Fiscal Union Without Factor Union: Optimal VAT under Monopolistic Competition*

Nicolas Djob Li Ngue Bikob†

July 13, 2026

Abstract

Value-added taxes are often viewed as neutral under the destination principle because goods are taxed where they are consumed rather than where they are produced. This paper revisits that argument in a two-country economy with monopolistic competition, endogenous entry, and asymmetric fiscal needs. The analysis shows that destination-based taxation does not generally imply uniform taxation. In the first-best, the optimal tax depends on the level of competition and on the ratio of marginal utility of labor. In the constrained optimum – social planner without lump-sum taxes – optimal taxes depend on the destination-country fiscal constraint, the degree of product-market competition and on the origin-country cost of public funds; the latter is absent from decentralized tax formulas because national governments ignore the effects of their taxes on foreign production, entry, and labor use. Numerical simulations confirm that directional tax wedges do arise endogenously. These results highlight the importance of market power and fiscal asymmetry in designing VAT, especially in economically diverse unions.

Keywords: optimal taxation, monopolistic competition, fiscal asymmetry, tariff equivalence, tax coordination, VAT.

JEL Classification: H21, H25, H77, F10, F13,

*This article is the first paper of my doctoral thesis. I wish to thank Pascal Belan, my thesis supervisor, who shaped my logic, my intuition, and passed on to me that special love for indirect taxation. Declarations of interest: None.

†CY Cergy Paris Université, CNRS, THEMA, F-95000 Cergy, France. Email:nnguebikob@yahoo.fr

1 Introduction

The destination principle is one of the central pillars of modern value-added taxation. Under this principle, goods are taxed in the country where they are consumed, independently of where they are produced. In policy discussions, this feature is often interpreted as a neutrality property: by rebating exports and taxing imports symmetrically at the destination, VAT is thought to avoid distorting international production decisions. This neutrality argument has played an important role in the global diffusion of VAT and in the design of tax systems in economically integrated areas.

Yet the neutrality of destination-based VAT is not automatic once markets are imperfectly competitive and governments face asymmetric fiscal constraints. In many economies, differentiated goods are produced under increasing returns and monopolistic competition. Firms charge markups above marginal cost, entry is endogenous, and taxes affect not only consumer prices but also the number of active varieties and the allocation of labor across countries. At the same time, governments differ in their fiscal needs and in the welfare cost of raising public funds. These features are especially relevant in economic unions, where trade barriers are reduced but fiscal capacity, administrative constraints, and the social cost of public funds remain heterogeneous across member states.

This paper revisits the optimality of uniform destination-based VAT in a two-country open-economy model with monopolistic competition. The model combines three ingredients. First, differentiated varieties are produced by monopolistically competitive firms that face fixed and variable labor costs. Second, countries differ in production costs, preferences, and fiscal requirements. Third, public expenditures must be financed either with lump-sum instruments, in the first-best benchmark, or with distortionary commodity taxes, in the constrained Ramsey problem. The central question is whether destination-based taxation remains neutral and uniform in such an environment, or whether optimal taxes should differ by origin and destination. The analysis delivers three main results.

First, in the first-best allocation, where lump-sum transfers are available, optimal commodity taxes correct monopolistic markups. Domestic goods are subsidized because firms charge prices above marginal cost. Cross-border taxes are also generally subsidies, but they need not be symmetric across directions. The first-best tax on cross-border goods depends on the substitution parameter of those goods and on the relative social valuation of labor across countries. Hence, even when taxes are levied on a destination basis, optimal tax rates may differ across trade directions because the social opportunity cost of production differs across origins.

Second, when lump-sum transfers are unavailable, commodity taxes must simultaneously correct markup distortions and finance country-specific public expenditures. The resulting constrained Ramsey tax rule depends on three objects: the marginal cost of public funds in the origin country, the fiscal constraint in the destination country, and the degree of product-market competition in the relevant trade direction. As a result, the constrained optimum can generate origin-destination tax wedges that resemble tariff-like interventions, even though the statutory instrument remains a consumption tax levied at destination.

Third, the paper studies whether the supranational Ramsey allocation can be decentralized by national governments. In the decentralized economy, each government sets taxes on goods consumed within its own jurisdiction and takes the other country's taxes as given. The decentralized tax formulas differ from the supranational Ramsey rule because national governments internalize domestic consumer welfare and domestic tax revenue, but they do not internalize the effect of their taxes on entry, labor demand, and welfare in the exporting country. This creates a coordination wedge. The paper then derives a participation condition: a country accepts the supranational allocation only if its welfare under that allocation is at least as high as under the decentralized Nash equilibrium, unless compensating transfers are available. With transfers, implementation requires aggregate gains large enough to compensate any losing country.

The numerical analysis illustrates these mechanisms in a calibrated two-country economy. The simulations compare four regimes: an analytical Ramsey first-order-condition allocation, a verified global Ramsey allocation, a uniform destination-based VAT benchmark, and a decentralized Nash equilibrium. Directional tax wedges arise endogenously and vary systematically with cross-border market competition. The simulations also clarify why the Ramsey allocation must be interpreted carefully. The analytical first-order-condition candidate may lie below the uniform VAT benchmark, but the directly computed global Ramsey allocation weakly dominates it, as expected because uniform VAT is nested within the broader direction-specific tax space. The broader lesson is not that differentiated VAT always produces large welfare gains, but that destination-based taxation does not by itself imply uniform optimal taxation. Market power, endogenous entry, and fiscal asymmetry generate forces that justify origin-destination tax wedges, while their quantitative value and political acceptability depend on the distribution of gains and losses across countries.

1.1 Relation to the Literature.

This paper builds on several strands of existing research. First, it contributes to the literature on optimal commodity taxation in imperfectly competitive markets. Auerbach and

Hines Jr. (2002) argue that optimal taxation in such environments often requires nuanced border adjustments. Haufler and Pflüger (2004) show that tariffs can improve welfare in monopolistic competition models by influencing firm entry and correcting price distortions. Our analysis extends these insights to an open economy with explicitly asymmetric fiscal capacities, deriving the full optimal tax vector as a function of bilateral trade parameters and country-level multipliers. Second, the paper engages with the literature on international tax coordination. Keen and Konrad (2013) provide a comprehensive treatment of tax competition and coordination, emphasizing the challenges of harmonizing policy across sovereign states. Our work extends their insights by showing how asymmetric fiscal needs can justify directionally differentiated commodity taxation even under an ostensibly harmonized VAT regime. We also build on Aiura and Ogawa (2019, 2023), who demonstrate that destination-based VAT systems can exacerbate inefficiencies in the presence of firm heterogeneity and cross-border shopping. Third, the paper speaks to the debate on VAT design in both developed and developing economies. While international institutions have promoted VAT as an efficient substitute for trade taxes (Ebrill et al., 2001), scholars such as Emran and Stiglitz (2005) and de la Feria and Walpole (2009) have documented the practical deviations from theoretical neutrality. Our analysis provides a formal theoretical rationale for why such deviations may arise in an optimal-tax problem under monopolistic competition and fiscal constraints, although their welfare ranking relative to uniform VAT depends on calibration and participation constraints.

The rest of the paper proceeds as follows. Section 2 presents the model, including preferences, firm behavior, government budgets, and general-equilibrium conditions. Section 3 derives the first-best allocation and the associated markup-correcting tax formula. Section 4 characterizes the constrained Ramsey optimum when lump-sum transfers are unavailable. Section 5 studies decentralized tax setting by national governments, derives the Nash tax formulas, and establishes the national participation condition for accepting the supranational allocation. Section 6 presents the numerical analysis comparing the Ramsey allocation, the uniform VAT benchmark, and the decentralized Nash equilibrium. Section 7 concludes.

2 Model

We build a two-country general equilibrium model with monopolistic competition, asymmetric fiscal capacity, and cross-border trade in differentiated goods. The model integrates consumer preferences, firm behavior, taxation, and government budget constraints in a unified framework governed by a supranational planner. The primary purpose is to analyze how optimal tax policy varies with cross-country differences in labor valuation, production cost, and fiscal efficiency.

The countries—labeled North (developed) and South (developing)—trade goods across multiple industries. The supranational authority uses destination-based consumption taxes to fund public goods and correct market distortions. By embedding a Dixit and Stiglitz (1977) structure and fiscal asymmetry, the model captures key frictions relevant to international tax coordination.

We now describe each component of the model in detail.

2.1 Consumers and Preferences

Each country $k \in \{N, S\}$ is populated by a representative consumer endowed with L_k units of time. Time can be allocated either to leisure — captured through consumption of a numeraire good ℓ_k— or to labor, supplied to firms producing differentiated goods. Each consumer in country k earns a wage ω_k per unit of time supplied and faces destination-based ad valorem taxes on all goods consumed. Labor markets are perfectly competitive and country-specific.

Consumer preferences are given by:

$$U_k(\ell_k, \{Y^i_{jk}\}) = \delta^0_k \ell_k + \sum_{j \in \{N,S\}} \sum_{i=1}^{I} \frac{\delta^i_{jk}}{1 - 1/E^i_{jk}} \left(Y^i_{jk}\right)^{1-1/E^i_{jk}}, \tag{1}$$

where: (i) δ^0_k is the utility weight on the numeraire, (ii) $\delta^i_{jk} > 0$ reflects the importance of industry i goods from origin j in the preferences of country k, (iii) $E^i_{jk} > 1$ is the elasticity of substitution between industries, it governs how easily consumers can shift consumption across industries when relative prices change. Y^i_{jk} is a CES aggregator defined by:

$$Y^i_{jk} = \int_0^{n^i_{jk}} q^i_{jk}(f)^{\rho^i_{jk}} df, \quad 0 < \rho^i_{jk} < 1. \tag{2}$$

The parameter ρ^i_{jk} governs the elasticity of substitution between varieties of goods in industry i, produced in country j , and consumed in country k ; it shows how much each variety is differentiated. A lower level of ρ^i_{jk} implies stronger perceived differentiation among varieties, and a higher level of ρ^i_{jk} implies easier substitution among varieties.

Consumers face the budget constraint:

$$\sum_j \sum_i (1+t^i_{jk}) \int_0^{n^i_{jk}} p^i_{jk}(f) q^i_{jk}(f) df = (1-t^0_k)\omega_k(L_k - \ell_k) + T_k, \tag{3}$$

where T_k is a transfer distributed by government as lump-sum to each consumer in country k.

First-order conditions yield:

$$p^i_{jk}(f) = \frac{\delta^i_{jk}(1-t^0_k)\omega_k}{\delta^0_k(1+t^i_{jk})} \left(Y^i_{jk}\right)^{-1/E^i_{jk}} \rho^i_{jk} q^i_{jk}(f)^{\rho^i_{jk}-1}, \tag{4}$$

where $\frac{(1-t^0_k)\omega_k}{\delta^0_k}$, this term captures the marginal utility of income (or purchasing power) of the representative consumer in country k, adjusted for labor taxation and their valuation of the numeraire good. It is a scaling factor for demand and influences how much consumers are willing to pay for differentiated goods. When it is high, consumers can and want to spend more on differentiated goods, raising their willingness to pay. When it is low, either because labor is taxed heavily or consumers value the numeraire highly, their demand for differentiated goods is more elastic (sensitive to price).

