International commodity taxation in an economy with unemployment*

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Abstract

This paper compares non-cooperative commodity taxation under the destination and the origin principle in presence of unemployment due to a fixed wage. In this setting we discover an employment spillover which is negative under the destination and positive under the origin principle. While the non-cooperative tax rate is inefficiently high under both principles, we show that, when the fixed wage is high enough, the origin principle is consistent with higher employment in the economy.

1 Introduction

During the last two decades, there has been an ongoing debate on the choice of the principle of commodity taxation for the EU VAT system. The EU VAT after the 1993 reform still relies on a hybrid system that, roughly speaking, applies the origin

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principle to consumers transactions and the destination principle to firms transactions[1]. Policy makers claim that a complete switch to the origin principle would be necessary since the destination principle in Europe is becoming unsustainable due to increases in administrative costs, which make monitoring and tax collection difficult and hence, enhance the risk of tax fraud and erosion (Nam et al. [**?**]).

Related to the discussions on the choice of a principle, existing studies on international commodity taxation (see Lockwood [**?**] and Haufler Pflüger [**?**] for reviews) gave normative support to the destination principle in perfectly competitive settings (Kanbur and Keen [**?**]; Mintz and Tulkens [**?**]). However, they obtained much less clear-cut results in imperfect competitive settings. Keen and Lahiri [**?**] considered duopoly and showed that, when goods are homogeneous in consumption, non-cooperative taxation under the origin principle restores production efficiency and delivers the first best outcome. Lockwood [**?**] and Haufler and Pflüger [**?**] showed that the result obtained in Keen and Lahiri [**?**] does not hold in a monopolistically competitive setting wih mobile firms. Behrens et al. [**?**] qualify some of the results of Haufler and Pflüger [**?**] and conclude that under the destination principle a tax increase always generate an outflow of firms while this is not always true under the origin principle.

All these models focus on firms market power misregarding other inefficiencies such as unemployment due to wage rigidity[2]. Nevertheless, the sharp increase of aggregate unemployment in

[1]The difference between the two principles is that local production is taxed and imports exempted under the origin principle whereas local consumption is taxed and exports exempted under the destination principle.

[2]The only exception is Lockwood et al. [**?**] who study the effect of commodity taxation in presence of unemployment due to fixed wage provisions. However, their main focus was not on unemployment as they studied the equivalence of DP and OP when wages are fixed and check for the unemployment effects of a switch from the DP to the OP from DP when tax rates are fixed.

EU countries in the last few decades[3] has attracted attention toward this issue and economic analysis devoted some effort to identify its main determinants. The most commonly shared view about EU unemployment takes an institutional perspective: Brown [**?**] and Bazen and Martin [**?**] pointed out minimum wages provisions as the main forces behind unemployment rise in EU. Other studies (Checchi and Lucifora [**?**], Bertola Blau and Kahn [**?**], Blanchard and Wolfers [**?**]) analyse labour market institutions in Europe and assess their role in explaining European unemployment. Moreover, the existence of a channel through which commodity taxation affect uneployment has been already pointed out empirically: Fiorito and Padrini [**?**] find a positive correlation between commodity tax rates and unemployment rates in Continental Europe between 1970 and 1994.

The purpose of this paper is to investigate the interaction between commodity taxation and unemployment dynamics[4] and, more specifically, to identify the unemployment effects of the adoption of either principle of commodity taxation.

We consider an economy with two countries and two goods differentiated in consumption and sold on a perfectly competitive market. Each good is produced in just one country but consumed in both via international trade[5]. Each good is produced under constant returns to scale using labour and capital. The capital market is global and perfectly competitive. The labor market is local and imperfect in the sense that there is unemployment due to minimum wage provisions. Governments choose commodity tax rates to maximize the weighted sum of

[3]The average unemployment rate in European countriesf has risen from 2% in 1960 to $9,2\%$ in 1999 (see Bertola Blau and Kahn [**?**], Blanchard and Wolfers [**?**] and Artis [**?**])

[4]Ogawa et al. [**?**] already analysed the relationship existing between capital taxation and unemployment due to wage rigidities.

[5]See Haufler and Pflüger [**?**] for a description of this framework with perfectly and imperfectly competititive product market

the utilities of employed and unemployed individuals in each country and redistribute tax revenue as lump sum transfer to its workers.

