, $\{w_i\}_i$, such that:

- Consumers and firms make optimal decisions
- w_i clears the labor market $\forall i$
- The final goods market is cleared $\forall i$
- The current account is balanced $\forall i$

Aggregate resource constraint:

$$Xi = w_i L_i + Net\Pi_i \quad \forall i \tag{15}$$

Net aggregate profits of integrated firms $= M_i \Psi_i^{\frac{\sigma-1}{\theta}} B_i \Gamma\Big(1 - \frac{\sigma-1}{\theta}\Big) \sum_{k=1}^{N} T_k^{VI} \psi_{ik} \gamma_{ik}^{\frac{\theta}{\sigma-1}}$

Net aggregate profits of outsourcing firms $= M_i \left(1 - t_i\right)^{\frac{\theta}{\sigma-1}} \Psi_i^{\frac{\sigma-1}{\theta}} B_i \Gamma\Big(1 - \frac{\sigma-1}{\theta}\Big) \sum_{k=1}^{N} T_k^{O} \psi_{ik}$

Recall that $B_i = X_i P_i^{\sigma-1} \Big(\frac{\sigma}{\sigma-1}\Big)^{1-\sigma} \frac{1}{\sigma}$, and $\psi_{ik} = \frac{(\tau_{ik} w_k)^{-\theta}}{\Psi_i}$so that

$$\begin{aligned}
Net\Pi_i &= M_i \Psi_i^{\frac{\sigma-1}{\theta}} X_i P_i^{\sigma-1} \Big(\frac{\sigma}{\sigma-1}\Big)^{1-\sigma} \frac{1}{\sigma} \Gamma\Big(1 - \frac{\sigma-1}{\theta}\Big) \sum_{k=1}^{N} \psi_{ik} \Big(T_k^{VI} \gamma_{ik}^{\frac{\theta}{\sigma-1}} + T_k^{O} \left(1 - t_i\right)^{\frac{\theta}{\sigma-1}} \Big) \\
&= M_i \Psi_i^{\frac{\sigma-1}{\theta}-1} X_i P_i^{\sigma-1} \Big(\frac{\sigma}{\sigma-1}\Big)^{1-\sigma} \frac{1}{\sigma} \Gamma\Big(1 - \frac{\sigma-1}{\theta}\Big) \sum_{k=1}^{N} (\tau_{ik} w_k)^{-\theta} \Big(T_k^{VI} \gamma_{ik}^{\frac{\theta}{\sigma-1}} + T_k^{O} \left(1 - t_i\right)^{\frac{\theta}{\sigma-1}} \Big)
\end{aligned}$$

And so, the aggregate constraint becomes:

$$X_i = w_i L_i + M_i \Psi_i^{\frac{\sigma-1}{\theta}-1} X_i P_i^{\sigma-1} \Big(\frac{\sigma}{\sigma-1}\Big)^{1-\sigma} \frac{1}{\sigma} \Gamma\Big(1 - \frac{\sigma-1}{\theta}\Big) \sum_{k=1}^{N} (\tau_{ik} w_k)^{-\theta} \Big(T_k^{VI} \gamma_{ik}^{\frac{\theta}{\sigma-1}} + T_k^{O} \left(1 - t_i\right)^{\frac{\theta}{\sigma-1}} \Big) \tag{16}$$

The balanced current account condition would be:

$$Imp_i = \frac{\sigma-1}{\sigma} X_i = \frac{\sigma-1}{\sigma} \sum_{j=1}^{N} X_{ij} = \frac{\sigma-1}{\sigma} \sum_{j=1}^{N} X_{ji} = Exp_i$$

Noting that $X_{ji} = \lambda_{ji}^{VI} X_j + \lambda_{ji}^{O} X_j = \lambda_{ji} X_j$,I ca express the balanced current account condition as:

$$X_i = \sum_{j=1}^{N} \lambda_{ji} X_j \tag{17}$$

where $\lambda_{ij}$is given by (13). Also, from (7) and (8), total sales are:

$X_i = \sum_{j=1}^{N} X_{ij}^{VI} + X_{ij}^{O} = \sigma M_i \Psi_i^{\frac{\sigma-1}{\theta}} B_i \Gamma\left(1 - \frac{\sigma-1}{\theta}\right) \sum_{j=1}^{N} \psi_{ij} \left(T_j^{VI} \gamma_{ij}^{\frac{\theta}{\sigma-1}-1} + T_j^{O} \left(1 - t_i\right)^{\frac{\theta}{\sigma-1}-1} \right)$

Noting that $B_i = X_i P_i^{\sigma-1} \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} \frac{1}{\sigma}$, prices would be:

$$P_i^{1-\sigma} = M_i \Psi_i^{\frac{\sigma-1}{\theta}-1} \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} \Gamma\left(1 - \frac{\sigma-1}{\theta}\right) \sum_{k=1}^{N} (\tau_{ik} w_k)^{-\theta} \left(T_k^{VI} \gamma_{ik}^{\frac{\theta}{\sigma-1}-1} + T_k^{O} \left(1 - t_i\right)^{\frac{\theta}{\sigma-1}-1} \right) \tag{18}$$

combining equation (16) and (18) we have:

$$X_i = w_i L_i + \frac{1}{\sigma} X_i \frac{\sum_{k=1}^{N} (\tau_{ik} w_k)^{-\theta} \left(T_k^{VI} \gamma_{ik}^{\frac{\theta}{\sigma-1}} + T_k^{O} \left(1 - t_i\right)^{\frac{\theta}{\sigma-1}} \right)}{\sum_{k=1}^{N} (\tau_{ik} w_k)^{-\theta} \left(T_k^{VI} \gamma_{ik}^{\frac{\theta}{\sigma-1}-1} + T_k^{O} \left(1 - t_i\right)^{\frac{\theta}{\sigma-1}-1} \right)}$$

Or:

$$X_i = w_i L_i \left(1 - \frac{1}{\sigma} \frac{\sum_{k=1}^{N} (\tau_{ik} w_k)^{-\theta} \left(T_k^{VI} \gamma_{ik}^{\frac{\theta}{\sigma-1}} + T_k^{O} \left(1 - t_i\right)^{\frac{\theta}{\sigma-1}} \right)}{\sum_{k=1}^{N} (\tau_{ik} w_k)^{-\theta} \left(T_k^{VI} \gamma_{ik}^{\frac{\theta}{\sigma-1}-1} + T_k^{O} \left(1 - t_i\right)^{\frac{\theta}{\sigma-1}-1} \right)} \right)^{-1} \tag{19}$$

where the expression in brackets is less than 1.

Equations (17) and (19) form a system of $2N$ equations and $2N$ unknowns that give solutions for $\{X_i\}_i$, $\{w_i\}_i$.

3 Empirical analysis

3.1 Testing model predictions

I use the U.S. Census Related Party Trade data in manufacturing at the 6-digit NAICS level and statutory corporate tax rates to test two predictions of the model: 1) a decrease in the corporate tax rate of a potential source country leads to a higher volume of related party imports with that country, and 2) a decrease in the corporate tax rate of a potential source country leads to a higher related party imports share of total imports. The related party trade sample consists of 136 countries and covers 472 industries during the period 2002-2014. The statutory tax rates were compiled using annual reports from KPMG. Table 1 contains the reduced form estimation results.