2.2 Firms and Market Structure

Each firm produces a unique variety under monopolistic competition and faces fixed and variable labor costs. Exporting entails additional fixed costs.

Let c^i_j be the marginal labor cost in country j, F^i_{jk} the fixed cost of producing in j and selling in k, ω_j the nominal wage in j. Therefore, the total cost paid by each firm :

$$C^i_{jk}(x) = \omega_j(c^i_j x + F^i_{jk}). \tag{5}$$

Let us assume that one unit of the numeraire is produced under constant return to scale and perfect competition by using one unit of labor. We further assume that this numeraire is not part of international trade. [1] These two assumptions simplify the model and help focus on real variables; they remove nominal rigidities and center analysis on real distortions. We

[1] The numeraire is often conceptualized as a non-tradable service or good (e.g., local haircuts, real estate services, construction) whose international exchange is either impossible or prohibitively costly. This assumption is standard in international trade and tax competition models, particularly those that aim to simplify general equilibrium dynamics while isolating the effects of tax policy on traded goods (Atkeson and Burstein, 2008, Grossman and Rossi-Hansberg, 2008).

can therefore set $w_N = w_S = 1$, and normalize the price of the numeraire.

Firms choose q^i_{jk} to maximize profits:

$$\Pi^i_{jk}(q^i_{jk}(f)) = p^i_{jk}(f)q^i_{jk}(f) - \left(c^i_j q^i_{jk}(f) + F^i_{jk}\right). \tag{6}$$

First-order condition yields the optimal monopoly price as following:

$$p^i_{jk}(f) = \frac{c^i_j}{\rho^i_{jk}}. \tag{7}$$

all firms in the same industry i, producing in country j and selling to country k, sell at the same price, regardless of variety.

Assuming free entry in our model, therefore each firm has zero profits. (7) into (6) and free entry assumption lead to:

$$q^i_{jk} = \frac{F^i_{jk}}{c^i_j} \cdot \frac{\rho^i_{jk}}{1 - \rho^i_{jk}}. \tag{8}$$

A lower level of ρ^i_{jk}, signifies a high level of monopoly power by firms, that is, a high markup. The firm can and would charge a high price —that departs from the marginal cost c^i_j— for each unit of good sold. Quantities, on the other hand, decrease and fall down from what would have been optimally produced under perfect competition.

In the context of monopolistic competition with free entry, firm output increases with fixed costs due to the zero-profit condition. Since each firm must cover its fixed production and entry costs from variable profits, higher fixed costs require firms to operate at a larger scale to break even. As a result, equilibrium output per firm rises with fixed costs. This relationship reflects a core feature of Dixit and Stiglitz (1977) framework, where firm size adjusts endogenously to ensure zero economic profits in the long run.

2.3 Supranational Authority and Public Sector

Each country k has a government that must finance a predetermined level of public goods, denoted g_k. This variable represents the provision of public goods or services in country k, such as infrastructure, public administration, or other government activities that enter the planner's resource constraint. In our framework, g_k is treated as exogenous and must be financed through available tax instruments (a labor tax t^0_k and a consumption tax t^i_{jk}). In the first-best, this financing can be achieved without distortion through lump-sum transfers. However, in the constrained setting where such transfers are unavailable, the requirement to finance g_k becomes a key driver of optimal tax policy. The presence of g_k thus introduces a fundamental fiscal trade-off: the planner must raise sufficient revenue to finance public spending while minimizing the distortions induced by taxation. This trade-off is captured by the marginal cost of public funds λ_k, which reflects how costly it is to finance an additional unit of g_k through distortionary taxes.

The planner ensures that each national budget constraint is balanced, that is,

$$t_k^0(L_k - \ell_k) + \sum_j \sum_i t_{jk}^i p_{jk}^i q_{jk}^i n_{jk}^i = g_k + T_k. \tag{9}$$

such that there are two marginal costs λ_k, one for each individual country k.

2.4 General Equilibrium Conditions

Having determined equilibrium output quantities q_{jk}^i and aggregators Y_{jk}^i, we now give a characterization of the numeraire (l_k), numbers of firms (n_{jk}^i), producer prices (p_{jk}^i) and wage rates (ω_k) at equilibrium, for given fiscal instruments $\left(T_k, t_k^0, \left(t_{jk}^i\right)_{i,j}\right)_k$ that satisfy the budget constraint of the supranational authority. In this framework, an equilibrium consists of allocations satisfying:

- Household budget constraint given by

$$\sum_j \sum_i \left(\frac{1+t_{jk}^i}{1-t_k^0}\right) p_{jk}^i q_{jk}^i n_{jk}^i = L_k - l_k + \frac{T_k}{1-t_k^0}.$$

- Firm pricing and entry given by (7) and (8)
- Labor market constraint in each country of production j:

$$L_j - l_j = g_j + \sum_k \sum_i n_{jk}^i (c_j q_{jk}^i + F_{jk}^i). \tag{10}$$

The previous equations can be transformed by changing the instruments $\left(T_k, t_k^0, \left(t_{jk}^i\right)_{i,j}\right)_k$ into new ones $\left(\tilde{T}_k, \left(\tilde{t}_{jk}^i\right)_{i,j}\right)_k$ where $\tilde{T}_k = \frac{T_k}{1-t_k^0}$, $\forall k$ and $\tilde{t}_{jk}^i = \frac{t_{jk}^i}{1-t_k^0}$, $\forall i$.

The linear tax on labor is redundant, equivalent to a uniform tax on all goods. So we can always find an indirect tax and a lump-sum transfer that reduce the three previous instruments $\left(T_k, t_k^0, \left(t_{jk}^i\right)_{i,j}\right)_k$ to two $\left(\tilde{T}_k, \left(\tilde{t}_{jk}^i\right)_{i,j}\right)_k$.

3 First-Best Optimum

In this section, we analyze the first-best scenario in which the planner has access to the full set of policy instruments, including lump-sum transfers. Our goal is to derive the optimal commodity tax structure when the planner can fully internalize monopolistic distortions and redistribute resources across countries without facing fiscal constraints. This setup serves as a benchmark for evaluating the efficiency of different tax instruments in an open economy with asymmetric valuations of labor and public spending. By solving for the planner's optimal allocation and pricing rules, we uncover how market power and fiscal asymmetries interact to determine optimal taxes and subsidies across trade directions.

3.1 Planner's Objective and Constraints

Let β_k be the welfare weights assigned by the supranational planner to each country. These weights capture the planner's redistributive preferences across countries and need not be equal. In particular, β_k may reflect normative concerns for equity across countries, differences in economic size, or, more generally, the relative importance assigned to each country in the policy objective.[2] δ_k^0 represent the marginal utility of the numeraire in country k; a high value of δ_k^0 means the representative consumer in country k places a high value on leisure, thus labor supply is costly in welfare terms: any distortion that induces more labor has a high welfare cost.[3] The planner chooses the mass of firms n_{jk}^i and quantity per firm q_{jk}^i to maximize total welfare:

$$\sum_{k\in\{N,S\}} \beta_k \mathcal{W}_k \left(l_k, \left(n_{jk}^i\right)_{i,j}\right) = \sum_{k\in\{N,S\}} \beta_k \left[\delta_k^0 l_k + \sum_{j\in\{N,S\}} \sum_{i=1}^{I} \delta_{jk}^i \frac{\left(n_{jk}^i \left(q_{jk}^i\right)^{\rho_{jk}^i}\right)^{1-1/E_{jk}^i}}{1-1/E_{jk}^i}\right], \quad (11)$$

subject to the labor market constraint (10) in each country.

[2]This formulation allows us to capture cross-country asymmetries in a reduced-form way without explicitly modeling a strategic game between national governments. When $\beta_N = \beta_S$, the planner corresponds to a global welfare maximizer with equal weights. When β_k differ, the planner places greater emphasis on the welfare of some countries, which can be interpreted either normatively (redistribution) or as reflecting political economy considerations.

[3]Since leisure is tied to the numeraire good (produced one-to-one with labor), δ_k^0 also captures how much consumers value income (purchasing power) in country k; a higher δ_k^0 raises the weight on leisure in country k, which makes the planner less willing to tax consumption in that country, since taxation indirectly pushes consumers to work more; in that case, the planner is more inclined to subsidize consumption if market power distorts prices upward.

3.2 Optimal Quantities and Entry

Replacing ℓ_k and Y^i_{jk} in the utility function by their values from the labor market constraint and the goods' aggregator equation give the following problem:

$$\max_{\left(n^i_{jk},q^i_{jk}\right)_{i,j,k}} \sum_{k\in\{N,S\}} \beta_k \left[\delta^0_k \left(L_k - g_k - \sum_{j\in\{N,S\}} \sum_{i=1}^{I} n^i_{kj} \left(c^i_k q^i_{kj} + F^i_{kj} \right) \right) \right.$$
$$\left. + \sum_{j\in\{N,S\}} \sum_{i=1}^{I} \delta^i_{jk} \frac{\left(n^i_{jk} (q^i_{jk})^{\rho^i_{jk}} \right)^{1-1/E^i_{jk}}}{1-1/E^i_{jk}} \right].$$

The first-order conditions allow us to obtain the optimal quantities produced :

$$\left(q^i_{jk}\right)_{opt} = \frac{F^i_{jk}}{c^i_j} \frac{\rho^i_{jk}}{1-\rho^i_{jk}} \tag{12}$$

Equation (12) is the zero-profit condition under monopolistic competition with free entry, adjusted by the planner in the first-best to correct for market distortion. So, $\frac{F^i_{jk}}{c^i_j}$ gives the baseline production scale needed to cover the fixed cost. Higher fixed costs or lower marginal cost require a larger output per firm to break even; and $\frac{\rho^i_{jk}}{1-\rho^i_{jk}}$ captures the markup structure from Dixit-Stiglitz monopolistic competition; a lower (resp. Higher) ρ^i_{jk} means that firms have high (resp.low) markup and therefore produce less (resp. more); this term ensures firms produce enough to recover their fixed costs at the planner-corrected price level.

The optimal number of varieties is therefore given by:

$$\left(n^i_{jk}\right)_{opt} = \left(\frac{\rho^i_{jk}}{c^i_j}\right)^{E^i_{jk}\rho^i_{jk}\left(1-1/E^i_{jk}\right)} \left(\frac{1-\rho^i_{jk}}{F^i_{jk}}\right)^{E^i_{jk}(1-\rho^i_{jk}+\rho^i_{jk}/E^i_{jk})} \left(\frac{\beta_k\delta^i_{jk}}{\beta_j\delta^0_j}\right)^{E^i_{jk}} \tag{13}$$

Equation (13) is made up of three terms:

- Cost and market structure term, $\left(\frac{\rho^i_{jk}}{c^i_j}\right)^{E^i_{jk}\rho^i_{jk}\left(1-1/E^i_{jk}\right)}$: more firms enter when marginal production costs (c_j) are low and competition (ρ^i_{jk}) is strong.
- Fixed costs and returns to scale term, $\left(\frac{1-\rho^i_{jk}}{F^i_{jk}}\right)^{E^i_{jk}(1-\rho^i_{jk}+\rho^i_{jk}/E^i_{jk})}$: lower fixed costs and higher markups make it easier for more firms to enter. This term reflects the zero-profit condition; each firm must be large enough to recover its fixed cost, and this limits how many firms can enter.