Using this framework we show that a scope for consumption subsidies arise in presence of labour market imperfections. Minimum wage provisions make consumer prices too high, demand for consumption too low and produce unemployment in the economy. To increase efficiency, *welfare maximising governments choose to subsidise consumption to boost aggregate demand and employment.*

Our results on non-cooperative tax policy are consistent with those by previous studies (see Lockwood [**?**] and Haufler and Pflüger [**?**] for reviews). Only under the origin principle, tax competition produces a negative consumer price spillover [6] that creates incentives for governments to increase taxes over the optimal level. Meanwhile, if wages were flexible no externality would result under the destination principle that would deliver the first best.

The striking novelty of our analysis however is that adding wage rigidity associates an additional *employment spillover* to commodity taxation. This spillover takes opposite signs under the two principles. *Under the destination principle, a rise in the domestic tax rate has a negative impact over foreign employment and welfare. Under the origin principle a domestic tax rise boosts foreign employment and wage income.*

Non-cooperative tax policy leads to suboptimally high tax rates under either principle. However se show that when the degree of wage rigidity in the economy is high enough, the origin principle is Pareto-superior to the destination principle. In fact when the fixed wage is high, the positive wage income spillover tends balances the negative consumer price spillover and tax

[6] This effect can be decomposed in private consumption spillover and public consumption spillover (see Lockwood [**?**], equation (13))

rates under the origin principle get closer to optimality than under the destination principle. As the optimal tax rate in this framework is a subsidy designed to correct unemployment in the economy we conclude that when the degree of wgae rigidity in the economy is high enough the origin principle is consistent with higher employment than the destination principle.

The paper is structured as follows. Section 2 introduces the basic structure of the model and shows the existence of an employment spillover. Section 3 reveals the welfare properties of non-cooperative taxation under both principles. Section 4 deals with employment issues. Concluding remarks are provided in Section 5.

2 The model

In order to describe unemployment caused by minimum wage provisions, we use a fixed-wage model *a la* Bhagwati [**?**] in which exogenously fixed wages lead to unemployment.

2.1 Consumption

Consider two symmetric countries, labeled H (home) and F (foreign)[7]. Each country is endowed with a continuum of immobile workers/consumers of size one. Workers obtain utility from consumption of three goods: X, Y and Z. X and Y are produced in H and F, respectively. They are freely traded and consumption of them is taxed. Z is the numeraire, which is assumed to be untaxed. Workers in this model are assumed to have an identical utility function of the quadratic form:

$$U(X,Y,Z) = -\frac{a}{2}(X^2+Y^2) + b(X+Y) - cXY + Z, \quad (1)$$

[7]In the remainder of the paper all variables related to F are described by a hat ($\widehat{\ }$).

where a, b, and c are positive constants. Here, b represents the intensity of preference for a joint consumption of X and Y while a/c represents the degree of heterogeneity between goods X and Y satisfying $a > c$ for concavity.

As we focus on a case in which fixed wages lead to unemployment, we assume workers can be either employed (e) or unemployed (u). The budget constraint of type j worker ($j = e, u$) in H is given by:

$$q_x X + q_y Y + Z = I_j, \tag{2}$$

where I_j, q_x and q_y are the total income and consumer prices of X and Y, respectively. We consider an ad valorem consumption tax that is levied according to either the destination principle (DP) or to the origin principle (OP). These two principles are equivalent when applied to "intranational consumption" (*i.e.*, consumption of X in H and that of Y in F). The relevant variables of the destination and origin principles carry subscripts d and o, respectively. Letting p_x and p_y denote the producer prices, we have

$$q_x = p_x(1 + t_k), \qquad \widehat{q_y} = p_y(1 + \widehat{t_k}),$$

where $k = d, o$. DP and OP imply different taxation regimes for "international consumption" (*i.e.*, consumption of Y in H and that of X in F):

$$\begin{aligned} &q_y = p_y(1 + t_d), \qquad \widehat{q_x} = p_x(1 + \widehat{t_d}), \qquad \textit{under } DP \\ &q_y = p_y(1 + \widehat{t_o}), \qquad \widehat{q_x} = p_x(1 + t_o), \qquad \textit{under } OP. \end{aligned} \tag{3}$$

Hereafter, since the two countries are symmetric in all respects, we concentrate the analysis on H. Results regarding F can be obtained analogously.

