Tax Policy Design in a Globalized Economy: A Comparative Analysis of Destination and Origin Principles.*

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Abstract

This paper is a model of an open economy in two countries in which we answer the question of whether the non-cooperative indirect tax should be in the country of consumption or the country of production. In this paper, each country has skilled and unskilled labor used in the production of differentiated goods in a monopolistically competitive economy. When a country raises its tax level, this causes both cross-border movement of firms and changes in labor and capital income, influencing welfare at home and abroad. We show that if in a country skilled labor is used more intensively than unskilled labor in the production of differentiated goods, the non-cooperative tax levied in the country of production leads to higher welfare than that levied in the country of consumption. The opposite is true if the country uses unskilled labor more intensively in the production of differentiated goods.

Keywords: tax competition, origin principle, destination principle, monopolistic competition.

JEL classification: F10, H20, H25.

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1 Introduction

This paper is a contribution to design a tax policy within a framework where countries have established agreements that facilitate trade without imposing additional border taxes, similar to the arrangements found among EU member states or the USMCA agreement between the United States, Canada, and Mexico. In an era where globalization drives complex trade flows and fiscal decisions can have international ramifications, assessing the destination and origin principles becomes crucial for formulating effective economic policies. The increasing interconnectedness of economies necessitates a re-evaluation of traditional taxation models to ensure they align with contemporary economic realities. To this end, I examine an economy characterized by taxes levied exclusively on commodities that are produced monopolistically, consumed locally, or traded internationally. Within this context, commodity taxation is intended to mitigate distortions arising from monopolistic practices and enhance consumer purchasing power through redistribution in the form of a lump-sum transfer. The central question addressed is whether this tax should be applied based on the destination principle-where goods are taxed at rates determined by the governments of the consuming countries-or the origin principle, where tax rates are set by the governments of the producing countries, particularly in a labor market featuring two distinct types of workers: unskilled and skilled.

The presence of two distinct types of labor–unskilled labor, which wage remains unaffected by tax levels, and skilled labor, which wage varies according to tax rates–raises important questions about how tax levels influence their utilization in firms' production processes. In fact, different tax levels can alter the ratio of skilled to unskilled wages, affecting the combination of these types of labor that firms choose to employ. This wage variation resulting from tax differences means that a portion of the tax burden is transferred to the producers. Furthermore, a tax rate established in one country can significantly impact wage levels in another, resulting in wage spillovers between countries (Krugman (2001)). Consequently, a critical issue for any national government is how to respond, in terms of tax policy, to taxation decisions made abroad. This paper examines such governmental reactions under both the destination and the origin principles. Despite the widespread adoption of destination-based taxation globally, recent developments have prompted a re-evaluation, at least from a theoretical standpoint, of whether this taxation framework remains appropriate for contemporary economic realities. Firstly, there has been a significant increase in global integration, with countries forming institutions that exempt member states from tariffs, as seen in the European Union, or entering into agreements such as the USMCA, which aim to eliminate trade restrictions, either partially or entirely. Such integrations enable consumers to source goods from countries with more favorable tax jurisdictions. For instance, within the EU, countries like France and Germany exhibit similar production costs, meaning that variations in consumer prices can be attributed solely to differences in tax levels. Secondly, the rise of the Internet has led to a substantial increase in e-Commerce. The share of e-Commerce as a percentage of total retail sales worldwide rose from 18.8% in 2021 to 19. 4% in 2023, projections suggesting that it will reach 21.8% in 2026 and 22.6% in 2027. In monetary terms, e-Commerce comprised approximately 5 trillion in 2021 and 5.8 trillion in 2023, with expectations of growing to 7.5 trillion in 2026 and up to 8 trillion in 2027 (Statista, 2024a). This trend supports the claim of Sinn (1990) that cross-border purchases will continue to rise unless value-added taxes (VAT) are sufficiently harmonized between countries. The increasing prevalence of e-Commerce presents additional challenges for the implementation of destination-based taxation, as highlighted in the literature (Keen et al., 1996; McLure, 1999; Devereux and Griffith, 1998).

The choice between the destination and origin principles has been extensively analyzed in the literature, resulting in the conclusion that these principles are equivalent under certain conditions: specifically, when commodity taxes are uniform across countries, when prices and wages are flexible, and when production factors are supplied inelastically (Grossman, 1980). However, in reality, tax levels vary significantly based on the types of goods and the government's inclination to facilitate or hinder the circulation of those goods. These disparities in tax rates create different distortions depending on whether the destination or origin principle is applied. Under the destination principle, producer prices are equalized, and variations in tax levels between countries lead to distortions in international consumption patterns. Conversely, when taxes are imposed under the origin principle, distortions manifest in international production patterns (Haufler et al., 2000). Importantly, the choice of taxation principle should ideally leave firms' input choices unaffected by commodity taxes, in line with the production efficiency lemma, suggesting that the destination principle may be preferable. Furthermore, the size of countries should be taken into account when evaluating the implications of adopting either principle, as it may significantly influence the outcomes of tax policies (Anderson and van Wincoop, 2003).

Numerous contributions to the literature have examined the merits and drawbacks of the destination and origin tax principles, with some studies advocating for one principle over the other, while others present more nuanced findings. For example, Keen and Lahiri (1998) demonstrated that taxes based on the destination principle are less effective than those based on the origin principle in both cooperative and non-cooperative scenarios, utilizing a duopoly model for their analysis. Lockwood (1993), employing an imperfect competition model with imperfect substitution between goods and using simulation methods, found that the destination principle Pareto dominates the origin principle, but only in the context of small countries. However, this conclusion is contingent upon specific preferences that allow for uniform taxation across all countries and fixed terms of trade. In contrast, Haufler and Pflüger (2004) examined a framework that allows for firm relocation and international capital mobility, concluding that the destination principle Pareto dominates the origin principle. Their model suggests that in noncooperative cases, the fiscal externalities arising from the mobility of firms and capital between countries lead to an optimal outcome under the destination principle, as these externalities effectively offset each other. Conversely, under the origin principle, an additional externality emerges: any increase in domestic tax rates raises foreign prices, consequently reducing foreign welfare. This results in a tax rate that exceeds the Pareto efficient level.

In this paper, we develop a model that features two countries and two types of labor: skilled and unskilled. We allow the wage rate for skilled labor to fluctuate in response to changes in the tax rate. Although neither the destination nor the origin principle achieves the optimum, we can differentiate between the two principles by comparing the intensity of skilled labor in production to the elasticity of substitution among various differentiated goods. This approach marks a significant departure from the prevailing practices in the recent literature, which often assume constant wages. Under such assumptions, the entirety of the tax burden-particularly in scenarios of tax increases-falls solely on consumers. However, by allowing wages to vary with tax rates, we also alter producer prices; consequently, the tax burden is shared between producers and consumers. This paper takes into account the additional spillover effects generated by wage variations and demonstrates that the distinction between the origin and destination principles can be made by looking at the share of revenue allocated to the remuneration of skilled labor: if this share is greater than one-half, the origin principle Pareto dominates the destination principle; else, the destination principle Pareto dominates the origin principle. This nuanced analysis provides a deeper understanding of how tax policy can influence labor dynamics and economic outcomes.

The rest of the paper is organized as follows. In Section 2 we present the theoretical model. In Section 3, we describe what the equilibrium looks like in the destination and in the origin principle. In Section 4, we describe the optimal tax rate in the cooperative case, while in Sections 5 , we study the question in the non-cooperative case both under the destination and origin principles. In Section 6, we make conclusive remarks.