The specification in column (1) is inspired by equation (7) with the dependent variable as the logarithm of related party imports. Country fixed effects capture exporter fixed effects. I also specify time fixed effects to account for potential common trends in the dependent and independent variables, since the dependent variable is a level variable. In addition to exporter fixed effects, I include the log of GDP and the log GDP per capita based on the hypothesis that bigger and richer countries imply thicker markets and more opportunities for arm's length contracting. This hypothesis is rejected, however. Importantly, the coefficient of taxrate has the expected sign and is statistically significant. In column (2), the dependent variable is the log of the share of related party imports to total imports, inspired by equation (10). As expected, an increase in the taxrate lowers the share of intra-firm imports.

In columns (3) and (4), I use industry level data. Given that the sample size increases 10-fold, I include more country-year covariates expected to capture the institutional quality of potential sources. These covariates are informed by Antras et al. [2009]. All else equal, higher private sector credit as a share of GDP indicates a higher level of financial development, which could mean a more favorable environment for arm's length contracts. A similar hypothesis is maintained for institutional quality as captured by the International Country Risk Guide (ICRG)'s law and order and financial risks rating. For ICRG's indices, a higher value signifies higher risk. Albeit insignificant, the coefficients suggest an alternative interpretation: The higher the risk of a potential source, the lower the propensity to vertically integrate in the country. Taxrate maintains the negative and significant contribution to the share of intrafirm trade. In column (4), I include intra-company trade determinants that vary by industry as in Antras [2016]. The sample size decreases because the industry covariates, which are downloaded from Pol Antras' website, are available only until 2011.[2] Freight costs and U.S. tariffs capture trade frictions, whereas the log of capital/labor ratio captures headquarter intensity. As in the book, freight costs and tariffs have a negative coefficient, with freight costs statistically significant.

Bernard et al. [2006] show that the wedge between related party and arm's length prices is higher for differentiated goods. I use elasticity of substitution estimates from Broda and Weinstein [2006], found in Pol Antras' website, to identify industries with more differentiated products and interact the industry dummy with the tax rate. In my sample, these elasticity of demand estimates range from 1.3 to 94.3, with a mean of 9.95. I apply a cutoff of $\sigma = 5$, which covers about 18% of annual imports on average during 2002-2011. The last column in Table 1 shows that indeed, the tax rate coefficient is statistically significant and bigger in absolute value for industries with $\sigma < 5$.

In tables A1, A2 and A3 in the appendix, I show regression results for the following checks: dropping years 2004 and 2005, dropping countries that are classified as tax havens: Switzerland, Luxembourg, Bermuda, Gibraltar, and the Cayman Islands, and dropping both years and tax havens. I perform the first check to ensure that the results are not driven by these two years alone, when strategic transfer pricing could would have been more prevalent due to the passing of the Homeland Investment Act (HIA) in October 2004. I discuss this law detail in the following section. With industry level aggregation, the results still hold. At the country level aggregation, however, coefficients become insignificant, but maintain the sign and magnitude. I perform the second check to ensure that the taxrate coefficients reflect the mechanism described in the theoretical model. Table 7 shows that results are robust to the exclusion at both the aggregate level and the industry level. Lastly, dropping 2004, 2005 and tax haves shows that the results are robust at the industry aggregation level.

[2] http://scholar.harvard.edu/antras/books

Table 1: Determinants of U.S. Intrafirm Trade Shares

	(1)	(2)	(3)	(4)	(5)
	AGGREGATE	AGGREGATE	INDUSTRY	INDUSTRY	INDUSTRY
VARIABLES	log(imp_rel)	log(imp_rel/imp_tot)	log(imp_rel/imp_tot)	log(imp_rel/imp_tot)	log(imp_rel/imp_tot)
lGDP	0.190	0.105	0.113***	0.129***	0.128***
	(0.184)	(0.119)	(0.0384)	(0.0379)	(0.0379)
lGDP_capita	0.893**	0.824**	0.334***	0.215**	0.210**
	(0.419)	(0.343)	(0.0898)	(0.105)	(0.105)
taxrate	-1.705**	-1.000*	-0.637***	-0.503***	-0.215
	(0.840)	(0.578)	(0.167)	(0.194)	(0.217)
Dummy*taxrate					-0.755***
					(0.236)
lcredit/GDP			0.161***	0.0635*	0.0623*
			(0.0306)	(0.0326)	(0.0325)
ICRG: law & order			-0.00197	-0.0112	-0.0115
			(0.0160)	(0.0169)	(0.0169)
ICRG: financial risk			-0.00416**	-0.00506**	-0.00504**
			(0.00204)	(0.00244)	(0.00244)
Freight costs				-5.396***	-5.555***
				(0.603)	(0.608)
Tariffs				-0.0165	-0.0144
				(0.0104)	(0.00921)
lCapital/Labor				-0.197***	-0.215***
				(0.0275)	(0.0272)
Fixed effects	Country & Year	Country	Country	Country	Country
Observations	1,390	1,390	176,424	134,872	134,872
Time period	2002-2014	2002-2014	2002-2014	2002-2011	2002-2011
R-squared	0.961	0.727	0.098	0.141	0.144

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

3.2 Tax elasticity of intrafirm trade

My next task is to estimate the deep parameters of the model, which govern the elasticity of intrafirm trade with respect to taxes, $(1-\eta)(\frac{\theta}{\sigma-1}-1)$. Taking the log of equation (14), I obtain a linear relationship between the ratio of intrafirm to arms' length trade and taxes.

$$log(Ratio_{ij}^{\frac{VI}{O}}) = \underbrace{\left(\frac{\theta}{\sigma-1}-1\right)(\eta-1)}_{A} log(1-t_i) + \underbrace{\left(\frac{\theta}{\sigma-1}-1\right)(1-\eta)}_{B} log(1-t_j) + \underbrace{log\left(\frac{T_j^{VI}}{T_j^{O}}\right)}_{Source \quad charac.}$$

Since I only have data for one country i's bilateral trade, observing that $t_i = 0.4$ is a constant and noting that $A = -B$, I can rewrite the equation as:

$$log(Ratio_{ij}^{\frac{VI}{O}}) = \left(\frac{\theta}{\sigma-1}-1\right)(1-\eta)log\left(\frac{1-t_j}{1-0.4}\right) + log\left(\frac{T_j^{VI}}{T_j^{O}}\right) \tag{20}$$

Before discussing the estimation strategy, I highlight a concern with taking the model to the data using data on the U.S. only. Missing the entire matrix of bilateral intrafirm trade means that I cannot use fixed effects estimation in a cross-section in a given year. Under these circumstances, cross-country regressions could be misspecified due to omitted variables, which would bias the taxrate coefficient. Indeed, for most years in 2002-2014 cross-country regressions show a negative relationship between $log(Ratio_{ij}^{\frac{VI}{O}})$ and $log\left(\frac{1-t_j}{0.6}\right)$, even after controlling for variables that could be correlated with the tax rate like institutional quality and market thickness. Notable exceptions are the years 2004 and 2005 in some specifications, which I discuss in detail below. In all specifications, I exclude countries that are primarily tax havens, namely Switzerland, Luxembourg, Bermuda, Gibraltar, and the Cayman Islands.