- Demand and redistribution term, $\left(\frac{\beta_k \delta^i_{jk}}{\beta_j \delta^0_j}\right)^{E^i_{jk}}$: this term reflects the planner's incentive to redistribute production to serve countries that value consumption more and where labor is less socially costly.[4]

3.3 First-Best Tax Rates

At the first-best, lump-sum transfers T_k are available. The optimal ad valorem tax t^i_{jk} applied to a good produced in country j, consumed in k, and belonging to industry i is derived by equating marginal rates of substitution and marginal cost:

(13) and (7) in the inverse demand function (4) allow to describes the tax vector that characterize the first-best at equilibrium:

$$t^{i,*}_{jk} = -1 + \rho^i_{jk} \cdot \frac{\beta_j \delta^0_j}{\beta_k \delta^0_k}, \tag{14}$$

The quantity of the numeraire ℓ_j purchased by each consumer in each country j is then derived from the labor constraint equation (10) in each country. And the level of the lump sum transfer T_k in each country k is obtain from the consumer budget constraint (3).

Proposition 1 (Proposition 1: First-Best Optimal Taxation Structure)**.** *Let t^i_{jk} denote the ad valorem tax on goods produced in j and consumed in k. Then:*

1. ***Domestically produced and consumed goods are subsidized:***

$$t^{i,*}_{jj} = -1 + \rho^i_{jj} < 0$$

   This corrects monopolistic distortions and restores marginal cost pricing.

2. ***Subsidy Increases with Market Power:*** *Industries with stronger monopolistic power (lower ρ^i_{jk}) receive larger subsidies.*

3. ***Cross-Border Subsidies Depend on social-valuation Asymmetry:*** *There always exists at least one cross-border direction $j \to k$ such that $t^i_{jk} < 0$. In particular, if the marginal social valuation of labor income (or leisure) in the origin country is*

[4] $\beta_k \delta^0_k$ measures how much welfare is gained in country k by increasing consumption of goods produced in country j; $\beta_j \delta^0_j$ measures the social cost of labor used to produce those goods. Therefore, $\frac{\beta_k \delta^0_k}{\beta_j \delta^0_j}$ can be seen as the planner's marginal cost-benefit ratio for allocating labor to produce variety from country j for country k.

lower than the one in the destination, then imports from j to k are subsidized:

$$\textit{if} \quad \beta_j \delta_j^0 \leq \beta_k \delta_k^0 \ \textit{then} \quad t_{jk}^{i,*} \leq 0.$$[5]

4. ***Directional Tax Asymmetries:***

$$t_{jk}^{i,*} \neq t_{kj}^{i,*}$$

Even under symmetric market structure, taxes may differ by trade direction because the planner attaches different social values to labor and leisure across countries.

In monopolistic competition, firms charge prices above marginal cost, this causes consumers to under-consume relative to the efficient level. Therefore, for domestically produced and consumed goods, a subsidy reduces the consumer price, moving the consumer price back to marginal cost, thus correcting this distortion (Reinhorn, 2012 concludes the same in a close economy model).[6] The term $\frac{\beta_j \delta_j^0}{\beta_k \delta_k^0}$ reflects the relative social opportunity cost of production in the origin country compared with the social value of consumption in the destination country. It allows the planner to redirect demand and production toward origins where labor is less costly in welfare terms, and toward destinations where consumption is more valuable. The previous result also shows that taxes are not symmetric across trade directions (i.e., exports from j to k are treated differently than exports from k to j). Indeed, even if both countries have the same market structure, they can, for example, differ in marginal valuation of labor/leisure. These asymmetries justify different tax treatment, the planner using tax policy to reallocate production and consumption efficiently across borders.

4 Constrained optimum

In this section, we analyze the optimal tax structure in a constrained policy environment where lump-sum transfers are not available. While such transfers are a standard instrument in first-best analyses, their use is often limited in practice, particularly in international or supranational contexts. In many economic unions, large-scale inter-country transfers face significant political, institutional, and commitment constraints, making them difficult to implement or sustain. As a result, governments must rely primarily on distortionary

[5]If $\beta_j \delta_j^0 \geq \beta_k \delta_k^0$, then goods in the cross-border direction $j \to k$ may be taxed depending on the relative size of the markup ρ_{jk}^i.

[6]Indeed, with the formulae of the commodity tax given by (14), the consumer price is given by $\left(1 + t_{jj}^i\right) p_{jj}^i = c_j$.

tax instruments to finance public spending and address economic distortions. Accordingly, we restrict the planner's policy instruments to commodity taxation. This setting is best interpreted as a constrained (Ramsey) optimum, in which the planner chooses the optimal structure of distortionary taxes subject to the absence of lump-sum transfers. Unlike the first-best benchmark, where redistribution and efficiency can be fully separated, the planner here faces an inherent trade-off between revenue generation and distortion correction.

This constrained environment introduces an additional layer of complexity. Commodity taxes must now simultaneously serve two roles: correcting distortions arising from monopolistic competition and generating sufficient revenue to finance public goods. As a result, the optimal tax structure departs from the first-best allocation and reflects both efficiency and fiscal considerations. Importantly, the absence of lump-sum transfers does not stem from informational asymmetries in our framework, but rather from institutional constraints that limit the feasibility of inter-country redistribution. The planner continues to observe all relevant economic variables and optimally chooses tax instruments within the restricted set available. Therefore, the results derived in this section should be interpreted as characterizing optimal policy under realistic fiscal constraints, rather than as a second-best outcome driven by asymmetric information.We now formalize the planner's problem under this constrained setting and derive the corresponding optimal tax rules.

4.1 Modified Optimal Tax Rule

When lump-sum transfers are available, the planner can separate redistribution from efficiency. In that first-best environment, public expenditures can be financed without distorting commodity demands, and the planner's tax problem reduces to the correction of monopolistic markups. This separation is no longer possible once lump-sum transfers are ruled out.

In the constrained Ramsey problem, we set $T_k = 0$ for each country $k \in \{N, S\}$. The planner chooses the vector of gross destination-based commodity taxes

$$\tau \equiv \left(\tau^i_{jk}\right)_{i,j,k},$$

where $\tau^i_{jk} = 1 + t^i_{jk}$ is the gross tax on goods produced in country j, consumed in country k, and belonging to industry i. The statutory tax is levied at destination, but it affects production and entry in the origin country through equilibrium demand.

Given firm behavior and free entry condition, price and output per firm are respectively given by (7) and (8)

Let us denote $D^i_{jk} \equiv p^i_{jk} q^i_{jk} = c_j q^i_{jk} + F^i_{jk}$ denote the value of sales, equivalently the labor-resource cost per active firm serving market k from origin j.

The planner maximizes:

$$\sum_{k \in \{N,S\}} \beta_k \mathcal{W}_k,$$

where:

$$\mathcal{W}_k = \left(\delta^0_k \ell_k + \sum_{j \in \{N,S\}} \sum_{i=1}^{I} J^i_{jk} \frac{\left(n^i_{jk}\right)^{1-1/E^i_{jk}}}{1 - 1/E^i_{jk}} \right) \tag{15}$$

where leisure ℓ_j in country j is determined by the resource constraint:

$$L_j - \ell_j = g_j + \sum_k \sum_i n^i_{jk} D^i_{jk}.$$

The key Ramsey restrictions are the national government budget constraints. Since lump-sum transfers are unavailable, each country must finance its own public expenditure using commodity-tax revenue collected on goods consumed in that country:

$$R_k(\tau) \equiv \sum_j \sum_i \left(\tau^i_{jk} - 1\right) D^i_{jk} n^i_{jk}(\tau) = g_k, \quad k \in \{N, S\}.$$

Therefore the constrained Ramsey problem is

$$\begin{aligned} \max_{\tau} \quad & \sum_{k \in \{N,S\}} \beta_k W_k(\tau) \\ \text{subject to} \quad & R_N(\tau) = g_N, \quad R_S(\tau) = g_S, \quad \tau^i_{jk} > 0, \qquad \forall i, j, k. \end{aligned}$$

The constrained nature of the problem implies that raising public revenue is no longer costless. In the absence of lump-sum transfers, the planner must rely on distortionary commodity taxation, which affects consumption and production decisions. As a result, the planner faces a trade-off between efficiency and revenue generation. To capture this trade-off, we introduce the marginal cost of public funds in each country, denoted by λ_k. Formally, λ_k is the Lagrange multiplier associated with the budget constraint of country k in the planner's problem. It measures the marginal welfare cost of raising an additional unit of public revenue through distortionary taxation.

Remark 1. *With the firm behavior and market clearing condition described in Section 2,* *the mass of firms serving the market k from country j is given by:*

$$n_{jk}^i = \left[\frac{\rho_{jk}^i J_{jk}^i}{\delta_k^0 \tau_{jk}^i D_{jk}^i}\right]^{E_{jk}^i}$$

and is a decreasing function of the level of tax τ_{jk}^i.

Proof. See Appendix A □

Proposition 2 (Interior constrained Ramsey tax rule)**.** *The constrained Ramsey allocation satisfies*

$$\tau_{jk}^{i,R} = \frac{\lambda_j \rho_{jk}^i}{\beta_k \delta_k^0 + \left(1 - \frac{1}{E_{jk}^i}\right) \rho_{jk}^i \left(\lambda_k - \beta_k \delta_k^0\right)} \tag{16}$$

or equivalently

$$\frac{1}{\tau_{jk}^{i,R}} = \frac{\beta_k \delta_k^0}{\lambda_j \rho_{jk}^i} + \left(1 - 1/E_{jk}^i\right) \frac{\lambda_k - \beta_k \delta_k^0}{\lambda_j} \tag{17}$$

Proof. See Appendix B □

Equation (16) expresses the inverse of the optimal tax rate, $\frac{1}{\tau_{jk}^{i,R}}$, as a weighted sum of two distinct components. This decomposition provides valuable economic intuition by separating the redistributive efficiency motive from the corrective pricing objective.

The first term, $\frac{\beta_k \delta_k}{\lambda_j \rho_{jk}^i}$, captures the redistributive pressure tied to the value of labor in the consuming country k and the fiscal capacity of the producing country j . A high social marginal utility of leisure in the consuming country (high $\beta_k \delta_k^0$) implies that labor is valuable and taxing consumption should be avoided; this pushes the term up and thus lowers $\tau_{jk}^{i,R}$, potentially even below 1 (i.e., implying a subsidy). Conversely, a high marginal cost of public spending in the producing country (high λ_j) increases the fiscal burden of using labor to produce goods, discouraging subsidies. This term also inversely depends on ρ_{jk}^i, meaning goods with stronger monopoly power (lower ρ_{jk}^i) justify larger corrections through lower taxes or greater subsidies.[7] The second term, $\left(1 - 1/E_{jk}^i\right) \frac{\lambda_k - \beta_k \delta_k^0}{\lambda_j}$, reflects the Ramsey component of the tax, the extent to which distortionary taxation should fall on goods with more inelastic substitution possibilities. It is only activated when $\lambda_k \neq \beta_k \delta_k^0$, that is, when there is a wedge between the social value of leisure and the fiscal cost of public spending

[7] Unlike the canonical Corlett and Hague (1953) correction, which compares goods within a single economy based on their substitutability with leisure, the first term in (19) reflects a cross-country fiscal arbitrage. It captures the planner's incentive to shift production toward countries with lower marginal cost of public funds λ_j and lower social cost of labor δ_j^0, thereby relaxing the overall distortionary burden of taxation.

in the consuming country. If , $\lambda_k > \beta_k \delta_k^0$ meaning it is costly to finance public goods in country k, this term contributes positively, increasing the tax burden on goods with greater substitution elasticity (as captured by E_{jk}^i). Again, ρ_{jk}^i amplifies this effect, since goods with more market power respond differently to tax-induced price changes.