2 The Model

We consider a version of the Dixit-Stiglitz-Krugman model of monopolistic competition (Dixit and Stiglitz, 1977; Krugman, 1979 and Krugman, 1980) where firms produce monopolistically goods that enter international trade using one unit of capital and a variable amount of labor. The economy is made up of two countries, home h and foreign f. We assume that the home and the foreign countries are populated by L and L^* individuals respectively. In addition, suppose that each country is populated by two types of individuals, skilled denoted by s and unskilled denoted by u. Let us further denote by ψ_i (resp. ψ_i^*) $i \in \{s, u\}$ the proportion of individuals of type i in the total population of the home country (resp. in the foreign country). Each individual owns one unit of labor and an amount of capital that differs from one type of individual to another while being the same for all individuals of the same type.

We assume that there are two goods in the world; a numeraire produced exclusively by unskilled individuals, and the other good being produced by firms using both unskilled and skilled labor. We further suppose that firms produced goods using a Cobb-Douglas technology and these goods are sold domestically and abroad. A tax is applied to each unit of good so that when it becomes too high in a given country, some firms relocate abroad, in this paper, without costs. Finally, in each country, there is a local government that collects fiscal revenues and redistributes them to their citizenship as a lump sum.

In what follows, we describe the economy and then discuss changes that occur when the level of the tax changes in one country according to the destination and origin principles.

2.1 Consumer demand

A given consumer of type i in the home country maximizes its utility under the tax principle k and defined on a set of differentiated goods $D_{i,k}$ and a numeraire $E_{i,k}$. We assume $D_{i,k}$ is produced by monopolistic firms located in the home and foreign countries and the numeraire $E_{i,k}$ is produced under perfect competition.

We further assume that the numeraire enters the utility function linearly. Therefore, the utility function of a type-i consumer is represented by the following equation :

$$U_{i,k} = \mu_i \ln D_{i,k} + E_{i,k}, \quad \mu_i > 0 \tag{1}$$

where

$$D_{i,k} = \left[\int_{\Omega} D^h_{i,k}(v)^{(\sigma-1)/\sigma} dv + \int_{\Omega^*} D^f_{i,k}(v)^{(\sigma-1)/\sigma} dv \right]^{\sigma/(\sigma-1)}, \ \sigma > 1. \tag{2}$$

$D^h_{i,k}$ is the demand for variety v produced in the home country h (resp. $D^f_{i,k}$ the demand for variety v produced in the foreign country f) of any consumer of type i located in the home country h. Ω (resp. Ω^*) is the number of varieties in the home country (resp. in the foreign country).

Let us assume that one unit of the numeraire is produced under constant return to scale and perfect competition by using one unit of unskilled labor. We further assume that this numeraire is not part of international trade.[1]. These two assumptions allow us to normalize the price of the numeraire and the wage of the unskilled workers.

For any differentiated good, an ad valorem tax is applied to the producer price regardless of destination or origin principles. Therefore, the budget constraint of a type-i consumer is given by:

$$\int_{\Omega} (1 + t_{h,k})\, p_{h,k}(v) D^h_{i,k}(v) dv + \int_{\Omega^*} (1 + t_{f,k})\, p_{f,k}(v) D^f_{i,k}(v) dv + E_{i,k} = \omega_{i,k} + R_k K_i + B_{i,k}. \quad (3)$$

K_i is the amount of capital supplied by the consumer of type i, R_k is the capital return under the tax principle k, and $B_{i,k}$ is a lump sum to any consumer of type i. In addition, $p_{h,k}$ (resp. $p_{f,k}$) represents the producer price for goods produced in the home country (resp. in the foreign country).[2]

Maximizing the consumer utility function (1) taking into account the budget constraint (3), one obtains:

$$\frac{\mu_i}{D_{i,k}} \left(\frac{D^h_{i,k}(v)}{D_{i,k}} \right)^{\frac{-1}{\sigma}} = (1 + t_{h,k})\, p_{h,k}(v), \text{ for all } v \quad (4)$$

$$\frac{\mu_i}{D_{i,k}} \left(\frac{D^f_{i,k}(v)}{D_{i,k}} \right)^{\frac{-1}{\sigma}} = (1 + t_{f,k})\, p_{f,k}(v), \text{ for all } v \quad (5)$$

Introducing the price index P_k, k,

$$P_k = \left(\int_{\Omega} [(1 + t_{h,k})\, p_{h,k}]^{1-\sigma} + \int_{\Omega^*} [(1 + t_{f,k})\, p_{f,k}]^{1-\sigma} \right)^{\frac{1}{1-\sigma}} \quad (6)$$

the above budget constraint in the home country h can be re-written as

$$P_k D_{i,k} + E_{i,k} = \omega_i + R_k K_i + B_{i,k}, \qquad k \in \{d, o\}. \quad (7)$$

Furthermore, maximizing (1) subject to (7) and taking into account (4) and (5), we can now

[1] We can refer the numeraire to any good for which the transportation cost is so high (or the legislation is restrictive toward them) that the benefit of transporting it to another country does not fit the cost that has to be paid. The literature often uses the example of a barber who needs to obtain a visa and pays a high transportation cost to relocate to another country with a higher salary

[2] In the foreign country f, will be denoting respectively $p^*_{h,k}$ and $p^*_{f,k}$ the producer prices for goods produced in the home country h and in the foreign country f respectively.

express the demand for domestic and foreign goods as a function of tax levels and the price index, for a consumer located in the domestic country h, as follows:

$$D^h_{i,k} = \mu_i \left[(1 + t_{h,k})\, p_{h,k}\right]^{-\sigma} P_k^{\sigma-1} \tag{8}$$

$$D^f_{i,k} = \mu_i \left[(1 + t_{f,k})\, p_{f,k}\right]^{-\sigma} P_k^{\sigma-1}, \tag{9}$$

Using the same reasoning, the domestic and foreign demand of any consumer of type i located in the foreign country are given by:

$$D^{h,*}_{i,k} = \mu_i \left[\left(1 + t^*_{h,k}\right) p^*_{h,k}\right]^{-\sigma} \left(P^*_k\right)^{\sigma-1} \tag{10}$$

$$D^{f,*}_{i,k} = \mu_i \left[\left(1 + t^*_{f,k}\right) p^*_{f,k}\right]^{-\sigma} \left(P^*_k\right)^{\sigma-1} \tag{11}$$

with

$$P^*_k = \left(\int_{\Omega} \left[\left(1 + t^*_{h,k}\right) p^*_{h,k}\right]^{1-\sigma} + \int_{\Omega^*} \left[\left(1 + t^*_{f,k}\right) p^*_{f,k}\right]^{1-\sigma}\right)^{\frac{1}{1-\sigma}}, \;\; k \in \{d, o\} \tag{12}$$

$D^{h,*}_{i,k}$ (resp. $D^{f,*}_{i,k}$) is the demand for the variety v produced in the domestic country (resp. produced in the foreign country) by an individual of type i located in the foreign country.

The indirect utility function in the domestic country is then given by:

$$V_{i,k}\left(t_{h,k}, t_{f,k}\right) = \mu_i \ln\left(\mu_i P_k^{-1}\right) + \left(\omega_i + R_k K_i + B_{i,k} - \mu_i\right), \;\; k \in \{d, o\} \tag{13}$$

2.2 The production

A firm located in the home country h uses skilled and unskilled labor to produce goods that will be sold on the domestic and foreign markets. We assume a Cobb-Douglas production function represented as follows:

$$\sum_i \psi_i D^h_{i,k}(v) L + \sum_i \psi^*_i D^{h,*}_{i,k}(v) L^* = F_k\left(\ell_{s,k}, \ell_{u,k}\right) \equiv A \ell^{\alpha}_{s,k} \ell^{1-\alpha}_{u,k}, \tag{14}$$

where $\ell_{i,k}$ is the amount of labor of type i that is used by firms in their production process under the tax principle k.