My first specification, column (1) in Table 2, relies on a country-year panel fixed effects estimation to inform the choice of η. This allows me to eliminate country specific characteristics correlated with the tax rate that are either unobservable or difficult to measure. The specification takes the following form:

$$log(Ratio_{jt}^{\frac{VI}{O}}) = \alpha_j + \beta log\Big(\frac{1-t_{jt}}{0.6}\Big) + \epsilon_{jt} \tag{21}$$

where α_j are country fixed effects, and $\beta = \Big(\dfrac{\theta}{\sigma-1} - 1\Big)(1-\eta)$ is the effect of $log\Big(\frac{1-t_j}{0.6}\Big)$ on the dependent variable.[3] With choices for θ and σ, the estimated coefficient $\hat{\beta}$ helps identify η. The second specification relies on an industry-country-year panel of the form of (21) with the only difference being the increased sample size. Motivated by the reduced form findings of the previous section, column (3) reports the results for industries $\sigma < 5$.

The third specification has cross section estimates at the industry level for the years 2004 and 2005 to inform the choice for η. In October 2004, the Homeland Investment Act (HIA) was passed into law. The HIA allowed firms a one-time deduction of 85% of the dividends received, from additional taxes coming from controlled foreign operations.[4] As reported in Flaaen [2016], according to calculations done by Redmiles [2008] around 850 corporations repatriated $360 billion as part of HIA during 2004-2006. I expect the incentives for strategic transfer pricing to increase the year after the law changed, and to a lesser extent the year the law changed.[5] The tax holiday would induce companies to shift more profits overseas to increase the repatriation value of their profits. I do find this relationship in the data.

Table 2 gives the regression results and the implied η. In the first row, we assume $\sigma = 3.8$ as in Antras et al. [2014] and consistent with the ranges found in the literature. I also assume that $\theta = 8.28$ as in Eaton and Kortum [2002]. Looking at columns (1) to (3), my assumptions, together with estimated elasticities imply quite low values of η, with the lowest value of 0.01 in column (3). Columns (4) and (5) indicate that the incentive for strategic transfer pricing was indeed higher in 2004 and 2005, compared to other years. Since in all other years that I run cross-country regressions the coefficient on ltaxes is negative, I conclude that the cross-section specification

[3] The U.S. tax rate has been unchanged during 2002-2014, so I can just treat it as a constant.
[4] Flaaen [2016]provides a detailed description of the terms of the bill.
[5] Flaaen [2016]argues that there was uncertainty around the passing by the House of the American Job Creation Act, part of which HIA is, in June 2004.

estimates suffer from omitted variable bias: I am omitting a variable that is positively correlated with the tax rate in a non-time varying way. Yet, despite the bias, ltaxes has the correct sign in 2004 and 2005, but a lower magnitude. In the second row, I assume that $\frac{\theta}{\sigma-1} = 4.34$, based on Boehm et al. [2015]. In that paper, the authors use firm level data to estimate what they call the elasticity of firm revenues with respect to firm efficiency, $\frac{\sigma-1}{\theta}$. The parameters θ and σ are the dispersion parameter of the Frechet distribution, as in this paper, and the demand elasticity of substitution, respectively. Their highest point estimate is 0.23, in year 1997 which implies $\frac{\theta}{\sigma-1} = 4.34$.[6] Coupled with an assumption of $\theta = 12.86$, which is in the range of estimates produced by Eaton and Kortum [2002], this choice implies that $\sigma = 3.96$. I find the implied values of η more reasonable under the second set of assumptions, and will proceed with those in the counterfactual analyses.

3.3 Estimating T_i^{VI} and T_i^O

Letting $T_i^{VI} = e_i T_i^O$, I can rewrite equation (21) as:

$$log(Ratio_{ij}^{\frac{VI}{O}}) = log(e_i) + \Big(\frac{\theta}{\sigma - 1} - 1\Big)(1-\eta)log\Big(\frac{1-t_j}{1-0.4}\Big)$$

The specification in (22) allows me back out $\hat{\alpha}_i$. I use the specification in column 1 of Table 2 to obtain estimates for e_i's. Since I do not have data for within U.S. related party and arm's length production, I assume that $e_{USA} = 1$. The analyses in the following section assumes that a country's overall state of technology is a simple average of the outsourcing and integration states of technology. Therefore, with estimates for T_i, I can obtain estimates for T_i^{VI} and T_i^O. As a first attempt, I use T_i estimates found in Eaton and Kortum [2002] and decompose them into T_i^{VI} and T_i^O using my own estimates for e_i obtained by running the regression above.

[6] Their lowest point estimate is 0.06, in 2007, which implies $\frac{\theta}{\sigma-1} = 16.7$. I have not encountered big enough values of θ in the literature to support this high ratio.

Table 2: Implied η

	(1)	(2)	(3)	(4)	(5)
	AGGREGATE	ALL INDUSTRY	$\sigma < 5$ INDUSTRY	2004 INDUSTRY	2005 INDUSTRY
VARIABLES	lratio	lratio	lratio	lratio	lratio
ltaxes	1.291***	1.549***	1.555***	0.501***	0.622***
	(0.434)	(0.154)	(0.204)	(0.144)	(0.155)
Dummy*ltaxes			0.379**		
			(0.155)		
lcredit/GDP				0.348***	0.374***
				(0.0368)	(0.0351)
ICRG: financial risk				0.0134***	0.00543
				(0.00371)	(0.00449)
ldistance				-0.529***	-0.419***
				(0.0571)	(0.0545)
comlang				-0.0743**	-0.152***
				(0.0331)	(0.0364)
contig				-0.244***	-0.115
				(0.0848)	(0.0870)
constant				2.183***	1.463***
				(0.514)	(0.515)
			$\sigma = 3.8$ and $\theta = 8.28$		
Implied η	0.44	0.3	0.01	0.74	0.68
			$\frac{\theta}{\sigma-1} = 4.34$ and $\theta = 12.86$		
Implied η	0.7	0.54	0.42	0.85	0.81
Fixed effects	Country	Country	Country	No	No
Observations	1,468	190,319	190,319	13,484	13,658
R-squared	0.682	0.117	0.118	0.030	0.026

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3: Parameter choices

e_{USA}	1	$\tau_{USA-DEU}$	1.032
e_{DEU}	0.61	$\tau_{USA-DNK}$	1.034
e_{DNK}	0.54	$\tau_{GER-SWE}$	1
T^O_{USA}	1	t_{USA}	0.4
T^O_{DEU}	0.679	t_{DEU}	0.296
T^O_{DNK}	0.494	t_{DNK}	0.245
$L_{USA} = M_{USA}$	1	σ	3.96
$L_{DEU} = M_{DEU}$	0.42	θ	12.86
$L_{DNK} = M_{DEN}$	0.02	η	0.4, 0.65, 0.85

4 Counterfactual exercise

With choices for σ, θ, η and e_i I am a step closer to performing counterfactual analyses using the theoretical model. At this stage of my work, I am performing simulations to illustrate the workings of the model. For the exercise, I assume that the world is populated by three countries: The United States, Germany, and Denmark. The manufacturing labor force parameters L_i, which are adjusted for education, are found in Table 1 of Eaton and Kortum [2002]. M_i, the measure of firms in each country, is assumed equal to L_i. I calculate average manufacturing tariffs for the years 2002-2014 obtained from the WITS database and I use the statutory tax rates for 2014.