Overall, this expression makes clear that the optimal tax rate is lower (or more likely to be a subsidy) when: (1) Labor is highly valuable in the consuming country k (large $\beta_k \delta_k^0$); (2) The producing country j has low fiscal capacity (small λ_j), (3) good produced in country j and consumed in country k has strong monopoly power (small ρ_{jk}^i). It also shows that Ramsey-type taxes emerge when public spending is more costly in the consuming country than the value of leisure, and that this interacts with the degree of substitutability and market power of the good. This version of the formula thus neatly separates the redistributive motive (first term) from the efficiency-corrective and Ramsey pricing motive (second term), highlighting the complexity of designing optimal commodity taxes in open, asymmetric economies with monopolistic competition.

Lemma 1. *: for every country $j, k \in \{N, S\}$:*

- *for all i, j, k such that $\rho_{jk}^i \leq \frac{\lambda_k}{\lambda_j}$, there is k, $\lambda_k > \beta_k \delta_k^0$*
- *for all j, k such that $\lambda_j = \lambda_k = \lambda$, there is k, $\lambda > \beta_k \delta_k^0$.*

Proof. See Appendix C □

Lemma 1 formalizes the fiscal tension created by the absence of lump-sum transfers. Markup correction pushes the planner toward subsidies, whereas the government budget constraints require positive net revenue. Hence the constrained optimum cannot generally subsidize all directions simultaneously. At least one country must bear a positive fiscal burden, reflected in a shadow cost of public funds above the social value of private income. This is the force behind the directional tax wedges characterized below.

Proposition 3 (Directional wedges in the second-best; compact characterization)**.** *For a given industry i in the second-best (without lump-sum) and for any pair (j,k) of countries:*

1. ***Sign characterization:***
   The direction $j \to k$ is subsidized ($\tau_{jk}^i < 1$), iff, respectively

$$\frac{\beta_k \delta_k^0}{\rho_{jk}^i} + \left(1 - 1/E_{jk}^i\right)\left(\lambda_k - \beta_k \delta_k^0\right) < \lambda_j.$$

   The direction $j \to k$ is taxed ($\tau_{jk}^i > 1$), iff the above inequality is reversed.

2. ***Subsidies toward fiscally constrained destinations:***
   Suppose that in every country $k \in \{N, S\}$ the social marginal utility of income is less than the marginal cost of public spending, that is, we have $\beta_k \delta_k^0 \leq \lambda_k$. If the marginal cost of public spending of the country j is less than the social marginal utility of income ($\beta_k \delta_k^0$) of the country k that is $\lambda_j < \beta_k \delta_k^0$ then goods produced in country j and consumed in country k are subsidized, i.e., $\tau_{jk}^i < 1$.

Proof. See Appendix D □

Proposition 3 shows that whether a good produced in country j and consumed in k is taxed or subsidized depends on where it is cheaper to raise revenue and on how elastic demand and firm entry are. In the second-best setting, the planner cannot use lump-sum transfers and must rely on distortionary consumption taxes. If the marginal cost of public funds in the origin country, λ_j, is low relative to the term $\frac{\beta_k \delta_k^0}{\rho_{jk}^i} + \left(1 - 1/E_{jk}^i\right)\left(\lambda_k - \beta_k \delta_k^0\right)$, the planner will subsidize imports from j. The intuition is that it is cheaper to finance public spending by encouraging production in the fiscally efficient origin: when it is cheaper to raise revenue in the origin country (low λ_j), then producing and exporting from there is optimal subsidizing imports from such countries can increase global efficiency by allocating production where it has the lowest fiscal distortion. Conversely, when λ_j is high relative to that threshold, it is costlier to raise revenue in j than in k, so the planner uses a positive tax on goods from j to shift production away from the fiscally inefficient origin and toward k.

5 Decentralized optimum

5.1 Motivation and Scope

The analysis in Sections 3 and 4 characterizes optimal commodity taxation from the perspective of a benevolent supranational planner who internalizes the welfare of both countries and coordinates fiscal instruments across jurisdictions. A natural and empirically relevant question is whether this optimal allocation can be *decentralized* to national governments acting independently under a destination-based VAT regime, and if not, what coordination mechanism restores efficiency.

We now replace the supranational planner with two national governments $k \in \{N, S\}$, each choosing consumption taxes on goods sold within its territory to maximize the welfare of its own citizens subject to its own budget constraint. Under the destination principle, government k sets the ad valorem tax t_{jk}^i on all goods produced in j and consumed in k, for every industry i and origin $j \in \{N, S\}$. Government k does *not* control taxes on goods produced domestically and consumed abroad — those are set by the destination country.

The timing is as follows. In the first stage, both governments simultaneously announce their tax schedules $\{t^i_{jk}\}_{j,i}$. In the second stage, firms make entry and pricing decisions, consumers optimize, and markets clear. We focus on *pure-strategy Nash equilibria* of the first-stage tax game, taking firm behavior and market clearing as described in Section 2 as given.

5.2 The national government problem

Under the destination principle, government $k \in \{N, S\}$ chooses, for each industry i, the vector of gross consumption taxes

$$\tau^i_k \equiv (\tau^i_{jk}, \tau^i_{jk})_{j \in \{N,S\}},$$

levied on all goods consumed in country k, irrespective of their country of origin. It takes the tax vector chosen by the foreign government $\tau^i_j \equiv (\tau^i_{jk}, \tau^i_{jk})_{j \in \{N,S\}}$, $j \neq k$ as given.

Given firm behavior and free entry condition, price and output per firm are respectively given by (7) and (8) whereas the optimal number of firms is given by Remark 1.

Each national government k maximizes the welfare of its representative consumer describes

$$\mathcal{W}_k = \left(\delta^0_k \ell_k + \sum_{j \in \{N,S\}} \sum_{i=1}^{I} J^i_{jk} \frac{\left(n^i_{jk}\right)^{1-1/E^i_{jk}}}{1 - 1/E^i_{jk}} \right)$$

subject to two national constraints:

- The labor-resource constraint:

$$L_k - \ell_k = g_k + \sum_j \sum_i n^i_{kj} D^i_{kj}$$

- The resource budget constraint:

$$R_k(\tau) \equiv \sum_j \sum_i \left(\tau^i_{jk} - 1\right) D^i_{jk} n^i_{jk}\left(\tau\right) = g_k.$$

Let μ_k and ξ_k denote respectively the multipliers associated with country k's budget constraint and country k's resource constraint. Therefore, country k's Lagrangian is given by :

$$\mathcal{L}_k = \mathcal{W}_k + \mu_k \left[\sum_j \sum_i \left(\tau^i_{jk} - 1 \right) D^i_{jk} n^i_{jk} \left(\tau \right) - g_k \right] + \xi_k \left[L_k - \ell_k - g_k - \sum_j \sum_i n^i_{kj} D^i_{kj} \right] \quad (18)$$

Definition 5.1 (Decentralized Nash equilibrium)**.** *A decentralized Nash equilibrium when national governments behave independently is a tax vector* $\tau^{D\star} = (\tau_N^{D\star}, \tau_S^{D\star})$*, where* $\tau^{k\star} = \{\tau^i_{jk}\}_{i,j}$ *such that for each country* $k \in \{N, S\}$ *:*

$$\mathcal{W}_k(\tau^{k\star}, \tau^{j\star}) \geq \mathcal{W}_k(\tau^k, \tau^{j\star})$$

subject to country k*'s budget constraint given in* (9) *and the labor market equilibrium* (10)*, with firm equilibrium behavior taken as given from Section 2.*

The first-order conditions of (18) in respect of τ^i_{jk} and τ^i_{kk} yield the following optimal tax formulas:

Proposition 4 (Optimal tax system in the decentralized constraint)**.** *The optimal tax system in the decentralized constraint for any country* k *is given by :*

(1) for domestic goods:

$$\tau^{i,D}_{kk} = \frac{\left(\mu_k + \delta^0_k\right) \rho^i_{kk}}{\delta^0_k + \mu_k \left(1 - 1/E^i_{kk}\right) \rho^i_{kk}} \quad (19)$$

(2) for imported goods:

$$\tau^{i,D}_{jk} = \frac{\mu_k \rho^i_{jk}}{\delta^0_k + \mu_k \left(1 - 1/E^i_{jk}\right) \rho^i_{jk}} \quad (20)$$

Proof. See Appendix E □

The decentralized tax formulas differ from the supranational Ramsey formula because national governments do not internalize the full cross-border consequences of their tax choices. In particular, when government k taxes imports from country j, it internalizes the effect of the tax on consumers in k and on its own tax revenue, but not the effect on production, labor use, and leisure in the exporting country j.

The decentralized import-tax formula depends on the national fiscal multiplier μ_k, the destination valuation of leisure δ^0_k, and the competitiveness parameter ρ^i_{jk}:

$$\frac{1}{\tau^{i,D}_{jk}} = 1 - \frac{1}{E^i_{jk}} + \frac{\delta^0_k}{\mu_k \rho^i_{jk}}, \qquad j \neq k.$$

The presence of ρ^i_{jk} reflects the monopolistic distortion: when ρ^i_{jk} is low, market power is strong and the decentralized tax formula places greater weight on the corrective subsidy motive.

For domestic goods, the government also internalizes the effect of taxation on domestic labor use and domestic leisure. This generates the additional term in the domestic tax formula:

$$\frac{1}{\tau^{i,D}_{kk}} = \frac{\delta^0_k}{\rho^i_{kk}\left(\mu_k + \delta^0_k\right)} + \left(1 - 1/E^i_{kk}\right)\left(1 - \frac{\delta^0_k}{\mu_k + \delta^0_k}\right)$$

Thus, domestic and imported goods are treated differently because only domestic production affects the national government's own labor-market constraint.

Proposition 5 (Sign characterization)**.** *For all goods consumed in country k*

(i) domestic goods are taxed when the revenue motive dominates the markup-corrective motive, that is $\tau^{i,D}_{kk} > 1$ *if* $\frac{\mu_k}{\delta^0_k} > E^i_{kk}\left(\frac{1}{\rho^i_{kk}} - 1\right)$

(ii) foreign goods are taxed if $\frac{\mu_k}{\delta^0_k} > \frac{E^i_{jk}}{\rho^i_{jk}}$.

Proof. The proof is straightforward. □

The term $\frac{\mu_k}{\delta^0_k}$ measures the strength of the government's revenue requirement relative to the welfare value of private resources and leisure. A high μ_k means that relaxing the national budget constraint is particularly valuable, which pushes the government toward positive taxation. By contrast, a high δ^0_k increases the welfare cost of tax-induced distortions and strengthens the case for correcting the monopolistic markup through a subsidy.