The corresponding technological constraint for any firm located in the foreign country is given by :

$$\sum_i \psi_i D^f_{i,k}(v) L + \sum_i \psi^*_i D^{f,*}_{i,k}(v) L^* = F_k\left(\ell^*_{s,k}, \ell^*_{u,k}\right) \equiv A\left(\ell^*_{s,k}\right)^{\alpha}\left(\ell^*_{u,k}\right)^{1-\alpha} \tag{15}$$

In addition, let suppose that prior to operate, each firm uses one unit of capital as fixed costs (those fixed costs encompass costs of building new factory, new machines, R&D and other needs); this unit of capital is paid back at a return denoted R_k. In addition, we assume that for each unit of skilled labor used by the firms, the firms pay a cost equal to ω_k which represents the skilled wage. Therefore, the firm that produces variety w in the country h maximizes its profits given by:

$$\pi_{h,k}(v) = p_{h,k}(v) \sum_i \psi_i D^h_{i,k}(v) L + p^*_{h,k}(v) \sum_i \psi^*_i D^{h,*}_{i,k} L^* - \omega_k \ell_{s,k}(v) - \ell_{u,k}(v) - R_k, \quad (16)$$

Under monopolistic competition, each firm sets the domestic and foreign prices, $p_{h,k}(v)$ and $p^*_{h,k}(v)$, which maximize its profit in each market. Therefore from the first-order conditions we have $p_{h,k}(v) = p^*_{h,k}(v)$; and using the technological constraint (14), we can re-write firms' profit function as follow:

$$\pi_{h,k}(v) = \frac{p_{h,k}(w) F_k(w)}{\sigma} - R_k \quad (17)$$

Therefore, the remuneration of skilled and unskilled labor used in the production process is given by:

$$\begin{aligned} \omega_k \ell_{s,k}(v) &= \alpha(\sigma - 1) R_k & (18) \\ \ell_{u,k}(v) &= (1-\alpha)(\sigma - 1) R_k & (19) \end{aligned}$$

Using the same reasoning for a given firm's profit function abroad, we have the following first-order conditions: The foreign counterpart of the above reasoning allows us to re-write the foreign firm profit as:

$$\pi_{f,k}(v) = \frac{p_{f,k}(v) F^*(v)}{\sigma} - R^*_k \quad (20)$$

First-order conditions and free entry allow, as previously, to obtain the expression of the remuneration of the skilled and unskilled labor used by firms in their production process as follows:

$$\begin{aligned} \omega^*_k \ell^*_{s,k}(v) &= \alpha(\sigma - 1) R^*_k & (21) \\ \ell^*_{u,k}(v) &= (1-\alpha)(\sigma - 1) R^*_k & (22) \end{aligned}$$

2.3 The Government

Now we will give a proper expression to the income that comes from taxes and is distributed to consumers as a lump sum. As a reminder, in our paper, the sole purpose of governments is to maximize the welfare of consumers in their respective countries. Governments therefore set the level of tax paid per unit of good consumed, and this fiscal revenue is collected and passed on to all citizens in the form of lump sum transfers. In the destination principle, taxes are collected on goods sold on the domestic market (locally and imported goods), while in the origin principle, taxes are collected on goods locally produced (whether sold domestically or exported).

Therefore, the fiscal revenue in the home and foreign countries in the destination principle are given by:

$$t_d T_d = t_d L \sum_i \psi_i \left(N_d p_{h,d} D^h_{i,d} + N^*_d p_{f,d} D^f_{i,d} \right) = L \sum_i \psi_i B_{i,d} \tag{23}$$

$$t^*_d T^*_d = t^*_d L^* \sum_i \psi^*_i \left(N_d p^*_{h,d} D^{h,*}_{i,d} + N^*_d p^*_{f,d} D^{f,*}_{i,d} \right) = L^* \sum_i \psi^*_i B^*_{i,d} \tag{24}$$

While in the origin principle, fiscal revenues in the home and foreign countries are:

$$t_o T_o = t_o N_o \left[L \sum_i \psi_i p_{h,o} D^h_{i,o} + L^* \sum_i \psi^*_i p^*_{h,o} D^{h,*}_{i,o} \right] = L \sum_i \psi_i B_{i,o} \tag{25}$$

$$t^*_o T^*_o = t^*_o N^*_o \left[L \sum_i \psi_i p_{f,o} D^f_{i,o} + L^* \sum_i \psi^*_i p^*_{f,o} D^{f,*}_{i,o} \right] = L^* \sum_i \psi^*_i B^*_{i,o} \tag{26}$$

where $T_k, k \in \{d, o\}$ (resp. $T^*_k, k \in \{d, o\}$) is the fiscal base under the tax principle k in the domestic country (resp. in the foreign country).

3 Equilibrium

In this Section we give the remaining equations that characterized the equilibrium in the model and the hypothesis associated to each of them.

- Labor market equilibria : we assume in our model that there is no international mobility of skilled labor; therefore, the supply of skilled labor in a given country is equal to the amount of skilled labor effectively used by firms located in that country. This is characterization is given by:

$$\begin{aligned} \psi_s L &= N_k \ell_{s,k} && (27) \\ \psi_s^* L^* &= N_k^* \ell_{s,k}^* && (28) \end{aligned}$$

The previous equations state that the number of companies existing in the two countries depends inversely on the quantity of skilled labor used: the greater the quantity of skilled labor used, the smaller the number of companies existing.

- Capital market equilibrium: Each firm used one unit of capital as fixed costs and capital is freely mobile between countries. Therefore the amount of capital in the economy determines the overall existing number of firms; this is characterized by:

$$N_k + N_k^* = \bar{K} \tag{29}$$

- Free-Entry Conditions: Under monopolistic competition, firms enter markets until profits fall to zero; the entry of each new firm diminishes the profits of existing ones until revenue exactly balances fixed costs. This is therefore represented as:

$$p_{f,k} A \left(\ell_{s,k}^*\right)^{\alpha} \left(\ell_{u,k}^*\right)^{1-\alpha} = p_{h,k} A \left(\ell_{s,k}\right)^{\alpha} \left(\ell_{u,k}\right)^{1-\alpha} = \sigma R_k \tag{30}$$

From now on, we will refer to ω_k $k \in \{d, o\}$ as the wage rate of the skilled worker. Indeed, since the unskilled wage rate is constant and equal to one, thus not subject to tax variation, this will ease our notation. In addition, we choose to fix to a constant the redistribution from tax collection B_u and B_u^* that goes to the unskilled workers both in the home and in foreign countries.

Using the labor demands equations (18) (19), (21) and (22) and the free-entry conditions (30), we can derive producer prices at home and abroad as follows:

$$\begin{aligned} p_{h,k} = p_{h,k}^* &= \frac{\sigma}{\sigma - 1} \frac{\omega_k^{\alpha}}{A \left(\alpha\right)^{\alpha} \left(1 - \alpha\right)^{1-\alpha}} && (31) \\ p_{f,k} = p_{f,k}^* &= \frac{\sigma}{\sigma - 1} \frac{\left(\omega_k^*\right)^{\alpha}}{A \left(\alpha\right)^{\alpha} \left(1 - \alpha\right)^{1-\alpha}} && (32) \end{aligned}$$

Therefore the two price indexes can be re-expressed as:

$$P_k = \left[N_k \left[\left(1 + t_{h,k}\right) p_{h,k}\right]^{1-\sigma} + N_k^* \left[\left(1 + t_{f,k}\right) p_{f,k}\right]^{1-\sigma}\right]^{\frac{1}{1-\sigma}}, \ k \in \{d, o\} \tag{33}$$

and

$$P_k^* = \left[N_k\left[\left(1+t_{h,k}\right)p_{h,k}\right]^{1-\sigma} + N_k^*\left[\left(1+t_{f,k}\right)p_{f,k}\right]^{1-\sigma}\right]^{\frac{1}{1-\sigma}}, \; k \in \{d, o\} \tag{34}$$

where N_k (resp. N_k^*) is the number of companies located in the domestic country (resp. in the foreign country).