Table 3 summarizes all the parameters. Results shown in Table 4 are obtained using equation (10) to calculate related party import shares implied by the model, averaged over 2002-2014. The actual shares are also averaged over 2002-2014. As expected, the match is not perfect, given my stylized model. The relative magnitudes observed in the data, however, are preserved.

I solve the model using the equilibrium conditions in Section 2.4 and do comparative statics to study the effect of taxation on firms' global sourcing patterns. In particular, I look at outcomes under two different tax regimes: harmonized taxation and equalized tax rates for the U.S. and Germany. Table 5 summarizes the results. As expected, this exercise shows that global sourcing patterns are distorted by heterogeneous taxation. Under all η regimes, which in here capture the

Table 4: Model fit

Average related party import share	Actual	Model		
		$\eta = 0.4$	$\eta = 0.65$	$\eta = 0.85$
Germany	0.684	0.704	0.671	0.642
Denmark	0.690	0.826	0.754	0.693

strength of the government in enforcing arm's length rules and punishing strategic transfer pricers, the location and mode choices are different from what a homogeneous tax regime would prescribe. Relative to a uniform global tax regime, more firms choose to invest in Germany and Sweden, and more firms opt for vertical integration. Furthermore, reducing the U.S. statutory tax rate to the German rate of 0.296 would increase U.S. real exports by approximately 3%.

5 Conclusion

It is well established that multinational firms arbitrage away tax differences among countries in which they operate through strategic profit shifting. Studies on the economic effects of practices that facilitate profit shifting like strategic transfer pricing, are usually confined to fiscal impacts. I argue that heterogeneous taxation has real consequences too, distorting two choices of the global firm: where to source, a location decision, and how to source, a decision about "make versus buy".

To study the extent to which taxation affects these two decisions, I build a parsimonious general equilibrium, multi-country trade model with heterogeneous firms. The model predicts that a decrease in the statutory corporate tax rate of a country induces more firms to locate to that country and to choose vertical integration over outsourcing. I empirically test and confirm that prediction. A 1 pp reduction in the tax rate of a potential trade partner, increases the intrafirm share of imports by 0.5%, at the lowest estimate. The counterfactual exercise shows that if all countries were to adopt the same tax rate, firms would change their sourcing patterns: more firms would invest in the U.S. and more firms would opt to outsource production.

Table 5: The effect of taxation on global sourcing

Taxes are harmonized						
% change	$\eta = 0.42$		$\eta = 0.65$		$\eta = 0.85$	
in sourcing1̂	No of firms	Real exports	No of firms	Real exports	No of firms	Real exports
From the US	1.9	3.13	1.37	3.13	1.01	3.14
VI	1.9	2.45	1.37	3.18	1.01	3.73
O	1.9	14.18	1.37	2.50	1.01	-4.72
From Germany	-3.8	-0.25	-2.79	-0.09	-2.09	0.02
VI	-17.15	-3.91	-10.90	-2.83	-5.66	-1.98
O	6.69	2.39	2.91	1.85	0.23	1.43
From Sweden	-7.29	-2.05	-5.28	-1.74	-3.91	-1.51
VI	-28.33	-10.89	-18.75	-8.17	-10.11	-5.91
O	10.19	-1.84	4.04	-1.58	-0.20	-1.41
U.S. adopts Germany's tax rate						
From the U.S	1.84	3.13	1.33	3.13	0.98	3.14
VI	1.84	2.46	1.33	3.17	0.98	3.71
O	1.84	14.13	1.33	2.64	0.98	-4.47
From Germany	-3.87	-0.25	-2.85	-0.09	-2.13	0.03
VI	-17.21	-3.91	-10.95	-2.85	-5.70	-2.00
O	6.61	2.39	2.86	1.87	0.18	1.45
From Sweden	-4.11	-0.25	-2.86	-0.08	-2.09	0.03
VI	-17.04	-4.08	-10.94	-2.98	-5.73	-2.07
O	6.63	-0.16	2.73	-0.01	0.10	0.08

[1] All changes are relative to the baseline solution with the calibration as in Table 3.

Note: Real exports represent the total value sourced from a country divided by the price index in that country

The next steps of this project are the following: First, structurally estimate the tax elasticity of intrafirm trade and calibrate the states of technology (T_i) for each country and sourcing mode to match observed trade shares of the U.S. top 40 trading partners. Second, measure the degree of resource misallocation by U.S. firms that is due to heterogeneous taxation through counterfactual analyses.

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A1. Empirical Appendix

Data description and sources (to be completed):

U.S. Census Related Party Trade - US CENSUS BUREAU

Statutory Tax Rates - KPMG Corporate Tax Surveys

GDP, GDP per capita, private sector credit to GDP - WORLD BANK DEVELOPMENT INDICATORS

Institutional quality variables - INTERNATIONAL COUNTRY RISK GUIDE (ICRG) from the PRS Group

Sector level covariates - Antras (2016)

Robustness checks:

A2. Mathematical Appendix

A microfoundation for η_{ij}:

In the VI mode, when using transfer pricing, a firm gets caught with probability η_{ij} and pays profit tax t_i (headquarter tax rate). With probability $(1-\eta_{ij})$ it does not get caught and successfully shifts all profits to the lower tax location. For every ϕ, the individual firm chooses intermediate input level m to maximize expected profits. The expected profit for each location production j and for every ϕ is:

$$\max_{m(\phi)} \eta_{ij}(1-t_i)\left(p\left(q\left(\phi\right)\right)q\left(\phi\right)-c_{ij}^{VI}m\left(\phi\right)\right)+(1-\eta_{ij})(1-t_j)\left(p\left(q\left(\phi\right)\right)q\left(\phi\right)-c_{ij}^{VI}m\left(\phi\right)\right)$$

Strategic transfer pricing is costly to the firm and whether it gets caught or not, a small part of its expected profit is lost. Transfer pricing accounting costs the firm $\left[(\eta_{ij}(1-t_i)+(1-\eta_{ij})(1-t_j))-(1-t_i)^{\eta_{ij}}(1-t_j)^{1-\eta_{ij}}\right]B_i c_{ij}^{VI1-\sigma}$. Thus, for every ϕ_j, the final profits in mode VI are$\gamma_{ij}B_i c_{ij}^{VI1-\sigma}$[7]

Section 2.3 derivations:

[7] I adopt the form$(1-t_i)^{\eta_{ij}}(1-t_j)^{1-\eta_{ij}}$ for tractability purposes. However, since $(1-t_i)^{\eta_{ij}}(1-t_j)^{1-\eta_{ij}} < \eta_{ij}(1-t_i)+(1-\eta_{ij})(1-t_j)$ this assumption can be justified on the basis that transfer pricing is costly.