For domestically produced goods, the government internalizes three effects of taxation. A higher tax generates revenue, reduces domestic consumption, and lowers domestic production and entry, thereby releasing labor for leisure. The last effect makes domestic goods relatively attractive tax bases because the government values the labor released within its own jurisdiction. Nevertheless, when ρ^i_{kk} is low, firms possess substantial market power and output is already inefficiently low. The corrective-subsidy motive is then strong, and a large fiscal pressure is required before the government chooses a positive tax. This is reflected in the condition

$$\frac{\mu_k}{\delta^0_k} > E^i_{kk}\left(\frac{1}{\rho^i_{kk}} - 1\right).$$

The threshold increases as ρ^i_{kk} falls because stronger monopoly power makes additional taxation more distortionary. It also increases with E^i_{kk}, since a more tax-responsive demand

and entry margin implies a larger contraction in consumption and varieties following a tax increase.

For imported goods, government k internalizes the loss suffered by its consumers and the revenue collected at destination, but it does not internalize the effect of the tax on production, employment, and leisure in the exporting country. In particular, a reduction in foreign labor demand does not directly enter the objective of government k. The import tax is therefore determined by the balance between the domestic revenue motive and the distortion imposed on domestic consumers. Using the corrected import-tax formula, imports are taxed whenever

$$\frac{\mu_k}{\delta_k^0} > \frac{E_{jk}^i}{\rho_{jk}^i}, \ j \neq k.$$

Thus, imports are more likely to be taxed when public revenue is highly valuable, while strong foreign market power or a highly responsive import demand strengthens the case for a lower tax or a subsidy.

A useful implication is that the threshold for taxing imported goods exceeds the threshold for taxing otherwise identical domestic goods: $\frac{E^i}{\rho} - \frac{E^i(1-\rho)}{\rho} = E^i > 0$. All else equal, the decentralized government is therefore more willing to tax domestic goods than imported goods. A tax on domestic goods releases domestic labor, an effect valued by the national government, whereas the corresponding labor-market effect of an import tax occurs abroad and is ignored. This difference illustrates the central coordination failure of the decentralized equilibrium: each government evaluates taxes using only the resource consequences occurring within its own jurisdiction.

Proposition 6 (Coordination wedge)**.** *For any industry i, define the inverse-tax coordination wedge as*

$$\Delta_{jk}^{i,R} \equiv \frac{1}{\tau_{jk}^{i,D}} - \frac{1}{\tau_{jk}^{i,R}}, \ \forall j,k \in \{N,S\}.$$

Then the wedge between the decentralized Nash tax and the supranational Ramsey tax satisfies the following expressions.

(i) for the trade direction $k \to k$:

$$\Delta_{kk}^i = \left(\frac{\delta_k^0}{\mu_k + \delta_k^0} - \frac{\beta_k \delta_k^0}{\lambda_k}\right)\left[\frac{1}{\rho_{kk}^i} - \left(1 - 1/E_{kk}^i\right)\right]$$

(ii) for the trade direction $j \to k$:

$$\Delta_{jk}^i = \frac{1}{\rho_{jk}^i}\left(\frac{\delta_k^0}{\mu_k} - \frac{\beta_k \delta_k^0}{\lambda_j}\right) + \left(1 - 1/E_{jk}^i\right)\left(1 - \frac{\lambda_k - \beta_k \delta_k^0}{\lambda_j}\right)$$

Proof. The proof is straightforward. □

The domestic coordination wedge has a particularly transparent multiplicative structure. The first factor, $\frac{\delta_k^0}{\mu_k+\delta_k^0} - \frac{\beta_k \delta_k^0}{\lambda_k}$, compares the decentralized government's valuation of domestic labor resources relative to fiscal revenue with the corresponding valuation of the supranational planner. The national government evaluates the welfare benefit of releasing domestic labor through the normalized term $\delta_k^0/(\mu_k + \delta_k^0)$, whereas the planner evaluates the same resources using $\beta_k \delta_k^0/\lambda_k$. A positive difference means that the national government places relatively greater weight on domestic leisure and labor-resource savings and therefore chooses a lower domestic tax than the coordinated planner.

The second factor, $\frac{1}{\rho_{kk}^i} - \left(1 - \frac{1}{E_{kk}^i}\right)$, amplifies the difference in fiscal-resource valuations. In particular, stronger market power, represented by a lower ρ_{kk}^i, increases the magnitude of the wedge because the treatment of monopolistic markups, domestic entry, and labor use becomes more important. Hence, whether decentralization leads to a higher or lower domestic tax depends on the relative shadow valuations of national resources, while market structure determines how strongly this valuation difference is translated into tax policy.

The import coordination wedge contains two distinct components. The first term $\frac{1}{\rho_{jk}^i}\left(\frac{\delta_k^0}{\mu_k} - \frac{\beta_k \delta_k^0}{\lambda_j}\right)$, is a fiscal-valuation and markup channel. Government k values the welfare cost imposed on its consumers relative to the marginal value of its own tax revenue, as summarized by δ_k^0/μ_k. The supranational planner instead evaluates consumption in country k relative to the shadow cost of the productive resources used in the exporting country j, as summarized by $\beta_k \delta_k^0/\lambda_j$. This difference is amplified by market power: when ρ_{jk}^i is low, the pre-existing monopoly distortion is large, and differences in the valuation of consumption and origin-country resources translate into a larger tax wedge.

The second component, $\left(1 - \frac{1}{E_{jk}^i}\right)\left[1 - \frac{\lambda_k - \beta_k \delta_k^0}{\lambda_j}\right]$, captures the different treatment of the tax-base and entry response. The national government considers how the import tax affects its own tax base and revenue. The supranational planner additionally internalizes the resulting changes in production, entry, labor demand, and leisure in the exporting country. It therefore compares the net fiscal pressure in the destination, $\lambda_k - \beta_k \delta_k^0$, with the shadow cost of resources in the origin country, λ_j.

Consequently, the sign of the coordination wedge is ambiguous. Decentralization leads to a higher import tax than the Ramsey allocation when country's k revenue motive is relatively strong. It leads to a lower import tax when the supranational planner attaches a sufficiently high shadow cost to the resources used in the exporting country. Market power and the responsiveness of entry determine how strongly these differences are translated into tax policy.

Definition 5.2 (National acceptance of the supranational allocation)**.** *Let $\mathcal{W}_k^R$ and $\mathcal{W}_k^D$ denote country k's welfare under the supranational Ramsey allocation and the decentralized Nash equilibrium respectively.*

(i) ***Without inter-country transfers:*** *The Ramsey allocation is voluntarily acceptable to both countries (i.e., it is a Pareto improvement over the Nash equilibrium) if and only if:*

$$\mathcal{W}_k^R \geq \mathcal{W}_k^D, \ \forall k \in \{N, S\}$$

(ii) ***With Lump-sum transfers:*** *The Ramsey allocation can be implementable if there is a transfer vector (T_N, T_S) with $T_N + T_S = 0$ such that*

$$\forall k \in \{N, S\}, \quad \mathcal{W}_k^R + T_k \geq \mathcal{W}_k^D \quad \textit{if and only if} \quad \mathcal{W}_N^R + \mathcal{W}_S^R \geq \mathcal{W}_N^D + \mathcal{W}_S^D$$

6 Numerical Analysis

This section illustrates the analytical mechanisms developed in Sections **??**–**??** in a calibrated two-country economy. The numerical exercise compares three fiscal regimes.

First, the global constrained Ramsey allocation, denoted by R^G, is obtained by directly maximizing weighted welfare over the complete vector of origin–destination taxes, subject to the two national fiscal constraints. Second, the uniform destination-based VAT benchmark, denoted by U, imposes a common tax on all goods consumed in a given country, independently of their country of origin. Third, the decentralized equilibrium, denoted by D, is obtained when each national government independently chooses the taxes applied to goods consumed within its own jurisdiction.

The direct global solution is the relevant benchmark for coordinated taxation. In particular, the uniform VAT allocation is a restricted element of the global Ramsey tax space:

$$\mathcal{T}^U = \{\boldsymbol{\tau} : \tau_{NN} = \tau_{SN}, \quad \tau_{NS} = \tau_{SS}\} \subset \mathcal{T}^R. \tag{21}$$

Consequently, a correctly computed global Ramsey allocation must satisfy

$$W^{R^G} \geq W^U, \tag{22}$$

up to numerical tolerance. This nesting property provides a direct computational validation of the global solution.

The numerical analysis has three objectives. First, it examines how coordination changes the level and structure of commodity taxes relative to decentralized national policy. Second, it quantifies the welfare gain from relaxing the uniformity restriction and from internalizing cross-border fiscal and resource effects. Third, it evaluates whether the coordinated allocation satisfies the national participation constraints and whether compensating transfers can support its implementation.

6.1 Baseline parameterization

The baseline parameterization is reported in Table 1. The two countries have the same labor endowment and receive equal welfare weights in the supranational objective. South has a lower marginal production cost, whereas cross-border sales involve larger fixed costs than domestic sales. The utility weight attached to leisure is larger in South, implying that labor use is more costly in welfare terms in that country. Domestic varieties are also characterized by stronger competition than cross-border varieties.

Table 1: Baseline parameterization

Direction	ρ_{jk}	E_{jk}	c_j	F_{jk}	δ_k^0	δ_{jk}	β_k	g_k	L_k
$N \to N$	0.7000	3.5000	1.0000	0.5000	1.0000	1.2000	0.5000	0.0180	10.0000
$S \to N$	0.5500	3.0000	0.6500	0.9000	1.0000	0.9000	0.5000	0.0180	10.0000
$N \to S$	0.5500	3.0000	1.0000	0.9000	1.2000	0.9000	0.5000	0.0220	10.0000
$S \to S$	0.7000	3.5000	0.6500	0.5000	1.2000	1.2000	0.5000	0.0220	10.0000

Notes: The index convention is origin–destination. Thus, $S \to N$ denotes a good produced in South and consumed in North. The parameters g_N and g_S are held fixed across the three fiscal regimes.