The equilibrium equation system is made up of

- 13 equations :
  14, 15, 18, 19, 21, 22, 27, 28, 29, 30 (x2), 33, 34
- 13 variables:
  N_k, N_k^*, $\ell_{s,k}$, $\ell_{u,k}$, ω_k, ω_k^*, R_k, $p_{h,k}$, $p_{f,k}$, P_k and P_k^*, $k \in \{d, o\}$.

3.1 Destination principle

In the destination principle, taxes are set up according to countries where goods are consumed without discrimination due to their productive origin. So we have, in the domestic country h, $t_{h,d} = t_{f,d}$, and in the foreign country f, $t^*_{h,d} = t^*_{f,d}$. In the remainder of this paper, when we are dealing with the destination principle, we will adopt the following notation $t_{h,d} = t_{f,d} = t$ and $t^*_{h,d} = t^*_{f,d} = t^*$.

Using the two expressions of the price indexes in the domestic and foreign countries f given by (6) and (12), we have the following equality in the destination principle.

$$\frac{P_d^*}{1+t^*} = \frac{P_d}{1+t}$$

Using the labor demand markets, the price indices and the free-entry conditions, one gets:

$$\omega_d = \omega_d^*; \quad \ell^*_{s,,d} = \ell_{s,d}; \quad p_{h,d} = p_{f,d} \tag{35}$$

In the destination principle, the wage rate of skilled workers is the same in the two countries and firms uses the same amount of skilled labor whatever their location. The intuition behind this result is that in the absence of transportation costs, an increase in the tax rate in one country affects the demand for domestic and foreign goods thus firm's profit. Then the reduction in the demand for skilled labor occurs exactly in the same way in both countries and since the direct effect of a tax increase on the domestic price is the same in both countries, that will lead to the same level of wage in both countries

Using the labor demand market and the capital market equilibrium, we obtain the domestic and foreign number of firms as following:

$$N_d = \frac{\bar{K}}{1 + \frac{\psi_s^* L^*}{\psi_s L}}; \qquad N_d^* = \frac{\bar{K}}{1 + \frac{\psi_s L}{\psi_s^* L^*}} \tag{36}$$

In the destination principle, the number of firms is independent of the level of tax rate; that is, they are not mobile whatever the level of tax. They are solely dependent on the ratio of the number of skilled labor available in a given country to the total number of skilled labor. *Ceteris Paribus* , the country with the largest population of qualified workers, includes the largest number of firms.

Using the the technological constrain and the free-entry condition, one gets the expression of the capital return as:

$$R_d = \frac{1}{\sigma \bar{K}} \left[\frac{L \sum_i \psi_i \alpha_i}{1+t} + \frac{L^* \sum_i \psi_i^* \alpha_i}{1+t^*} \right] \tag{37}$$

Using (18), (36) and (27), the wage of any skilled worker located abroad or in the domestic country is given by:

$$\omega_d = \frac{\alpha}{L\psi_s + L^* \psi_s^*} \frac{\sigma - 1}{\sigma} \left[\frac{L \sum_i \psi_i \mu_i}{1+t} + \frac{L^* \sum_i \psi_i^* \mu_i}{1+t^*} \right] \tag{38}$$

The wage rate as well as the capital return are decreasing functions of the tax rate. The intuition is that the increase in tax increases the consumer price, thus reducing the demand. This reduction of the demand of commodity goods has two effects: first, it decreases the demand of labor (both skilled and unskilled); but since the supply of skilled labor remains unchanged, the adjustment comes by decreasing the wage rate of the skilled labor. Second, it decreases the demand for capital, and since the supply is unchanged, then the capital return decreases to adjust the gap.

Finally, the fiscal base in the domestic country h and its foreign counterpart in the foreign country f are given by

$$T_d = \frac{L \sum_i \psi_i \mu_i}{1+t}; \qquad T_d^* = \frac{L^* \sum_i \psi_i^* \mu_i}{1+t^*} \tag{39}$$

In the destination principle, the tax revenue in a given country solely depends on the tax rate applied in this country : the greater the tax level (small subsidy), the lower the fiscal base. This is due to the fact that in the destination, tax directly target the consumer by increasing the consumer price, thus reducing the demand, further increasing the distortion due by the monopolistic competition.

3.2 Origin principle

In the origin principle, taxes are levied depending on the country in which the goods are produced; these taxes may be comprehended as taxes on production; that is $t_{h,k} = t^*_{h,k}$ and $t_{f,k} = t^*_{f,k}$. Thus, according to the origin principle, the tax is discriminatory and can be actively used as a tool to benefit domestic producers. In the remainder of this paper, when we are dealing with the origin principle, we will adopt the following notation : $t_{h,k} = t^*_{h,k} = t$ and $t_{f,k} = t^*_{f,k} = t^*$.

From the notations in this section and equations (6) and (12), we have :

$$P_o = P^*_o \tag{40}$$

From the two technological constraint equations (14) and (15), we have:

$$\left(\frac{\ell_{s,o}}{\ell^*_{s,o}}\right)^{\alpha} = \left[\frac{(1+t)\, p_{h,o}}{(1+t^*)\, p_{f,o}}\right]^{-\sigma}$$

From the two free-entry equations (30), we have

$$\left(\frac{\ell_{s,o}}{\ell^*_{s,o}}\right)^{\alpha} = \frac{p_{f,o}}{p_{h,o}}$$

Using the two equations above and the labor demand equations (**??**) and (**??**), we obtain

$$\frac{p_{h,o}}{p_{f,o}} = \left(\frac{1+t^*}{1+t}\right)^{\frac{\sigma}{\sigma-1}}; \qquad \frac{\omega^*_o}{\omega_o} = \frac{\ell_{s,o}}{\ell^*_{s,o}} = \left(\frac{1+t^*}{1+t}\right)^{\frac{-\sigma}{\alpha(\sigma-1)}} \tag{41}$$

From the two labor demand equations (27) and (28) and (41), we have:

$$B := \frac{N^*_o}{N_o} = \frac{\psi^*_s L^*}{\psi_s L}\left(\frac{1+t^*}{1+t}\right)^{-\frac{\sigma}{\alpha(\sigma-1)}} \tag{42}$$

Therefore using (42) and the capital market equation (29), we have :

$$N_o = \frac{\bar{K}}{1+B} \tag{43}$$

$$N^*_o = \frac{\bar{K}B}{1+B} \tag{44}$$

Using the free-entry equation and the price index expression, the capital price in the origin principle is given by :

$$R_o = \left(1 + \frac{L^* \sum_i \psi_i^* \mu_i}{L \sum_i \psi_i \mu_i}\right) \frac{L \sum_i \psi_i \mu_i}{\bar{K}\sigma\left(1+t\right)} \frac{1+B}{1+B\left(\frac{1+t^*}{1+t}\right)} \tag{45}$$