Table A.1: Determinants of U.S. intrafirm trade excluding years 2004 and 2005

VARIABLES	(1) AGGREGATE log(imp_rel)	(2) AGGREGATE log(imp_rel/imp_tot)	(3) INDUSTRY log(imp_rel/imp_tot)	(4) INDUSTRY log(imp_rel/imp_tot)	(5) INDUSTRY log(imp_rel/imp_tot)
lGDP	0.190	0.105	0.113***	0.129***	0.128***
	(0.184)	(0.119)	(0.0384)	(0.0379)	(0.0379)
lGDP_capita	0.893**	0.824**	0.334***	0.215**	0.210**
	(0.419)	(0.343)	(0.0898)	(0.105)	(0.105)
taxrate	-1.705**	-1.000*	-0.637***	-0.503***	-0.215
	(0.840)	(0.578)	(0.167)	(0.194)	(0.217)
Dummy*taxrate					-0.755***
					(0.236)
lcredit/GDP			0.161***	0.0635*	0.0623*
			(0.0306)	(0.0326)	(0.0325)
ICRG: law & order			-0.00197	-0.0112	-0.0115
			(0.0160)	(0.0169)	(0.0169)
ICRG: financial risk			-0.00416**	-0.00506**	-0.00504**
			(0.00204)	(0.00244)	(0.00244)
Freight costs				-5.396***	-5.555***
				(0.603)	(0.608)
Tariffs				-0.0165	-0.0144
				(0.0104)	(0.00921)
lCapital/Labor				-0.197***	-0.215***
				(0.0275)	(0.0272)
Fixed effects	Country & Year	Country	Country	Country	Country
Observations	1,390	1,390	176,424	134,872	134,872
Time period	2002-2014	2002-2014	2002-2014	2002-2011	2002-2011
R-squared	0.961	0.727	0.098	0.141	0.144

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A.2: Determinants of U.S. intrafirm trade excluding tax havens

	(1)	(2)	(3)	(4)	(5)
	AGGREGATE	AGGREGATE	INDUSTRY	INDUSTRY	INDUSTRY
VARIABLES	log(imp_rel)	log(imp_rel/imp_tot)	log(imp_rel/imp_tot)	log(imp_rel/imp_tot)	log(imp_rel/imp_tot)
lGDP	0.190	0.105	0.113***	0.129***	0.128***
	(0.184)	(0.119)	(0.0384)	(0.0379)	(0.0379)
lGDP_capita	0.893**	0.824**	0.334***	0.215**	0.210**
	(0.419)	(0.343)	(0.0898)	(0.105)	(0.105)
taxrate	-1.705**	-1.000*	-0.637***	-0.503***	-0.215
	(0.840)	(0.578)	(0.167)	(0.194)	(0.217)
Dummy*taxrate					-0.755***
					(0.236)
lcredit/GDP			0.161***	0.0635*	0.0623*
			(0.0306)	(0.0326)	(0.0325)
ICRG: law & order			-0.00197	-0.0112	-0.0115
			(0.0160)	(0.0169)	(0.0169)
ICRG: financial risk			-0.00416**	-0.00506**	-0.00504**
			(0.00204)	(0.00244)	(0.00244)
Freight costs				-5.396***	-5.555***
				(0.603)	(0.608)
Tariffs				-0.0165	-0.0144
				(0.0104)	(0.00921)
lCapital/Labor				-0.197***	-0.215***
				(0.0275)	(0.0272)
Fixed effects	Country & Year	Country	Country	Country	Country
Observations	1,390	1,390	176,424	134,872	134,872
Time period	2002-2014	2002-2014	2002-2014	2002-2011	2002-2011
R-squared	0.961	0.727	0.098	0.141	0.144

Robust standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table A.3: Determinants of U.S. intrafirm trade excluding 2004, 2005 and tax havens

VARIABLES	(1) AGGREGATE log(imp_rel)	(2) AGGREGATE log(imp_rel/imp_tot)	(3) INDUSTRY log(imp_rel/imp_tot)	(4) INDUSTRY log(imp_rel/imp_tot)	(5) INDUSTRY log(imp_rel/imp_tot)
lGDP	0.263	0.227*	0.115***	0.139***	0.138***
	(0.208)	(0.136)	(0.0392)	(0.0382)	(0.0457)
lGDP_capita	0.599	0.447	0.317***	0.171	0.167
	(0.483)	(0.385)	(0.0921)	(0.104)	(0.128)
taxrate	-1.398	-0.717	-0.632***	-0.439***	-0.167
	(0.971)	(0.663)	(0.172)	(0.202)	(0.297)
Dummy*taxrate					-0.708***
					(0.320)
lcredit/GDP			0.161***	0.0591*	0.0585
			(0.0307)	(0.0330)	(0.0643)
ICRG: law & order			-0.00252	-0.0283	-0.0282
			(0.0170)	(0.0183)	(0.0197)
ICRG: financial risk			-0.00415**	-0.00526**	-0.00527**
			(0.00212)	(0.00258)	(0.00303)
Freight costs				-5.396***	-5.553***
				(0.608)	(0.485)
Tariffs				-0.0168	-0.0147
				(0.0103)	(0.00284)
lCapital/Labor				-0.197***	-0.216***
				(0.0280)	(0.0265)
Fixed effects	Country & Year	Country	Country	Country	Country
Observations	1,168	1,168	144,933	104,791	104,791
Time period	2002-2014	2002-2014	2002-2014	2002-2011	2002-2011
R-squared	0.962	0.736	0.094	0.138	0.141

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Here I derive the densities in (3) and (4). For each firm in country i:

$$\begin{aligned}
&Pr(\Pi_{i1}^{VI} \leq \pi_{i1}^{VI}, \Pi_{i1}^{O} \leq \pi_{i1}^{O}, \ldots, \Pi_{iN}^{VI} \leq \pi_{iN}^{VI}, \Pi_{iN}^{O} \leq \pi_{iN}^{O}) \\
&\quad = Pr\left(\gamma_{i1} B_i \left(\tau_{i1} w_1\right)^{1-\sigma} \phi_1^{VI\sigma-1} \leq \pi_{i1}^{VI}, \ldots, (1-t_i) B_i \left(\tau_{iN} w_N\right)^{1-s} \phi_N^{O\,\sigma-1} \leq \pi_{iN}^{O}\right) \\
&\quad = Pr\left(\phi_1^{VI} \leq \pi_{i1}^{VI\frac{1}{\sigma-1}} \gamma_{i1}^{\frac{-1}{\sigma-1}} B_i^{\frac{-1}{\sigma-1}} \left(t_{i1} w_1\right), \ldots, \phi_N^{O} \leq \pi_{iN}^{O\frac{1}{\sigma-1}} \left(1-t_i\right)^{\frac{-1}{\sigma-1}} B_i^{\frac{-1}{\sigma-1}} \left(t_{iN} w_N\right)\right)
\end{aligned}$$

$$\begin{aligned}
&= exp - \left\{ B_i^{\frac{\theta}{\sigma-1}} \sum_{j=1}^{N} T_j^{VI} \left(\pi_{ij}^{VI} \gamma_{ij} (t_{ij} w_j)^{\sigma-1}\right)^{\frac{-\theta}{\sigma-1}} + (1-t_i)^{\frac{\theta}{\sigma-1}} B_i^{\frac{\theta}{\sigma-1}} \sum_{j=1}^{N} T_j^{O} \left(\pi_{ij}^{O} (t_{ij} w_j)^{\sigma-1}\right)^{\frac{-\theta}{\sigma-1}} \right\} \\
&= F(\pi)
\end{aligned}$$

So profits are distributed Freshet with parameter $\frac{\theta}{\sigma-1}$.