6.2 Computational procedure

For any tax vector $\boldsymbol{\tau}$, the number of firms from origin j serving destination k is

$$n_{jk}^i(\boldsymbol{\tau}) = \left[\frac{\rho_{jk}^i J_{jk}^i}{\delta_k^0 \tau_{jk}^i D_{jk}^i}\right]^{E_{jk}^i}. \tag{23}$$

Leisure in each country is recovered from its labor-resource constraint:

$$\ell_j = L_j - g_j - \sum_k \sum_i D_{jk}^i n_{jk}^i. \tag{24}$$

National welfare is evaluated as

$$W_k = \delta_k^0 \ell_k + \sum_j \sum_i \frac{J_{jk}^i \left(n_{jk}^i\right)^{1-1/E_{jk}^i}}{1 - 1/E_{jk}^i}, \tag{25}$$

and aggregate welfare is

$$W = \beta_N W_N + \beta_S W_S. \tag{26}$$

The global Ramsey allocation solves

$$\max_{\boldsymbol{\tau}>0} \; \beta_N W_N(\boldsymbol{\tau}) + \beta_S W_S(\boldsymbol{\tau}) \tag{27}$$

subject to

$$R_N(\boldsymbol{\tau}) = \sum_j \sum_i \left(\tau_{jN}^i - 1\right) D_{jN}^i n_{jN}^i = g_N, \tag{28}$$

$$R_S(\boldsymbol{\tau}) = \sum_j \sum_i \left(\tau_{jS}^i - 1\right) D_{jS}^i n_{jS}^i = g_S. \tag{29}$$

The uniform VAT allocation solves the same problem subject to the additional restrictions

$$\tau_{NN} = \tau_{SN}, \qquad \tau_{NS} = \tau_{SS}. \tag{30}$$

For the decentralized equilibrium, each country solves its own national problem. Using Proposition **??**, the taxes controlled by country k can be expressed as functions of its national fiscal multiplier μ_k. For domestic goods,

$$\tau_{kk}^{i,D} = \frac{\left(\mu_k + \delta_k^0\right) \rho_{kk}^i}{\delta_k^0 + \mu_k \left(1 - \frac{1}{E_{kk}^i}\right) \rho_{kk}^i}, \tag{31}$$

whereas for imported goods, $j \neq k$,

$$\tau_{jk}^{i,D} = \frac{\mu_k \rho_{jk}^i}{\delta_k^0 + \mu_k \left(1 - \frac{1}{E_{jk}^i}\right) \rho_{jk}^i}. \tag{32}$$

For each destination k, the multiplier μ_k is determined from the national fiscal constraint

$$\sum_j \sum_i \left[\tau_{jk}^{i,D}(\mu_k) - 1\right] D_{jk}^i n_{jk}^i \left(\tau_{jk}^{i,D}(\mu_k)\right) = g_k. \tag{33}$$

This formulation reduces the decentralized computation to one scalar fiscal equation for each country. All reported allocations satisfy the national budget constraints up to numerical tolerance. Welfare comparisons are calculated using the unrounded numerical solutions, even though the tables display four decimal places.

6.3 First-best benchmark

Table 2 reports the firm-level equilibrium objects and the first-best taxes. All four directions are subsidized. For domestic goods, the subsidy corrects the monopolistic markup and restores marginal-cost pricing. Cross-border subsidies are asymmetric because the first-best tax also depends on the relative social valuation of labor in the origin and destination countries.

Table 2: First-best equilibrium

Direction	q_{jk}	p_{jk}	D_{jk}	J_{jk}	n^*_{jk}	t^*_{jk}	τ^*_{jk}
$N \to N$	1.1667	1.4286	1.6667	1.2961	0.4148	-0.3000	0.7000
$S \to N$	1.6923	1.1818	2.0000	1.0915	0.0941	-0.3400	0.6600
$N \to S$	1.1000	1.8182	2.0000	0.9320	0.1012	-0.5417	0.4583
$S \to S$	1.7949	0.9286	1.6667	1.6077	0.4657	-0.3000	0.7000

Notes: q_{jk} is the zero-profit output per firm, $p_{jk} = c_j/\rho_{jk}$, $D_{jk} = c_j q_{jk} + F_{jk}$, and $\tau^*_{jk} = 1 + t^*_{jk}$.

6.4 Baseline comparison across fiscal regimes

Table 3 compares the global Ramsey allocation, uniform VAT, and the corrected decentralized equilibrium.

Under decentralized taxation, imported goods are taxed if and only if

$$\frac{\mu_k}{\delta_k^0} > \frac{E^i_{jk}}{\rho^i_{jk}}, \qquad j \neq k. \tag{34}$$

At the baseline, the national fiscal multipliers are

$$\mu_N = 4.7984, \qquad \mu_S = 5.6671. \tag{35}$$

For imports into North,

$$\frac{\mu_N}{\delta_N^0} = 4.7984 < \frac{E_{SN}}{\rho_{SN}} = \frac{3}{0.55} = 5.4545, \tag{36}$$

while for imports into South,

$$\frac{\mu_S}{\delta_S^0} = \frac{5.6671}{1.2} = 4.7226 < \frac{E_{NS}}{\rho_{NS}} = 5.4545. \tag{37}$$

Consequently, both governments subsidize imports:

$$\tau_{SN}^D = 0.9564 < 1, \qquad \tau_{NS}^D = 0.9509 < 1. \tag{38}$$

By contrast, domestic goods are taxed whenever

$$\frac{\mu_k}{\delta_k^0} > E_{kk}^i \left(\frac{1}{\rho_{kk}^i} - 1 \right). \tag{39}$$

At the baseline,

$$E_{kk} \left(\frac{1}{\rho_{kk}} - 1 \right) = 3.5 \left(\frac{1}{0.7} - 1 \right) = 1.5, \tag{40}$$

which is below the fiscal-pressure ratio in both countries. Hence,

$$\tau_{NN}^D = 1.1941 > 1, \qquad \tau_{SS}^D = 1.1917 > 1. \tag{41}$$

Table 3: Equilibrium outcomes under three fiscal regimes

Regime	τ_{NN}	τ_{SN}	τ_{NS}	τ_{SS}	n_{NN}	n_{SN}	n_{NS}	n_{SS}	ℓ_N	ℓ_S	W_N	W_S	W
Global Ramsey	1.1037	1.0799	1.0622	1.1570	0.0843	0.0215	0.0081	0.0802	9.8253	9.8014	10.2618	12.1894	11.2256
Uniform VAT	1.0978	1.0978	1.1451	1.1451	0.0859	0.0204	0.0065	0.0832	9.8259	9.7985	10.2625	12.1878	11.2251
Decentralized equilibrium	1.1941	0.9564	0.9509	1.1917	0.0640	0.0309	0.0113	0.0723	9.8527	9.7956	10.2686	12.1701	11.2193

Notes: The indices follow the origin–destination convention. Thus, for example, $S \to N$ denotes goods produced in South and consumed in North. Weighted welfare is defined as $W = \beta_N W_N + \beta_S W_S$, with $\beta_N = \beta_S = 1/2$. The displayed values are rounded to four decimal places; all welfare comparisons are computed using the unrounded numerical solutions.

The corrected decentralized allocation displays a clear fiscal pattern. Each national government taxes domestically produced goods and uses part of the resulting revenue to finance an import subsidy. In North,

$$R_N^{\text{domestic}} = 0.020695, \qquad R_N^{\text{imports}} = -0.002695, \tag{42}$$

so that

$$R_N = 0.020695 - 0.002695 = 0.018. \tag{43}$$

Similarly, in South,

$$R_S^{\text{domestic}} = 0.023113, \qquad R_S^{\text{imports}} = -0.001113, \tag{44}$$

and therefore

$$R_S = 0.023113 - 0.001113 = 0.022. \tag{45}$$

This tax structure reflects the territorial limits of national welfare maximization. A tax on a domestically produced good lowers domestic production and entry and thereby releases labor within the taxing country. The national government internalizes the associated increase in domestic leisure. By contrast, the production and labor-market consequences of an import tax occur in the exporting country and do not enter the destination government's objective. The destination government therefore places relatively greater weight on correcting the foreign monopoly markup and may subsidize imports.

The global planner internalizes both sides of the transaction. It recognizes that an import subsidy raises production, entry, and labor use in the exporting country. The global Ramsey allocation therefore replaces the decentralized import subsidies with positive, though moderate, cross-border taxes.

6.5 Welfare comparisons

Because uniform VAT is nested within the global Ramsey tax space, the direct global allocation must weakly dominate the uniform benchmark. At the baseline,

$$W^{R^G} - W^U \simeq 0.000455 > 0. \tag{46}$$

The gain is quantitatively small because the uniform tax vector lies close to the global Ramsey allocation. Uniform destination taxation therefore performs well in the baseline, even though it prevents the planner from differentiating taxes according to origin.

The welfare gain from coordination relative to decentralized taxation is larger:

$$W^{R^G} - W^D \simeq 0.006255 > 0. \tag{47}$$

The decentralized equilibrium also lies below uniform VAT:

$$W^D - W^U \simeq -0.005755 < 0. \tag{48}$$

The baseline welfare ranking is therefore

$$\boxed{W^{R^G} > W^U > W^D}. \tag{49}$$

Table 4: Welfare comparisons

Comparison	Value	Interpretation
$W^{R^G} - W^U$	0.000455	Gain from relaxing the uniformity restriction
$W^{R^G} - W^D$	0.006255	Coordination gain relative to decentralization
$W^D - W^U$	−0.005755	Decentralization performs below uniform VAT
$W_N^{R^G} - W_N^D$	−0.006821	North loses from coordination
$W_S^{R^G} - W_S^D$	0.019332	South gains from coordination
$\sum_k (W_k^{R^G} - W_k^D)$	0.012511	Aggregate compensation condition is satisfied

Notes: Aggregate welfare W uses equal welfare weights. The final row is the unweighted sum of the two national welfare changes.

The comparison reveals two distinct gains. The first is the gain from allowing coordinated taxes to vary by origin:

$$W^{R^G} - W^U \simeq 0.000455. \tag{50}$$

The second is the gain from replacing independent national policy with coordinated optimization:

$$W^{R^G} - W^D \simeq 0.006255. \tag{51}$$

Most of the welfare advantage of the global Ramsey allocation therefore does not come from tax differentiation alone. It comes from internalizing the cross-border effects of taxation on foreign entry, production, labor demand, and leisure.

6.6 Decomposition of the coordination gain

To identify the source of the coordination gain, define the differentiated-goods component of welfare in country k as

$$C_k \equiv \sum_j \sum_i \frac{J_{jk}^i \left(n_{jk}^i\right)^{1-1/E_{jk}^i}}{1 - 1/E_{jk}^i}. \tag{52}$$

National welfare can then be written as

$$W_k = \delta_k^0 \ell_k + C_k. \tag{53}$$

The welfare change generated by coordination satisfies

$$W_k^{RG} - W_k^D = \delta_k^0 \left(\ell_k^{RG} - \ell_k^D\right) + \left(C_k^{RG} - C_k^D\right). \tag{54}$$

Table 5: Decomposition of the coordination gain

Country	Leisure/resource component	Differentiated-goods component	Total welfare change
North	−0.027397	0.020576	−0.006821
South	0.006918	0.012414	0.019332
Weighted aggregate	−0.010240	0.016495	0.006255

Notes: The weighted aggregate uses $\beta_N = \beta_S = 1/2$. Components may differ slightly from differences calculated from the displayed tables because the decomposition uses unrounded numerical values.

For North, coordination increases utility from differentiated consumption and varieties by approximately 0.020576. However, North's leisure falls from

$$\ell_N^D = 9.8527 \tag{55}$$

to

$$\ell_N^{RG} = 9.8253. \tag{56}$$

The resulting welfare cost of additional labor use is approximately

$$\delta_N^0 \left(\ell_N^{RG} - \ell_N^D\right) \simeq -0.027397. \tag{57}$$

This labor-resource cost exceeds North's differentiated-goods gain, leaving North with a net welfare loss:

$$W_N^{RG} - W_N^D \simeq -0.006821. \tag{58}$$

South benefits through both channels. Its leisure rises from

$$\ell_S^D = 9.7956 \tag{59}$$

to

$$\ell_S^{RG} = 9.8014, \tag{60}$$

generating a leisure contribution of approximately 0.006918. The differentiated-goods component rises by approximately 0.012414. South's total welfare gain is therefore

$$W_S^{R^G} - W_S^D \simeq 0.019332. \tag{61}$$

At the weighted aggregate level, coordination lowers the leisure component of welfare by approximately 0.010240, but raises the differentiated-goods component by approximately 0.016495. The latter effect dominates:

$$-0.010240 + 0.016495 = 0.006255. \tag{62}$$

The coordination gain therefore arises from a more efficient allocation of production, entry, and varieties across countries and trade directions. It does not arise from a uniform reduction in labor use. Indeed, coordination increases labor use in North while reducing it in South. The global planner accepts this reallocation because the resulting consumption and variety gains more than compensate for the aggregate welfare cost of additional labor.