Using the two labor demand equations in (18) and (21), the expressions of the wage rate of skilled workers are given by :

$$\omega_o = \frac{\alpha\left(\sigma-1\right)}{\sigma} \frac{\sum_i \psi_i \mu_i}{\psi_s\left(1+t\right)} \frac{1 + \frac{L^* \sum_i \psi_i^* \mu_i}{L \sum_i \psi_i \mu_i}}{1+B\left(\frac{1+t^*}{1+t}\right)} \tag{46}$$

$$\omega_o^* = \frac{\alpha\left(\sigma-1\right)}{\sigma} \left(1 + \frac{L^* \sum_i \psi_i^* \mu_i}{L \sum_i \psi_i \mu_i}\right) \frac{L \sum_i \psi_i \mu_i}{L^* \psi_s^*} \left[\frac{1}{1+t} \frac{B}{1+B\left(\frac{1+t^*}{1+t}\right)}\right] \tag{47}$$

Using (40), we have the following expressions of the fiscal bases in both countries:

$$T_o = \frac{Ł \sum_i \psi_i \mu_i + L^* \sum_i \psi_i^* \mu_i}{\left(1+t\right)\left(1+B\left(\frac{1+t^*}{1+t}\right)\right)} \tag{48}$$

$$T_o^* = \frac{Ł \sum_i \psi_i \mu_i + L^* \sum_i \psi_i^* \mu_i}{1+t^*} \frac{B\left(\frac{1+t^*}{1+t}\right)}{1+B\left(\frac{1+t^*}{1+t}\right)} \tag{49}$$

Finally, tax revenue at home and in the foreign country are given by

$$L \sum \psi_i B_{i,o} = t T_o$$

$$L^* \sum_i \psi_i^* B_{i,o}^* = t^* T_o^*$$

4 Cooperative optimum

In this section, we derive the optimal tax formulae that characterize the cooperative case; it will be used as a benchmark case. The analyzes will be performed in a symmetric case; therefore, the optimal tax formulae can be derived by maximizing the joint utilities of the two countries; that is to maximize the sum of the indirect utility in the domestic country h expressed in (13) and its foreign counterpart. The first-order condition is given by :

$$\frac{\partial V_{i,k}}{\partial t} + \frac{\partial V_{i,k}^*}{\partial t} = 0. \tag{50}$$

The effects that must be taken into account when changing the level of the commodity tax in the domestic country h are given by:

$$\frac{\partial V_{i,k}}{\partial t} := -\left(L\sum_i \psi_i\mu_i\right)\frac{\partial P_k/\partial t}{P_k} + L\psi_s\frac{\partial \omega_k}{\partial t} + \frac{\partial R_k}{\partial t}\left(L\sum_i \psi_i K_i\right) + L\psi_s\frac{\partial B_{s,k}}{\partial t} \tag{51}$$

For the government of the domestic country h, before taking the decision to change the existing tax level, it will have to consider the effects that this variation will have on the four terms of equation (51). *Ceteris paribus*, the first term captures the variation in welfare following a variation in private consumption. The second and third terms taken together capture the variation in welfare due to a variation in income; the second (resp. third) term being the variation in labor income (resp. capital income). Finally, the last term captures the effect of variation in public consumption (or, more specifically, variation in consumption due to government transfers) on welfare. It is therefore important to determine the effects of a tax variation on the elements described in the equation and its foreign counterpart.

4.1 Destination principle

In this subsection, we give a formula for the optimal tax in the cooperative when it is the destination principle that is used. For this purpose, we analyze how any tax variation affects the different variables and aggregate in the two countries.

In the destination principle, taxes are applied by the government of the country where the final good is consumed; therefore, we have $t_{h,d} = t_{f,d}$ in the domestic country h and $t^*_{h,d} = t^*_{f,d}$ in the foreign country f.

From (36), (27) and (28)we have :

$$\frac{\partial N_d}{\partial t} = \frac{\partial N^*_d}{\partial t} = 0; \qquad \frac{\partial \ell_{s,d}}{\partial t} = \frac{\partial \ell^*_{s,d}}{\partial t} = 0 \tag{52}$$

In the equilibrium, since the number of firms in the destination principle is independent of the level of the commodity tax so is the amount of skilled labor used: the number of existing firms in each of the two countries does not vary as well as the amount of skilled labor used.

Using equations (6), (12), (35) and (36), the effect of any tax variation in the domestic country on the two price indexes are given by:

$$\frac{\frac{\partial P_d}{\partial t}}{P_d} = \frac{1}{1+t} + \frac{\alpha}{\omega_d}\frac{\partial \omega_d}{\partial t}; \quad \frac{\frac{\partial P^*_d}{\partial t}}{P^*_d} = \frac{\alpha}{\omega_d}\frac{\partial \omega_d}{\partial t} \tag{53}$$

Equation (53) gives the mechanism that influences the prices of home (first equation) and foreign (second equation). Any variation in the tax influences domestic prices in two ways: the first term reflects the direct effect of a variation in the tax, and the second term captures the influence on prices in the two countries of the producer price spillovers. The effects of any variation in the tax on foreign prices are totally captured by the producer price spillovers, but on the domestic prices, a comparison needs to be done between the direct and indirect effects to see how prices evolve.

Using (19), (37), (38), (39), the effect of any tax variation in the domestic country on the skilled worker wages, capital return, tax revenue and the amount of unskilled labor are given by:

$$\frac{\partial \omega_d}{\partial t} = -\frac{\alpha}{2L\psi_s}\frac{\sigma-1}{\sigma}\frac{L\sum_i \psi_i \mu_i}{(1+t)^2} < 0, \qquad \frac{\partial R_d}{\partial t} = -\frac{1}{\sigma \bar{K}}\frac{L\sum_i \psi_i \mu_i}{(1+t)^2} < 0 \tag{54}$$

$$L\psi_s \frac{\partial B_{s,d}}{\partial t} = \frac{L\sum_i \psi_i \mu_i}{(1+t)^2} > 0, \qquad L^* \psi_s^* \frac{\partial B_{s,d}^*}{\partial t} = 0 \tag{55}$$

$$\frac{\partial \ell_{u,d}}{\partial t} = \frac{\partial \ell_{u,d}^*}{\partial t} < 0 \tag{56}$$

The increase in the tax level in the home country targets in the same way domestic and foreign firms that sell in the home country. The increase in the commodity tax in the home country makes the domestic market less profitable for both domestic and foreign firms: capital return decreases, and firms reduce their demand for labor, leading to the fall of the wage of skilled labor as depicted in (54) (since the supply of skilled labor is unchanged). Since the amount of skilled labor used in the production remains unchanged, firms reduction of labor simply translates into the reduction of the amount of unskilled labor used in the equilibrium; the quantity of unskilled labor removed from the production of the differentiated good is automatically returned to the production of the numeraire, thus satisfying the full employment of unskilled labor. Fiscal revenue increases in the domestic country but is unchanged abroad since there is no tax variation abroad and there is no firm's relocation.

Replacing (53), (54) and (55) to (50), we obtain the following.

$$-\frac{L\sum_i \psi_i \mu_i}{(1+t)^2}\left[(1+t)(1-\alpha) + \frac{\alpha(\sigma-1)}{\sigma} + \frac{1}{\sigma} - 1\right] = 0 \tag{57}$$

$$\hat{t} = -\frac{1}{\sigma} \tag{58}$$

4.2 Origin principle

In the origin principle, the changes that occur in the home and foreign countries due to a variation in the level of tax in the home country are represented as follows in the symmetric equilibrium.