Then,

$$\begin{aligned}
Pr\left(\Pi_{i1}^{VI} \leq \pi_{i1}^{VI}, \Pi_{i1}^{O} \leq \pi_{i1}^{VI}, \ldots, \Pi_{il}^{VI} = \pi_{il}^{VI}, \ldots, \Pi_{iN}^{VI} \leq \pi_{iN}^{VI}, \Pi_{iN}^{O} \leq \pi_{iN}^{O}\right) &= \frac{\partial F\left(\pi\right)}{\partial \pi_{il}^{VI}} \\
&= \frac{\theta}{\sigma-1} (\pi_{il}^{VI})^{\frac{-\theta}{\sigma-1}-1} B_i^{\frac{\theta}{\sigma-1}} \gamma_{il}^{\frac{\theta}{\sigma-1}} T_l^{VI} \left(\tau_{il} w_l\right)^{-\theta} F\left(\pi\right)
\end{aligned}$$

Also,

$$\begin{aligned}
Pr\left(\Pi_{i1}^{VI} \leq \pi_{i1}^{o}, \Pi_{i1}^{O} \leq \pi_{i1}^{o}, \ldots, \Pi = \pi_{il}^{O}, \ldots, \Pi_{iN}^{VI} \leq \pi_{iN}^{VI}, \Pi_{iN}^{O} \leq \pi_{iN}^{O}\right) &= \frac{\partial F\left(\pi\right)}{\partial \pi_{il}^{O}} \\
&= \frac{\theta}{\sigma-1} (\pi_{il}^{O})^{\frac{-\theta}{\sigma-1}-1} B_i^{\frac{\theta}{\sigma-1}} \left(1-t_i\right)^{\frac{\theta}{\sigma-1}} T_l^{O} \left(\tau_{il} w_l\right)^{-\theta} F\left(\pi\right)
\end{aligned}$$

We have,

$$\begin{aligned}
&Pr(\Pi_{i1}^{VI} \leq \pi, \Pi_{i1}^{O} \leq \pi, \ldots, \Pi_{il}^{VI} = \pi, \ldots, \Pi_{iN}^{VI} \leq \pi, \Pi_{iN}^{O} \leq \pi) = \\
&= \frac{\theta}{\sigma-1}\pi^{\frac{-\theta}{\sigma-1}-1} B_i^{\frac{\theta}{\sigma-1}} \gamma_{ij}{}^{\frac{\theta}{\sigma-1}} T_l^{VI} (\tau_{il} w_l)^{-\theta} \exp -\{B_i^{\frac{\theta}{\sigma-1}} \Psi_i \pi^{\frac{-\theta}{\sigma-1}}\} \\
&= \frac{\theta}{\sigma-1}\pi^{\frac{-\theta}{\sigma-1}-1} B_i^{\frac{\theta}{\sigma-1}} \gamma_{ij}{}^{\frac{\theta}{\sigma-1}} T_l^{VI} \psi_{il} \Psi_i \exp -\{B_i^{\frac{\theta}{\sigma-1}} \Psi_i \pi^{\frac{-\theta}{\sigma-1}}\} \qquad (22)
\end{aligned}$$

And

$$\begin{aligned}
&Pr(\Pi_{i1}^{VI} \leq \pi, \Pi_{i1}^{O} \leq \pi, \ldots, \Pi_{il}^{O} = \pi, \ldots, \Pi_{iN}^{VI} \leq \pi, \Pi_{iN}^{O} \leq \pi) = \\
&= \frac{\theta}{\sigma-1}\pi^{\frac{-\theta}{\sigma-1}-1} (1-t_i)^{\frac{\theta}{\sigma-1}} B_i^{\frac{\theta}{\sigma-1}} T_l^{O} (\tau_{il} w_l)^{-\theta} \exp -\{B_i^{\frac{\theta}{\sigma-1}} \Psi_i \pi^{\frac{-\theta}{\sigma-1}}\} \\
&= \frac{\theta}{\sigma-1}\pi^{\frac{-\theta}{\sigma-1}-1} (1-t_i)^{\frac{\theta}{\sigma-1}} B_i^{\frac{\theta}{\sigma-1}} T_l^{O} \psi_{il} \Psi_i \exp -\{B_i^{\frac{\theta}{\sigma-1}} \Psi_i \pi^{\frac{-\theta}{\sigma-1}}\} \qquad (23)
\end{aligned}$$

From here we see that the probability that a firm from i sources from country l in mode VI is the following

$$\begin{aligned}
\psi_{il}^{VI} &= \int_0^\infty Pr(\Pi_{i1}^{VI} \leq \pi, \Pi_{i1}^{O} \leq \pi, \ldots, \Pi_{il}^{VI} = \pi, \ldots, \Pi_{iN}^{VI} \leq \pi, \Pi_{iN}^{O} \leq \pi) d\pi \\
&= \int_0^\infty \frac{\theta}{\sigma-1}\pi^{\frac{-\theta}{\sigma-1}-1} B_i^{\frac{\theta}{\sigma-1}} \gamma_{ij}{}^{\frac{\theta}{\sigma-1}} T_l^{VI} (\tau_{il} w_l)^{-\theta} \exp -\{B_i^{\frac{\theta}{\sigma-1}} \Psi_i \pi^{\frac{-\theta}{\sigma-1}}\} d\pi \\
&= \gamma_{ij}{}^{\frac{\theta}{\sigma-1}} T_l^{VI} \psi_{il} \int_0^\infty \frac{\theta}{\sigma-1}\pi^{\frac{-\theta}{\sigma-1}-1} B_i^{\frac{\theta}{\sigma-1}} \Psi_i \exp -\{B_i^{\frac{\theta}{\sigma-1}} \Psi_i \pi^{\frac{-\theta}{\sigma-1}}\} d\pi
\end{aligned}$$

Letting $u = B_i^{\frac{\theta}{\sigma-1}} \Psi_i \pi^{\frac{-\theta}{\sigma-1}}$, $du = -\frac{\theta}{\sigma-1}\pi^{\frac{-\theta}{\sigma-1}-1} B_i^{\frac{\theta}{\sigma-1}} \Psi_i d\pi$ for $u \in (-\infty, 0)$. After the change of variable, the limits of integration get reversed, so we multiply by -1 to make $u \in (\infty, 0)$. The negative sign cancels with the $(-)$ from du.

$$\begin{aligned}
\psi_{il}^{VI} &= (1-\gamma_{il})^{\frac{\theta}{\sigma-1}} T_l^{VI} \psi_{il} \int_0^{\infty} -\exp -u du \\
&= \psi_{il} T_l^{VI} \gamma_{ij}{}^{\frac{\theta}{\sigma-1}} [-\exp -u]_0^{\infty} \\
&= \psi_{il} T_l^{VI} \gamma_{ij}{}^{\frac{\theta}{\sigma-1}} [0+1]_0^{\infty} \\
\psi_{il}^{VI} &= \psi_{il} T_l^{VI} \gamma_{ij}{}^{\frac{\theta}{\sigma-1}} \qquad (24)
\end{aligned}$$