6.7 Participation constraints and compensating transfers

Aggregate welfare dominance does not imply that both countries voluntarily prefer the global Ramsey allocation to decentralized policy. Without transfers, voluntary implementation requires

$$W_k^{R^G} \geq W_k^D, \qquad k \in \{N, S\}. \tag{63}$$

At the baseline,

$$W_N^{R^G} - W_N^D \simeq -0.006821 < 0, \tag{64}$$

whereas

$$W_S^{R^G} - W_S^D \simeq 0.019332 > 0. \tag{65}$$

North therefore rejects coordination in the absence of compensation, whereas South prefers the global Ramsey allocation.

The aggregate unweighted welfare gain is

$$\begin{aligned} &\left(W_N^{R^G} + W_S^{R^G}\right) - \left(W_N^D + W_S^D\right) \\ &\quad \simeq -0.006821 + 0.019332 = 0.012511 > 0. \end{aligned} \tag{66}$$

A compensating transfer can therefore make both countries weakly better off. Let T_N denote a utility-equivalent transfer from South to North and impose

$$T_S = -T_N. \tag{67}$$

North accepts coordination when

$$W_N^{RG} + T_N \geq W_N^D, \tag{68}$$

which requires

$$T_N \geq 0.006821. \tag{69}$$

South accepts coordination when

$$W_S^{RG} - T_N \geq W_S^D, \tag{70}$$

which requires

$$T_N \leq 0.019332. \tag{71}$$

The coordinated allocation can therefore be implemented by any utility-equivalent transfer satisfying

$$0.006821 \leq T_N \leq 0.019332. \tag{72}$$

The lower bound compensates North exactly for its welfare loss. The upper bound transfers South's entire gain from coordination. Any transfer strictly inside this interval allows both countries to share the aggregate coordination surplus.

These results highlight the distinction between aggregate efficiency and political feasibility. Coordinated taxation raises aggregate welfare, but it also redistributes production, labor use, and consumption opportunities across countries. Consequently, a country may prefer the decentralized equilibrium even when coordination is globally efficient. Compensating transfers, revenue-sharing arrangements, or other burden-sharing mechanisms are therefore an integral part of the implementation problem.

The interval in equation (72) is expressed in utility-equivalent units. If transfers are instead modeled as fiscal resources, their welfare effects must be converted using the relevant marginal utility of income and their financing must be included in the national budget constraints.

7 Conclusion

This paper revisits the neutrality of destination-based VAT in an open economy with monopolistic competition, endogenous entry, and asymmetric fiscal constraints. The usual argument in favor of the destination principle is that, by taxing goods where they are consumed, VAT should not distort where production takes place (Lockwood et al., 1994a Lockwood et al., 1994b). The analysis in this paper shows that this neutrality argument is incomplete once firms have market power and governments must finance country-specific public expenditures with distortionary commodity taxes.

The first-best benchmark clarifies the basic efficiency force. When lump-sum transfers are available, optimal taxes correct monopolistic markups. Domestic goods are subsidized (as in a closed-economy in Reinhorn, 2012), and cross-border tax rates may differ by direction because the social cost of labor differs across countries. Thus, even in a setting where taxes are levied at destination, optimal tax rates need not be uniform across origins. What matters is not only where goods are consumed, but also where they are produced and how costly it is, in welfare terms, to use labor in that origin country.

When lump-sum transfers are unavailable, the problem becomes more subtle. Commodity taxes must both correct markup distortions and raise public revenue. The constrained Ramsey formula shows that optimal taxes depend on the origin-country marginal cost of public funds, the destination-country fiscal constraint, and the degree of product-market competition. This creates origin-destination tax wedges that can look similar to tariff-like instruments, even though they arise from a destination-based consumption-tax system rather than from a protectionist motive. The key point is that VAT neutrality is not guaranteed by the destination principle alone; it also depends on market structure, fiscal asymmetries, and the instruments available to the planner – this add a formal theoretical dimension to the policy arguments of Rodrik (2018). The decentralized analysis adds a second layer to this argument. When each national government sets taxes on goods consumed domestically, it internalizes domestic consumer welfare and domestic revenue but ignores the effect of its taxes on production, entry, and labor use in the exporting country. The resulting Nash equilibrium therefore differs from the supranational allocation. This difference is not merely a technical detail: it reflects a fiscal externality across countries. National governments may choose taxes that are optimal from their own perspective but inefficient from the standpoint of a coordinated economy. The participation result further shows that coordination cannot be evaluated only by comparing aggregate formulas. A supranational tax allocation is politically acceptable only if each country weakly prefers it to its decentralized outside option, unless compensating transfers are available. If transfers are feasible, the aggregate surplus from coordination must be large enough to compensate any losing country. This distinction is important because the numerical analysis shows that the distribution of gains can be highly asymmetric. In the baseline calibration, South gains from the computed Ramsey allocation relative to Nash, while North loses; moreover, aggregate dominance holds, so compensation is sufficient to make the allocation acceptable in that calibration. The numerical simulations illustrate the mechanisms behind the theoretical results. They show that directional tax wedges arise endogenously and vary with market competition. They also clarify the distinction between the analytical Ramsey first-order-condition allocation and the verified global Ramsey allocation. Since the uniform VAT is a restricted element of the direction-specific Ramsey tax space, the global Ramsey allocation must weakly dominate the uniform VAT benchmark. This ranking is therefore not a numerical conjecture but a direct implication of the nesting of feasible tax instruments.

The broader implication is that the case for differentiated VAT should not be stated as a claim that differentiation always generates large welfare gains. The precise conclusion is that destination-based VAT does not imply uniform optimal taxation. Market power, endogenous entry, and fiscal asymmetry create forces that justify origin-destination tax wedges. The welfare gain from these wedges, their quantitative importance, and their political acceptability depend on the full equilibrium environment and on the distribution of gains and losses across countries.

Several extensions are natural. First, the numerical analysis should be complemented by a direct global maximization exercise to verify when the Ramsey candidate is truly the global constrained optimum. Second, the model could allow public spending to be chosen endogenously rather than treated as an exogenous fiscal requirement. Third, incorporating administrative and legal constraints would help determine which forms of differentiated destination-based taxation are feasible in practice, especially in settings such as the European Union. Finally, a richer calibration using sector-level markups, trade flows, and fiscal data would make it possible to quantify the empirical importance of the mechanisms identified here.

Overall, the paper shows that VAT neutrality is not a mechanical consequence of the destination principle. In economies with monopolistic competition and asymmetric fiscal constraints, consumption taxes affect entry, production, labor use, and the distribution of welfare across countries. Optimal VAT design therefore requires more than a choice between uniformity and differentiation. It requires understanding the market distortions that taxes correct, the fiscal constraints they relax, and the participation constraints that determine whether coordinated tax policy can actually be implemented.

Appendix A Remark 1

Proof. Under symmetry across firms in the direction $j \to k$, the CES aggregator (2) can be re-written as: $Y^i_{jk} = n^i_{jk}\left(q^i_{jk}\right)^{\rho^i_{jk}}$. Inserting this into the inverse-demand equation (4), we obtain:

$$\tau^i_{jk} p^i_{jk} = \frac{\delta^i_{jk}\rho^i_{jk}}{\delta^0_k}\left(n^i_{jk}\right)^{-1/E^i_{jk}}\left(q^i_{jk}\right)^{\rho^i_{jk}\left(1-1/E^i_{jk}\right)-1}$$

Multiplying both side of the equality by q^i_{jk} and using $D^i_{jk} = p^i_{jk} q^i_{jk} = c^i_j q^i_{jk} + F^i_{jk}$, one gets:

$$\left(n^i_{jk}\right)^{1/E^i_{jk}} = \frac{\delta^i_{jk}\rho^i_{jk}\left(q^i_{jk}\right)^{\rho^i_{jk}(1-1/E^i_{jk})}}{\delta^0_k \tau^i_{jk} D^i_{jk}}.$$

The result is achieved after recalling that $J^i_{jk} \equiv \delta^i_{jk}\left(q^i_{jk}\right)^{\rho^i_{jk}\left(1-\frac{1}{E^i_{jk}}\right)}$, as defined in Section (4) $\square$

Appendix B Proposition 2

Proof. The planner maximizes $\sum_k \beta_k \mathcal{W}_k$, where $\mathcal{W}_k$ is given by (15) subject to each country k's implementability constraint (3) and each country's resource constraint (10).

From Remark (1), one gets

$$\tau^i_{jk} D^i_{jk} n^i_{jk} = \frac{\rho^i_{jk} J^i_{jk}}{\delta^0_k}\left(n^i_{jk}\right)^{1-1/E^i_{jk}} \quad \text{or equivalently} \quad \tau^i_{jk} D^i_{jk} n^i_{jk} = H^i_{jk} q^i_{jk}\left(n^i_{jk}\right)^{1-1/E^i_{jk}},$$

where

$$H^i_{jk} q^i_{jk} = \frac{\rho^i_{jk} J^i_{jk}}{\delta^0_k}.$$

From (9), we get:

$$\ell_k = L_k - \sum_j \sum_i \tau^i_{jk} n^i_{jk} D^i_{jk} \quad \text{or} \quad \ell_k = L_k - \sum_j \sum_i H^i_{jk} q^i_{jk}\left(n^i_{jk}\right)^{1-1/E^i_{jk}}.$$

Replacing this equation in (10) and (15), one gets the following Lagrangian:

$$\mathcal{L} = \sum_{k\in\{N,S\}} \beta_k \left[\delta_k^0 \left(L_k - \sum_{j\in\{N,S\}} \sum_{i=1}^{I} H_{jk}^i q_{jk}^i \left(n_{jk}^i\right)^{1-\frac{1}{E_{jk}^i}} \right) + \sum_{j\in\{N,S\}} \sum_{i=1}^{I} J_{jk}^i \frac{\left(n_{jk}^i\right)^{1-1/E_{jk}^i}}{1-1/E_{jk}^i} \right]$$
$$+ \sum_{k\in\{N,S\}} \lambda_k \left(-g_k - \sum_{j\in\{N,S\}} \sum_{i=1}^{I} n_{kj}^i D_{kj}^i + \sum_{j\in\{N,S\}} \sum_{i=1}^{I} H_{jk}^i q_{jk}^i \left(n_{jk}^i\right)^{1-\frac{1}{E_{jk}^i}} \right)$$

First-order condition with respect to n_{jk}^i gives:

$$\left(n_{jk}^i\right)^{-\frac{1}{E_{jk}^i}} \left[\left(1-1/E_{jk}^i\right) \rho_{jk}^i \left(\lambda_k - \beta_k \delta_k^0\right) + \beta_k \delta_k^0 \right] J_{jk}^i = \lambda_j D_{jk}^i$$

Using the expression of n_{jk}^i from Remark (1), the above equality writes:

$$\frac{\delta_k^0 \tau_{jk}^i D_{jk}^i}{\rho_{jk}^i} \left[\left(1-1/E_{jk}^i\right) \rho_{jk}^i \left(\lambda_k - \beta_k \delta_k^0\right) + \beta_k \delta_k^0 \right] J_{jk}^i = \lambda_j D_{jk}^i \delta_k^0$$

Simplifying by δ_k^0 and re-arranging lead to

$$\tau_{jk}^i = \frac{\lambda_j \rho_{jk}^i}{\beta_k \delta_k^0 + \left(1-1/E_{jk}^i\right) \rho_{jk}^i \left(\lambda_k - \beta_k \delta_k^0\right)}$$

□

Appendix C Lemma 1

Proof. Here we adopt a *reductio ad absurdum argument*. Let us suppose that for all i,j,k such that $\rho_{jk}^i \le \frac{\lambda_k}{\lambda_j}$, $\lambda_k \le \beta_k \delta_k^0$ for all $k \in \{N, S\}$. Let us show that this is absurd.