Using the expression of dual price (6), producer price (32) , we can derive consumer dual price changes due to the change of tax in the domestic country h as follows:

$$\frac{\partial P_0}{\partial t}=P_o\left[\frac{1}{1+t}-\frac{1}{(\sigma-1)(1+B)}\left(-\frac{1}{1+t}+\frac{\partial B}{\partial t}\right)+\frac{\alpha}{\omega_o}\frac{\partial \omega_o}{\partial t}-\frac{1}{(\sigma-1)N_o}\frac{\partial N_o}{\partial t}\right]$$

In addition, using (42) and the capital market equilibrium (29), we can derive in the symmetric case the following relation:

$$\frac{\partial B}{\partial t}=-\frac{2}{N_o}\frac{\partial N_o}{\partial t}$$

Ultimately, in the symmetric equilibrium, the effect of any tax change in the domestic country h on the consumer dual price in the same country is given by:

$$\frac{\partial P_o}{\partial t}=P_o\left[\frac{1}{1+t}\left(1+\frac{1}{2(\sigma-1)}\right)+\frac{\alpha}{\omega_o}\frac{\partial \omega_o}{\partial t}\right] \tag{59}$$

According to the principle of origin, a tax increase in the domestic country h increases the general price level on the domestic and foreign markets through direct and indirect effects. The direct effect is represented by the first term in brackets on the right-hand side of (59); the higher the level of domestic consumption in each country, the greater this direct effect. In our model, the weight of domestic consumption is greater than 1, thus multiplying the direct effect of the tax. The second term in brackets reflects the indirect effect of the tax on the general price level; more precisely, this term shows that the price level is positively correlated with the wages of skilled workers; indeed, any tax that increases wages causes demand and, therefore, prices to rise.

$$\frac{\partial N_o}{\partial t}=-\frac{\sigma}{\alpha(\sigma-1)}\frac{\bar{K}}{4(1+t)}<0 \tag{60}$$

$$\frac{\partial \ell_{s,o}}{\partial t}=\frac{\sigma}{\alpha(\sigma-1)}\frac{\psi_s L}{\bar{K}}\frac{1}{1+t}>0; \qquad \frac{\partial \ell^*_{s,o}}{\partial t}=-\frac{\sigma}{\alpha(\sigma-1)}\frac{\psi_s L}{\bar{K}}\frac{1}{(1+t)}<0 \tag{61}$$

$$\frac{\partial \omega_o}{\partial t} = -\frac{\sum_i \psi_i \mu_i}{2\psi_s (1+t)^2} \left(1 + \frac{\alpha(\sigma-1)}{\sigma}\right) < 0; \quad \frac{\partial \omega_o^*}{\partial t} = \frac{\sum_i \psi_i \mu_i}{2\psi_s (1+t)^2} \left(1 - \frac{\alpha(\sigma-1)}{\sigma}\right) > 0 \tag{62}$$

Any tax increase in the home country h under the origin principle reduces the profitability of local firms, causing some of them to relocate, as shown by (60). The remaining firms are reducing their demand for labor, especially skilled labor (61). Since, in our model, the supply of skilled labor is fixed and fully utilized in the production of differentiated goods, the fall in demand for skilled labor translates into a decrease in the wages of skilled workers as in (62). In contrast, abroad, the influx of companies from the domestic country h leads to an increase in labor demand and consequently to a rise in the wages of skilled workers, as shown by equations (61) and (62).

$$\frac{\partial R_o}{\partial t} = -\frac{L \sum_i \psi_i \mu_i}{\sigma \bar{K} (1+t)^2} < 0 \tag{63}$$

It is not surprising to see that the price of the capital falls since it is a good that is freely mobile across countries. Since firm's profitability falls for those located in the home country, this induces a decrease of the number of firms thus a reduction of the capital return. The mobility of capital thus ensures the equality of capital price in both countries. It's worth mentioning that the reduction in return on capital is exactly the same as in the destination principle.

In addition, the number of unskilled labor is decreasing in both countries. In the domestic country, this decline is linked to a fall in demand for labor due to a decrease in profitability. This fall in demand for labor has repercussions on both the quantity of skilled and unskilled labor used. However, in other countries, the fall in the unskilled labor used is due to an increase in the skilled labor used.

$$\frac{\partial T_o}{\partial t} = -\left(1 + \frac{\sigma}{\alpha(\sigma-1)}\right) \frac{L \sum_i \psi_i \mu_i}{2(1+t)^2}; \qquad \frac{\partial T_o^*}{\partial t} = \left(\frac{\sigma}{\alpha(\sigma-1)} - 1\right) \frac{L \sum_i \psi_i \mu_i}{2(1+t)^2} \tag{64}$$

$$L\psi_s \frac{\partial B_s^o}{\partial t} = \frac{L \sum_i \psi_i \mu_i}{(1+t)^2} \left[1 - \frac{t}{2}\left(\frac{\sigma}{\alpha(\sigma-1)} - 1\right)\right]; \quad L\psi_s \frac{\partial B_s^{o,*}}{\partial t} = \frac{L \sum_i \psi_i \mu_i}{(1+t)^2} \left[\frac{t}{2}\left(\frac{\sigma}{\alpha(\sigma-1)} - 1\right)\right] \tag{65}$$

From (64), following an increase in the level of tax in the domestic country, the tax base decreases in that country but increases abroad. This is the simple result of the relocation to the foreign country f of some firms that had previously been located in the domestic country h due to the decrease in profitability. In the domestic country h, the tax revenue varies due to two effects: From the first equation in (65), the first term in brackets captures the increase in tax revenue due to the increase in the level of tax, while the second term captures the loss of tax revenue due to the fall of the fiscal base. This loss of revenue due to the reduction of the fiscal base in the domestic country is exactly what is gained in the foreign country, so these two effects cancel each other out.

Replacing (59), (62), (63) and (65) into (50), we have :

$$-\frac{L\sum_i \psi_i \mu_i}{2\left(1+t\right)^2}\left[2\left(1+t\right)\left(1-\alpha\right)+\left(1+\frac{\alpha\left(\sigma-1\right)}{\sigma}\right)-\left(1-\frac{\alpha\left(\sigma-1\right)}{\sigma}\right)+\frac{2}{\sigma}\right.$$
$$\left.-\left(2-t\left(\frac{\alpha\left(\sigma-1\right)}{\sigma}-1\right)\right)-t\left(\frac{\alpha\left(\sigma-1\right)}{\sigma}-1\right)\right] \;=\; 0,$$

where the first term in brackets captures changes on aggregates prices in both countries, the second (respectively the third) term is change on skilled labor revenue in the domestic (respectively foreign) country, the fourth is change on capital rent, the fifth (respectively the fifth) is changes on government revenue in the domestic (respectively foreign) country.

Changes in government revenue due to changes in the fiscal base in the two countries canceled each other out. In addition, changes in revenue in the domestic country due to an increase in the amount of tax that each remaining firm has to pay is canceled by the direct effect of the tax in both countries. The indirect effect on the aggregate level of prices is canceled out by part of changes in skilled labor revenue in the two countries. As mentioned above, all the effects canceled each other out and the cooperative optimal tax in the origin principle is therefore a subsidy equals to :

$$t_o = -\frac{1}{\sigma}. \tag{66}$$

Proposition 1 *The optimal tax rate in the cooperative case is the same in the destination or origin principle; this optimal tax is a subsidy equal to $\hat{t} = -\frac{1}{\sigma}$. This tax rate achieved the best.*

In fact, with this level of the optimal tax, the consumer price in the cooperative case is such as $\left(1+t\right)p_{h,k} = \frac{\sigma-1}{\sigma}p_{h,k}$ which equals the average variable cost. But with our production function with constant return to scale, it is easily proven from the first-order conditions that the average variable cost is, in fact, equal to the marginal cost. This result is a standard result in the literature that has been proven, among others, by Reinhorn (2012). This tax is purely corrective in the sense that it corrects the loss of welfare due to monopolistic competition. In fact, this level of tax brings the production in the economy to its efficient level.

5 Non cooperative case

In this section, we give a characterization of the optimal tax formulae for countries acting independently. The main idea here is to observe how governments set tax levels in response to any change in tax policy abroad. More specifically, the aim is to see how close the level of the non-cooperative tax is to that of the benchmark.