And the probability that a firm sources from i in mode O is:

$$\begin{aligned}
\psi_{il}^{O} &= \int_0^{\infty} Pr(\Pi_{i1}^{VI} \leq \pi, \Pi_{i1}^{O} \leq \pi, \ldots, \Pi_{il}^{O} = \pi, \ldots, \Pi_{iN}^{VI} \leq \pi, \Pi_{iN}^{O} \leq \pi) d\pi \\
\psi_{il}^{O} &= \psi_{il} T_l^{O} (1-t_i)^{\frac{\theta}{\sigma-1}} \qquad (25)
\end{aligned}$$

Note that, $\frac{\partial \psi_{il}^{VI}}{\partial t_l} < 0$, $\frac{\partial \psi_{il}^{O}}{\partial t_l} > 0$. Whereas, $\frac{\partial \psi_{il}^{VI}}{\partial t_i}?0$ and $\frac{\partial \psi_{il}^{O}}{\partial t_i}?0$.

$$\frac{\partial \psi_{il}^{VI}}{\partial t_l} = \frac{\partial \psi_{il}}{\partial t_l} T_l^{VI} \gamma_{il}{}^{\frac{\theta}{\sigma-1}} + \psi_{il} T_l^{VI} \frac{\partial \gamma_{il}{}^{\frac{\theta}{\sigma-1}}}{\partial t_l} = \psi_{il} T_l^{VI} \frac{\theta}{\sigma-1} (1-\eta) \gamma_{il}{}^{\frac{\theta}{\sigma-1}} (1-t_l)^{-1} (\psi_{il}^{VI} - 1) < 0$$

$$\frac{\partial \psi_{il}^{O}}{\partial t_l} = T_l^{O} T_l^{VO} \gamma_{il}^{\frac{\theta}{\sigma-1}} \frac{\theta}{\sigma-1} (1-\eta)(1-t_l)^{-1} (\psi_{il})^2 > 0$$

$$\begin{aligned}
\frac{\partial \psi_{il}^{VI}}{\partial t_i} &= T_l^{VI} \frac{\partial \psi_{il}}{\partial t_i} \gamma_{il}{}^{\frac{\theta}{\sigma-1}} + T_l^{VI} \psi_{il} \frac{\partial \gamma_{ij}{}^{\frac{\theta}{\sigma-1}}}{\partial t_i} \\
&= T_l^{VI} \psi_{il} \frac{\theta}{\sigma-1} (1-t_i)^{-1} \eta \left(\psi_{il} \left(T_l^{VI} \gamma_{il}{}^{\frac{\theta}{\sigma-1}} + T_l^{O} \frac{1}{\eta} (1-t_i)^{\frac{\theta}{\sigma-1}} \right) - \gamma_{il}^{\frac{\theta}{\sigma-1}} \right) \\
&> 0 \quad as \quad long \quad as \quad \psi_{il} \left(T_l^{VI} \gamma_{il}{}^{\frac{\theta}{\sigma-1}} + T_l^{O} \frac{1}{\eta} (1-t_i)^{\frac{\theta}{\sigma-1}} \right) > \gamma_{il}^{\frac{\theta}{\sigma-1}}
\end{aligned}$$

$$\begin{aligned}\frac{\partial\psi_{il}^{O}}{\partial t_i} &= T_l^O\psi_{il}\frac{\theta}{\sigma-1}\left(1-t_i\right)^{-1}\left(\psi_{il}\Big(\eta T_l^{VI}\gamma_{il}^{\frac{\theta}{\sigma-1}}+T_l^O\left(1-t_i\right)^{\frac{\theta}{\sigma-1}}\Big)-\left(1-t_i\right)^{\frac{\theta}{\sigma-1}}\right)\\ &> 0 \quad as \quad long \quad as \quad \psi_{il}\Big(\eta T_l^{VI}\gamma_{il}^{\frac{\theta}{\sigma-1}}+T_l^O\left(1-t_i\right)^{\frac{\theta}{\sigma-1}}\Big)>\left(1-t_i\right)^{\frac{\theta}{\sigma-1}}\end{aligned}$$

We calculate the amount of intrafirm imports in country i that come from country j by aggregating over individual firms' import spending. Note that $m_{ij}^{VI}=\frac{\sigma-1}{\gamma_{ij}}\Pi_{ij}^{VI}$. Using the density in (3):

$$\begin{aligned}Imp_{ij}^{VI} &= M_i\int_0^\infty m_{ij}^{VI}Pr(argmin_{l,mode}(\Pi_{il}^{mode})=j \quad and \quad VI)d\pi\\ &= M_i\int_0^\infty\frac{\sigma-1}{\gamma_{ij}}\pi\frac{\theta}{\sigma-1}\pi^{\frac{-\theta}{\sigma-1}-1}B_i^{\frac{\theta}{\sigma-1}}\gamma_{ij}^{\frac{\theta}{\sigma-1}}T_j^{VI}\psi_{ij}\Psi_i\exp-\{B_i^{\frac{\theta}{\sigma-1}}\Psi_i\pi^{\frac{-\theta}{\sigma-1}}\}d\pi\\ &= M_i\frac{\sigma-1}{\gamma_{ij}}\gamma_{ij}^{\frac{\theta}{\sigma-1}}T_j^{VI}\psi_{ij}\int_0^\infty\pi\frac{\theta}{\sigma-1}\pi^{\frac{-\theta}{\sigma-1}-1}B_i^{\frac{\theta}{\sigma-1}}\Psi_i\exp-\{B_i^{\frac{\theta}{\sigma-1}}\Psi_i\pi^{\frac{-\theta}{\sigma-1}}\}d\pi\end{aligned}$$

Let $u=B_i^{\frac{\theta}{\sigma-1}}\Psi_i\pi^{\frac{-\theta}{\sigma-1}}$, then $du=-\frac{\theta}{\sigma-1}\pi^{\frac{-\theta}{\sigma-1}-1}B_i^{\frac{\theta}{\sigma-1}}\Psi_i d\pi$ for $u\in(\infty,0)$. Note that $\pi=u^{\frac{-(\sigma-1)}{\theta}}B_i\Psi_i^{\frac{\sigma-1}{\theta}}$. Adding a $(-)$ to change the limits of integration back to $u\in(0,\infty)$ and making the change of variable:

$$\begin{aligned}Imp_{ij}^{VI} &= (-)M_i(\sigma-1)\gamma_{ij}^{\frac{\theta}{\sigma-1}-1}T_j^{VI}\psi_{ij}\Psi_i^{\frac{\sigma-1}{\theta}}B_i\int_0^\infty(-)u^{\frac{-(\sigma-1)}{\theta}}\exp-udu\\ &= M_i(\sigma-1)\gamma_{ij}^{\frac{\theta}{\sigma-1}-1}T_j^{VI}\psi_{ij}\Psi_i^{\frac{\sigma-1}{\theta}}B_i\Gamma\Big(1-\frac{\sigma-1}{\theta}\Big)\end{aligned}$$