From the two resource constraints, we have

$$\sum_k g_k + \sum_j \sum_k \sum_i n_{jk}^i D_{jk}^i = \sum_j \sum_k \sum_i \frac{\rho_{jk}^i}{\delta_k^0} J_{jk}^i \left(n_{jk}^i\right)^{1-1/E_{jk}^i}$$

Remark (1) and Proposition 3 lead to:

$$\sum_k g_k = \sum_j \sum_k \sum_i n_{jk}^i \rho_{jk}^i D_{jk}^i \frac{\beta_j \delta_j^0}{\beta_k \delta_k^0} \left[\frac{1}{\frac{\lambda_k/\beta_k\delta_k^0}{\lambda_j/\beta_j\delta_j^0} \left(1-1/E_{jk}^i\right) \rho_{jk}^i + \frac{\beta_j \delta_j^0}{\lambda_j} \left(1-\rho_{jk}^i + \rho_{jk}^i/E_{jk}^i\right)} - \frac{\beta_k \delta_k^0}{\beta_j \delta_j^0} \frac{1}{\rho_{jk}^i} \right]$$

If $\lambda_k < \beta_k\delta_k^0$ and $\lambda_j < \beta_j\delta_j^0$, then $\frac{\lambda_k/\beta_k\delta_k^0}{\lambda_j/\beta_j\delta_j^0} < \frac{\beta_j\delta_j^0}{\lambda_j}$ and $\frac{\lambda_j/\beta_j\delta_j^0}{\lambda_k/\beta_k\delta_k^0} < \frac{\beta_k\delta_k^0}{\lambda_k}$; therefore we have

$$\begin{aligned}
\sum_k g_k \quad &< \quad \sum_j\sum_k\sum_i n_{jk}^i\rho_{jk}^i D_{jk}^i \frac{\beta_j\delta_j^0}{\beta_k\delta_k^0}\left[\frac{1}{\frac{\lambda_k/\beta_k\delta_k^0}{\lambda_j/\beta_j\delta_j^0}} - \frac{\beta_k\delta_k^0}{\beta_j\delta_j^0}\frac{1}{\rho_{jk}^i}\right] \\
\iff \qquad & \sum_k g_k < \sum_j\sum_k\sum_i n_{jk}^i\rho_{jk}^i D_{jk}^i\left[\frac{\lambda_j}{\lambda_k} - \frac{1}{\rho_{jk}^i}\right] < 0
\end{aligned}$$

□

Appendix D Proposition 3

Proof. (1) Straightforward

(2) We can re-write (16) as

$$\tau_{jk}^{i,R} = \frac{1}{\frac{\beta_k\delta_k^0}{\lambda_j}\left(\frac{1}{\rho_{jk}^i} - 1 + \frac{1}{E_{jk}^i}\right) + \frac{\lambda_k}{\lambda_j}\left(1 - \frac{1}{E_{jk}^i}\right)}$$

and

$$\tau_{kj}^{i,R} = \frac{1}{\frac{\beta_j\delta_j^0}{\lambda_k}\left(\frac{1}{\rho_{kj}^i} - 1 + \frac{1}{E_{kj}^i}\right) + \frac{\lambda_j}{\lambda_k}\left(1 - \frac{1}{E_{kj}^i}\right)}$$

If $\lambda_j \le \beta_k\delta_k^0$, then $\frac{\beta_k\delta_k^0}{\lambda_j} > 1$ and since by hypothesis $\beta_k\delta_k^0 \le \lambda_k$, then $\lambda_j \le \lambda_k$. Therefore $\frac{\lambda_k}{\lambda_j} > 1$; hence $\tau_{jk}^i \le \frac{1}{\left(\frac{1}{\rho_{jk}^i} - 1 + \frac{1}{E_{jk}^i}\right) + \left(1 - \frac{1}{E_{jk}^i}\right)} = 1$.

□

Appendix E Proposition 4

Proof. First order conditions of (18) are written as:

$$\begin{aligned}
&\frac{\partial \mathcal{L}_k}{\partial \ell_k} = 0 \Rightarrow \;\; \delta_k^0 = \xi_k \\
&\frac{\partial \mathcal{L}_k}{\partial \tau_{jk}^i} = 0 \Rightarrow \;\; J_{jk}^i \left(n_{jk}^i\right)^{-1/E_{jk}^i} \frac{\partial n_{jk}^i}{\partial \tau_{jk}^i} + \mu_k \left[n_{jk}^i D_{jk}^i + \left(\tau_{jk}^i - 1\right) D_{jk}^i \frac{\partial n_{jk}^i}{\partial \tau_{jk}^i} \right] = 0 \\
&\frac{\partial \mathcal{L}_k}{\partial \tau_{kk}^i} = 0 \Rightarrow \;\; J_{kk}^i \left(n_{kk}^i\right)^{-1/E_{kk}^i} \frac{\partial n_{kk}^i}{\partial \tau_{kk}^i} + \mu_k \left[n_{kk}^i D_{kk}^i + \left(\tau_{kk}^i - 1\right) D_{kk}^i \frac{\partial n_{kk}^i}{\partial \tau_{kk}^i} \right] - \xi_k D_{kk}^i \frac{\partial n_{kk}^i}{\partial \tau_{kk}^i} = 0
\end{aligned}$$

But using the number of firms given by Remark 1, we know that

$$\frac{\partial n_{jk}^i}{\partial \tau_{jk}^i} = -E_{jk}^i \frac{n_{jk}^i}{\tau_{jk}^i}, \;\; \forall j, k.$$

Therefore

$$\frac{\partial \mathcal{L}_k}{\partial \tau_{jk}^i} = 0 \Rightarrow \;\; -E_{jk}^i \frac{\delta_k^0}{\rho_{jk}^i} + \mu_k \left(1 - E_{jk}^i + \frac{E_{jk}^i}{\tau_{jk}^i} \right) = 0$$

That leads to

$$\tau_{jk}^i = \frac{E_{jk}^i \mu_k \rho_{jk}^i}{E_{jk}^i \delta_k^0 + \mu_k \left(E_{jk}^i - 1\right) \rho_{jk}^i}$$

Dividing this equality by E_{jk}^i leads to the correct expression.

Using the same reasoning,

$$\begin{aligned}
\frac{\partial \mathcal{L}_k}{\partial \tau_{kk}^i} = 0 \Rightarrow & \; -\frac{\delta_k^0 E_{kk}^i}{\rho_{kk}^i} + \frac{\delta_k^0 E_{kk}^i}{\tau_{kk}^i} + \mu_k \left(1 - E_{kk}^i + \frac{E_{kk}^i}{\tau_{kk}^i} \right) = 0 \\
\Rightarrow & \;\; \frac{E_{kk}^i}{\tau_{kk}^i} \left(\delta_k^0 + \mu_k\right) - \frac{\delta_k^0 E_{kk}^i}{\rho_{kk}^i} + \mu_k \left(1 - E_{kk}^i\right) = 0
\end{aligned}$$

That leads to

$$\tau_{kk}^i = \frac{E_{kk}^i \left(\delta_k^0 + \mu_k\right) \rho_{kk}^i}{\delta_k^0 E_{kk}^i + \mu_k \left(E_{kk}^i - 1\right) \rho_{kk}^i}$$

A simple division by E_{kk}^i leads to the intended result. □

References

Aiura, H. and Ogawa, H. (2019). Indirect taxes in a cross-border shopping model: a monopolistic competition approach. *Journal of Economics, Springer*, 128(2):147–175.

Aiura, H. and Ogawa, H. (2023). Does e-commerce ease or intensify tax competition? destination principle versus origin principle. *International Tax and Public Finance*, 31(3):702–735.

Atkeson, A. and Burstein, A. T. (2008). Pricing-to-market, trade costs, and international relative prices. *American Economic Review*, 98(5):1998–2031.

Auerbach, A. J. and Hines Jr., J. R. (2002). Taxation and economic efficiency. In Auerbach, A. J. and Feldstein, M., editors, *Handbook of Public Economics*, volume 3, pages 1347–1421. Elsevier.

Corlett, W. J. and Hague, D. C. (1953). Complementarity and the excess burden of taxation. *The Review of Economic Studies*, 21(1):21–30.

de la Feria, R. and Walpole, M. (2009). Options for vat reform in australia: Lessons from new zealand. *Australian Tax Forum*, 24:275–299.

Dixit, A. K. and Stiglitz, J. E. (1977). Monopolistic Competition and Optimum Product Diversity. *American Economic Review*, 67(3):297–308.

Ebrill, L., Keen, M., Bodin, J.-P., and Summers, V. (2001). *The Modern VAT*. International Monetary Fund.

Emran, M. S. and Stiglitz, J. E. (2005). On selective indirect tax reform in developing countries. *Journal of Public Economics*, 89(4):599–623. Cornell - ISPE Conference on Public Finance and Development.

Grossman, G. M. and Rossi-Hansberg, E. (2008). Trading tasks: A simple theory of offshoring. *American Economic Review*, 98(5):1978–1997.

Haufler, A. and Pflüger, M. (2004). International Commodity Taxation under Monopolistic Competition. *Journal of Public Economic Theory*, 6(3):445–470.

Keen, M. and Konrad, K. A. (2013). The theory of international tax competition and coordination. In Auerbach, A. J., Chetty, R., Feldstein, M., and Saez, E., editors, *Handbook of Public Economics*, volume 5, pages 257–328. Elsevier.

Lockwood, B., Meza, D., and Myles, G. (1994a). When are origin and destination regimes equivalent? *International Tax and Public Finance*, 1(1):5–24.

Lockwood, B., Meza, D., and Myles, G. (1994b). When are origin and destination regimes equivalent? *International Tax and Public Finance*, 1(1):5–24.

Reinhorn, L. (2012). Optimal taxation with monopolistic competition. *International Tax and Public Finance*, 19(2):216–236.

Rodrik, D. (2018). Populism and the economics of globalization. *Journal of International Business Policy*, 1(1):12–33.