5.1 Non cooperative with the destination principle

In this subsection we study the non-cooperative tax in the destination principle. The key question here is to characterize what the reaction (in terms of tax policy) will be of one government in response to a foreign policy. We bring out some results in a Nash-symmetric equilibrium.

For this purpose, we examine how the domestic country h adjusts its tax level to maintain the individual level of welfare described in (13). The first derivative of the question writes as following:

$$\frac{\partial W_d}{\partial t} = -\left(L\sum_i \psi_i \mu_i\right)\frac{\frac{\partial P_d}{\partial t}}{P_d} + L\psi_s\frac{\partial \omega_d}{\partial t} + \frac{\partial R_d}{\partial t}\left(L\sum_i \psi_i K_i\right) + L\psi_s\frac{\partial B_s^d}{\partial t} \tag{67}$$

Equation (67) helps us to gain a deeper understanding on the different interactions and externalities that are needed to be taking into account by the local government when setting up its policy. Indeed, it is likely possible that, different from the cooperative case, the concern of any government in the non-cooperative case goes beyond the sole problem of resolving externalities from the monopolistic competition. Using the derivative of the results obtained in Section (3.1), equation (67) becomes:

$$-\frac{L\sum_i \psi_i \alpha_i}{2\left(1+t\right)^2}\left[\left(1+t\right)\left(2-\alpha\right) + \frac{\alpha\left(\sigma-1\right)}{\sigma} + \frac{1}{\sigma} - 2\right] \quad = \quad 0,$$

where the first term in the above brackets are changes on welfare due to changes on the aggregate level of prices, the second and third terms are changes on welfare due to changes of revenues (labor revenue and capital revenue respectively) and the final term been changes on welfare due to changes of the level of government lump sum transfers.

Therefore, the optimal tax response of the home country for any tax policy t^* in the foreign country, in the destination principle in a symmetric Nash equilibrium as following:

$$\bar{t}_d = -\frac{1}{\sigma}\left(\frac{1-\alpha}{2-\alpha}\right) \tag{68}$$

Then in the non-cooperative case, the best response of the home country to a given policy t^* in the foreign country is a subsidy (since $\alpha < 1$). But this subsidy is less than what is done in the cooperative case. The greater the contribution of skilled labor to the firm's production, the smallest the incentive to subsidize. Indeed, the wage of the skilled workers is negatively correlated with the level of tax; that is, if the marginal productivity of skilled labor is high, there is a reduction in the incentive to subsidized since the subsidy will increase the skilled workers' wage, thus firm's production costs increasing the monopolistic distortion. When the contribution of skilled labor to production is one ($\alpha \to 1$), then the optimal policy $\bar{t}_d$ is Pareto efficient ($\bar{t}_d = 0$, which is also the case in the perfectly competitive case where $\sigma \to \infty$)

Proposition 2 *Under the destination principle, the best response of the domestic country to any foreign policy t^* is a subsidy equals to $\bar{t}_d = -\frac{1}{\sigma}\left(\frac{1-\alpha}{2-\alpha}\right)$. This tax rate is higher (less subsidy) than in the cooperative case.*

In the non-cooperative case and under the destination principle, the effects that influence the level of social well-being cancel each other out either totally or partially. As shown in equation (68), the effect of a variation in lump sum transfers to skilled workers is completely canceled out by part of the direct effect that makes up the variation in the general price level. The variation in the wage level of skilled workers is partially canceled out by the indirect effect of the tax on the price level. The level of the tax in the non-cooperative case is therefore determined by taking into account the residual effects of the general price level and the residual effects of income. As stated in Proposition 2, the optimal tax in the non-cooperative case under the destination principle is a weighted value of the optimal tax found in the cooperative benchmark case; this weight equals the ratio of the remaining revenue effects over the remaining aggregate price effects.

5.2 Non cooperative case with the origin principle

In the origin principle, any tax variation falls solely on goods produced in the country that set it up, hence the profit of firms that are located in that country. As we did in the previous section, we analyze the reaction of the domestic government to any tax policy in the foreign country. For this purpose we determine the tax level that set to zero the following equation:

$$\frac{\partial W_o}{\partial t} = -\left(L\sum_i \psi_i \mu_i\right)\frac{\frac{\partial P_o}{\partial t}}{P_o} + L\psi_s\frac{\partial \omega_o}{\partial t} + \frac{\bar{K}}{2}\frac{\partial R_o}{\partial t} + L\psi_s\frac{\partial B_s^o}{\partial t} \tag{69}$$

Using the results in section (3.2) and so their derivatives, equation (69) writes:

$$-\frac{L\sum_i \psi_i \mu_i}{2\left(1+t\right)^2}\left[\left(1+t\right)\left(1-\alpha\right)+\left(1+\frac{\alpha\left(\sigma-1\right)}{\sigma}\right)+\frac{1}{\sigma}-\left(2-t\left(\frac{\sigma}{\alpha\left(\sigma-1\right)}-1\right)\right)\right] \quad = \quad 0,$$

where the first term in brackets is the effects of the aggregate price changes on welfare, the two following terms are the effects of changes of revenue on welfare and the last term is the effects of changes of government lump sum transfers on welfare.

Changes in revenue due to the increase in the amount collected from firms are offset by part of the change on the aggregate price level. Part of changes in revenue due to firms relocation is also canceled out by part of the changes in the aggregate price level. The remaining effects are those that form the structure of the non-cooperative tax.

Therefore, the best response to a foreign policy in a symmetric Nash equilibrium is the following tax level:

$$\bar{t}_o = -\frac{1}{\sigma}\frac{1-\alpha}{\frac{\sigma}{\alpha(\sigma-1)}-\alpha} \tag{70}$$

Proposition 3 *According to the origin principle, the best response of the domestic country h to any foreign policy* t^* *is a subsidy equal to* $\bar{t}_o = -\frac{1}{\sigma}\frac{1-\alpha}{\frac{\sigma}{\alpha(\sigma-1)}-\alpha}$*. This subsidy is lower than in the cooperative case and is inefficient.*

The non-cooperative tax in the origin principle is a weighted value of the optimal tax of our cooperative benchmark case. This weight is equal to the ratio of the remaining effects of the revenue over the difference of the remaining government transfers effects and the aggregate prices effects.

Proposition 4 *When the share of firm revenue allocated to the use of skilled labor is less than half, that is,* $\frac{\alpha(\sigma-1)}{\sigma} < \frac{1}{2}$*, then the best reaction of the domestic government for any tax policy* t^* *abroad led to a higher tax rate under the origin principle than under the destination principle. That is, government gives less subsidies in the origin principle than in the destination principle.*

The above result tends to mitigate the particular example given by Lockwood (1993) (paragraph 3 page 144) saying that taxes generally tend to be higher in the destination principle. The inequality that appears in proposition4 is revenue condition that allows us to decide between the two tax principles.[3] Therefore, the choice between destination and origin principles depends on whether the share of revenue allocated to the remuneration of skilled labor is greater (or smaller) than one-half. The implication of the above result can be explained as follows: In the domestic country, if skilled labor is used more intensively, the government best response to any tax variation abroad leads to a higher tax (less subsidy) in the destination principle, whereas the reverse is true in the case of the intensive use of unskilled labor. With the fact that W_d and W_o are concave in t, taxes that are higher in the origin principle mean that the destination is better (in the sense that the welfare of the various agents is higher), whereas the origin is better in the opposite sense. This result contributes to the existing literature.