And total sales of country i firms that import from j in mode VI:

$$X_{ij}^{VI}=\frac{\sigma}{\sigma-1}Imp_{ij}^{VI}=\sigma M_i\gamma_{ij}^{\frac{\theta}{\sigma-1}-1}T_j^{VI}\psi_{ij}\Psi_i^{\frac{\sigma-1}{\theta}}B_i\Gamma\Big(1-\frac{\sigma-1}{\theta}\Big) \tag{26}$$

Similarly, noting that $m_{ij}^{O} = \frac{\sigma-1}{1-t_i}\Pi_{ij}^{O}$and using the density in (4):

$$\begin{aligned} Imp_{ij}^{O} &= M_i \int_0^{\infty} \frac{\sigma-1}{1-t_i}\pi \frac{\theta}{\sigma-1}\pi^{\frac{-\theta}{\sigma-1}-1}(1-t_i)^{\frac{\theta}{\sigma-1}} B_i^{\frac{\theta}{\sigma-1}} T_j^{O}\psi_{ij}\Psi_i \exp-\{B_i^{\frac{\theta}{\sigma-1}}\Psi_i \pi^{\frac{-\theta}{\sigma-1}}\} d\pi \\ &= M_i(\sigma-1)(1-t_i)^{\frac{\theta}{\sigma-1}-1} T_j^{O}\psi_{ij}\Psi_i^{\frac{\sigma-1}{\theta}} B_i \Gamma\Big(1-\frac{\sigma-1}{\theta}\Big) \end{aligned}$$

Total sales of country i firms that import from j in O mode:

$$X_{ij}^{O} = \frac{\sigma}{\sigma-1} Imp_{ij}^{O} = \sigma M_i (1-t_i)^{\frac{\theta}{\sigma-1}-1} T_j^{O}\psi_{ij}\Psi_i^{\frac{\sigma-1}{\theta}} B_i \Gamma\Big(1-\frac{\sigma-1}{\theta}\Big) \tag{27}$$

Total sales of country i firms that import from j:

$$X_{ij} = \sigma M_i \psi_{ij}\Psi_i^{\frac{\sigma-1}{\theta}} B_i \Gamma\Big(1-\frac{\sigma-1}{\theta}\Big)\Big(T_j^{VI}\gamma_{ij}^{\frac{\theta}{\sigma-1}-1} + T_j^{O}(1-t_i)^{\frac{\theta}{\sigma-1}-1}\Big) \tag{28}$$

NOTE: Average sales for firms that source from country j are $\frac{X_{ij}}{M_i\psi_{ij}\Big(T_j^{VI}\gamma_{ij}^{\frac{\theta}{\sigma-1}} + T_j^{O}(1-t_i)^{\frac{\theta}{\sigma-1}}\Big)} = \frac{\sigma\Psi_i^{\frac{\sigma-1}{\theta}} B_i\Gamma\Big(1-\frac{\sigma-1}{\theta}\Big)\Big(T_j^{VI}\gamma_{ij}^{\frac{\theta}{\sigma-1}-1} + T_j^{O}(1-t_i)^{\frac{\theta}{\sigma-1}-1}\Big)}{\Big(T_j^{VI}\gamma_{ij}^{\frac{\theta}{\sigma-1}} + T_j^{O}(1-t_i)^{\frac{\theta}{\sigma-1}}\Big)}$

Spending on final goods assembled with VI and O imports from country j as a share of total spending in country i are, respectively:

$$
\begin{aligned}
\lambda_{ij}^{VI} &= \frac{\sigma M_i \gamma_{ij}{}^{\frac{\theta}{\sigma-1}-1} T_j^{VI} \psi_{ij} \Psi_i^{\frac{\sigma-1}{\theta}} B_i \Gamma\left(1-\frac{\sigma-1}{\theta}\right)}{\sigma M_i \Psi_i^{\frac{\sigma-1}{\theta}} B_i \Gamma\left(1-\frac{\sigma-1}{\theta}\right) \sum_{k=1}^{N} \psi_{ik}\left(T_k^{VI} \gamma_{ik}{}^{\frac{\theta}{\sigma-1}-1} + T_k^{O}\left(1-t_i\right)^{\frac{\theta}{\sigma-1}-1}\right)} \\
&= \frac{\gamma_{ij}{}^{\frac{\theta}{\sigma-1}-1} T_j^{VI} \psi_{ij}}{\sum_{k=1}^{N} \psi_{ik}\left(T_k^{VI} \gamma_{ik}{}^{\frac{\theta}{\sigma-1}-1} + T_k^{O}\left(1-t_i\right)^{\frac{\theta}{\sigma-1}-1}\right)} \\
&= \frac{\gamma_{ij}{}^{\frac{\theta}{\sigma-1}-1}}{\sum_{k=1}^{N} \psi_{ik}\left(T_k^{VI} \gamma_{ik}{}^{\frac{\theta}{\sigma-1}-1} + T_k^{O}\left(1-t_i\right)^{\frac{\theta}{\sigma-1}-1}\right)} \frac{T_j^{VI}(\tau_{ij} w_j)^{-\theta}}{\sum_{k=1}^{N} (\tau_{ik} w_k)^{-\theta}\left(T_k^{VI} \gamma_{ik}{}^{\frac{\theta}{\sigma-1}} + T_k^{O}\left(1-t_i\right)^{\frac{\theta}{\sigma-1}}\right)} \\
&= \frac{\gamma_{ij}{}^{\frac{\theta}{\sigma-1}-1} T_j^{VI}(\tau_{ij} w_j)^{-\theta}}{\sum_{k=1}^{N} (\tau_{ik} w_k)^{-\theta}\left(T_k^{VI} \gamma_{ik}{}^{\frac{\theta}{\sigma-1}-1} + T_k^{O}\left(1-t_i\right)^{\frac{\theta}{\sigma-1}-1}\right)} \\
\lambda_{ij}^{O} &= \frac{\left(1-t_i\right)^{\frac{\theta}{\sigma-1}-1} T_j^{O}(\tau_{ij} w_j)^{-\theta}}{\sum_{k=1}^{N} (\tau_{ik} w_k)^{-\theta}\left(T_k^{VI} \gamma_{ik}{}^{\frac{\theta}{\sigma-1}-1} + T_k^{O}\left(1-t_i\right)^{\frac{\theta}{\sigma-1}-1}\right)}
\end{aligned}
$$

Then, spending on final goods assembled with country j intermediates as a share of country i's total spending:

$$
\lambda_{ij} = \frac{(\tau_{ij} w_j)^{-\theta}\left(T_j^{VI} \gamma_{ij}{}^{\frac{\theta}{\sigma-1}-1} + T_j^{O}\left(1-t_i\right)^{\frac{\theta}{\sigma-1}-1}\right)}{\sum_{k=1}^{N} (\tau_{ik} w_k)^{-\theta}\left(T_k^{VI} \gamma_{ik}{}^{\frac{\theta}{\sigma-1}-1} + T_k^{O}\left(1-t_i\right)^{\frac{\theta}{\sigma-1}-1}\right)} \tag{29}
$$