For example, Haufler and Pflüger (2004) using a monopolistic model of imperfect competition shows that the Pareto destination principle dominates the origin principle. The reason behind their result is that in their model, since there is only one type of consumer, the wage is set up to unity according to the technology that produces the numeraire. The producer price is then fixed and unaffected by any change on the level of tax rate neither on the destination nor in the origin principle. Under the destination principle, spillovers on the consumer prices in the domestic and foreign countries due to the international relocation of firms and capital mobility are exactly offset by each other. Then any tax variation in the domestic country has the sole effect of targeting domestic inefficiency. In the origin principle, any tax variation in the domestic country has a direct effect on the domestic consumer price as well on the foreign consumer price. Relocating companies from home to abroad causes the fiscal base to fall domestically and rise abroad. This allows us to not reduce domestic inefficiency.

In our model, the wage rate is flexible and affected by the level of tax rate. Therefore, any change in the level of the tax rate affects both the producer and the consumer prices. In the destination principle, spillovers on the consumer prices due to the change in the level of the skilled labor's wage at home and abroad are not offsetting but are equal. Thus, these two spillovers on consumer prices do not allow the domestic government to combat domestic inefficiency by subsidy. In the origin principle, any tax change in the domestic country affects wages in the two countries in the opposite sense: it decreases the domestic wage while increasing the foreign wage. In addition, the relocation of firms from home to abroad decreases the domestic fiscal base while increasing the foreign fiscal base. These additional spillovers hinder the government's objective of aiming domestic inefficiency.

[3] We say that it is a revenue condition since $\frac{\alpha(\sigma-1)}{\sigma}$ is the share of revenue allocated to the remuneration of skilled labor.

6 Conclusion

Although the origin principle is widely used in most countries today, the economic literature is not unanimous on whether it is better than the destination principle. In the literature, it is known that under perfect competition the destination principle achieves production efficiency, while the origin principle achieves exchange efficiency, but the reverse is not generally true for both principles. But when turning to imperfect competition, things cease to be that simple due to additional distortions and conclusions are not so easily made. In this paper where the qualification of a worker have an impact on the production level, and where the level of tax rate has an impact on the use of one type of labor relative to the other, we find the conclusion in which between destination and origin principle one should applied depend on which sector of activities we are on. In the non-cooperative case, and in sector with intensive use of unskilled labor, the destination principle should be applied. Indeed, in this principle, producer prices are equal in both countries, and the difference yields in the consumer prices; distortions due to the change in wage are exactly the same in the two countries. In the non-cooperative case where the skilled labor is used intensively, the origin principle should be applied. In this principle, consumer prices are the same in the two countries. There are distortions that affect wages in both countries oppositely and bring firms to relocate.

So, rather than coming to a conclusion in favor of the principle of destination or of origin, our result can be related to those in the literature who believe that a general conclusion cannot be made. We do not claim to have settled the question of which of the origin and destination principles would be the best, as the hypotheses used in this research are not very general; however, our model does present a framework for choosing one principle over the other, under certain conditions.

7 Index: Concavity conditions

7.1 Destination principle

Let define by

$$f(t) = -t + \frac{\alpha(1+t)}{1 + \frac{1+t^*}{1+t}\frac{L^*\sum_i \psi_i^* \mu_i}{L\sum_i \psi_i \mu_i}} - \frac{\sigma-1}{\sigma}\frac{\alpha}{1+\frac{L^*\psi_i^*}{L\psi_s}} - \frac{1}{2\sigma},$$

the function that draw the sign of the utility in the destination non cooperative case. We will study the variation of this function.

For every given t, and $h \leq 0$

$$g(h) = f(t+h) - f(t) = -h + \frac{\alpha\gamma + \alpha h}{1+\frac{\theta}{\gamma+h}} - \frac{\alpha\gamma}{1+\frac{\theta}{\gamma}},$$

where $\gamma = 1+t$ and $\theta = (1+t^*)\frac{L^*\sum_i \psi_i^* \alpha_i}{L\sum_i \psi_i \alpha_i}$

$$\begin{aligned}
\lim_{h\to+\infty} g(h) &= \lim_{h\to+\infty} h\left[-1 + \frac{\alpha\left(1+\frac{\gamma}{h}\right)}{1+\frac{\theta}{\gamma+h}}\right] - \frac{\alpha\gamma}{1+\frac{\theta}{\gamma}} = -\infty \\
\lim_{h\to-\infty} g(h) &= \lim_{h\to-\infty} h\left[-1 + \frac{\alpha\left(1+\frac{\gamma}{h}\right)}{1+\frac{\theta}{\gamma+h}}\right] - \frac{\alpha\gamma}{1+\frac{\theta}{\gamma}} = +\infty \\
\lim_{h\to 0} g(h) &= \lim_{h\to 0} \frac{\alpha\gamma}{1+\frac{\theta}{\gamma}} - \frac{\alpha\gamma}{1+\frac{\theta}{\gamma}} = 0
\end{aligned}$$

Moreover, for any given t,

$$g'(h) = -1 + \alpha\frac{1+\frac{2\theta}{\gamma+h}}{\left(1+\frac{\theta}{\gamma+h}\right)^2}$$

$$\begin{aligned}
g'(h) = 0 \Longleftrightarrow \left(1+\frac{\theta}{\gamma+h}\right)^2 - \alpha\left(1+\frac{2\theta}{\gamma+h}\right) &= 0 \\
\Longleftrightarrow X^2 - 2X(1-\alpha) + (1-\alpha) &= 0,
\end{aligned}$$

where $X = \frac{\theta}{\gamma+h}$.
The discriminant of the above equation is given by:

$$\begin{aligned}
\Delta &= 4(1-\alpha)^2 - 4(1-\alpha) \\
&= -4\alpha(1-\alpha) < 0
\end{aligned}$$

$g'(h) < 0$, then g is decreasing, meaning f is strictly decreasing in $]-\infty;+\infty[$, specially in $]-1;1[$.

7.2 Origin principle

Let define by

$$
\begin{aligned}
f(t) &= \frac{\sigma}{\sigma-1}(1+t)(1+C)^2 - \frac{\sigma}{\alpha(\sigma-1)}\frac{(1+t)(1+C)^2}{(1-\sigma)(1+B)} \\
&+\alpha(1+t)(1+C)\left(1+\frac{\sigma}{\alpha(\sigma-1)}C\right)+t\left(1-\frac{L^*\sum_i\psi_i^*\mu_i}{L\sum_i\psi_i\mu_i}\right)\left(1-\frac{\sigma}{\sigma-1}C\right) \\
&\left(1-\frac{L^*\sum_i\psi_i^*\mu_i}{L\sum_i\psi_i\mu_i}\right)\left(1-\frac{\alpha(\sigma-1)}{\sigma}+\frac{(1+B)\left[\frac{\sigma}{\alpha(\sigma-1)}\frac{B-C}{1+B}-1\right]}{2\sigma}\right)
\end{aligned}
$$

the function that draws the sign of the utility in the origin non-cooperative case. We will study the variation of this function.

$$
\begin{aligned}
\lim_{t\to-1} f(t) &= \lim_{t\to-1}(1+t)\left[\frac{\sigma}{\sigma-1}\frac{\alpha(\sigma-1)+1}{\alpha(\sigma-1)}+\alpha+\left(1-\frac{L^*\sum_i\psi_i^*\mu_i}{L\sum_i\psi_i\mu_i}\right)\right] \\
&\quad -\left(1-\frac{L^*\sum_i\psi_i^*\mu_i}{L\sum_i\psi_i\mu_i}\right)\left(\frac{\alpha(\sigma-1)}{\sigma}+\frac{1}{2\sigma}\right) \\
&= +\infty
\end{aligned}
$$

In addition, $f(0) < +\infty$, so there is an interval in $]-1;1[$ where f is strictly decreasing.

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