Workers maximize their utility (**??**) under the budget constraint (**??**). First-order conditions for the maximization give

$$\begin{aligned} X &= \frac{b}{a+c} - \frac{a}{a^2-c^2}q_x + \frac{c}{a^2-c^2}q_y, \\ Y &= \frac{b}{a+c} + \frac{c}{a^2-c^2}q_x - \frac{a}{a^2-c^2}q_y, \\ Z_j &= I_j - q_x X - q_y Y. \end{aligned} \tag{4}$$

Under DP, demand in each country is affected only by the domestic tax rate whereas under OP, it is affected by both domestic and foreign tax rates.

Each worker (either employed or unemployed) in both countries is endowed with one unit of labor, some units of capital $\overline{K}$ and of the numeraire $\overline{Z}$[8]. We assume that the capital market is global and the two countries are small open regarding the capital market, *i.e.*, the capital price is exogenously determined. Without loss of generality, we normalize the capital price to one, implying that the capital income is also $\overline{K}$. Employed workers inelastically supply one unit of labour and obtain an exogenously fixed wage rate $\overline{w}$. Moreover, each worker obtains a lump sum transfer h from the government.[9] Because our main focus is on the relationship between commodity taxation and unemployment, we disregard the possible inefficiency of public goods provision and assume that national governments tax consumption to make their residents better off. Total income of each worker is:

$$I_e = \overline{w} + \overline{K} + \overline{Z} + h_k, \qquad I_u = \overline{K} + \overline{Z} + h_k. \tag{5}$$

[8]We assume that $\overline{Z}$ is large enough to guarantee the positive demand for the numeraire ($Z > 0$).

[9]Due to the assumption that the utility function is quasi-linear, our results do not change if we consider tax revenue partly accruing to unemployed individuals as unemployment benefits.

Notice that in order to involve only the effect of unemployment and abstract from the effect of fixed wage differentials, the level of the fixed wage is assumed to be the same in both countries.

2.2 Production

X and Y are produced in H and F, respectively, and their production functions take the identical Cobb-Douglas form:

$$x = K^{\alpha} L^{1-\alpha}, \qquad y = K^{\alpha} L^{1-\alpha},$$

where α is a positive constant satisfying $0 < \alpha < 1$. K and L represent the capital and labor inputs, respectively.

In each country, there is a continuum of firms of size 1. Each firm is assumed to be a price taker.[10] Hence, a firm in H maximizes its profits Π with respect to L and K taking prices as given, where Π is given by

$$\Pi = p_x x - \overline{w} L - K.$$

The first-order conditions for the maximization are

$$\alpha p_x \left(\frac{L}{K}\right)^{1-\alpha} = 1, \qquad (1-\alpha) p_x \left(\frac{K}{L}\right)^{\alpha} = \overline{w}, \tag{6}$$

which fix the producer prices for X and Y at their unit costs:[11]

$$p_x = p_y = \frac{1}{\alpha}\left(\frac{\overline{w}\alpha}{1-\alpha}\right)^{1-\alpha} = p(\overline{w}). \tag{7}$$

[10] As our primary focus here is the analysis of commodity taxation in presence of labour market imperfections, we want to abstract from other inefficiencies such as firms international market power due to specialisation in production. However the analysis of the interaction between imperfect competition and labour market imperfections might be a very interesting extension and we leave it as a topic for future research.

[11] In fact ,from the first-order conditions for the cost minimization the unit cost is $(1/\alpha)\left[\overline{w}\alpha/(1-\alpha)\right]^{1-\alpha}$ for both X and Y. Notice that, as both factor prices are exogenous, producer prices are fixed. This allows us to avoid producer price spillovers. See also Haufler and Pflüger [**?**](footnote 14) and Lockwood [**?**].

This implies that higher level of $\overline{w}$ leads to higher labour costs and thus higher producer price.

2.3 Market equilibrium

For given tax rates, a market equilibrium is summarized by a tuple (L_H, L_F, K_H, K_F) that are determined by the firm's first-order conditions (**??**) in both countries and the product market clearing conditions:[12]

$$x = X + \widehat{X}, \qquad y = Y + \widehat{Y}. \tag{8}$$

Notice here that the population size in each country is normalized to one, implying that X_d and Y_d ($\widehat{X}_d$ and $\widehat{Y}_d$) also represent the aggregate demands in H (F).

Substituting (**??**) into (**??**), we obtain firm's input requirements for a given level of output:

$$\begin{aligned} L &= (1-\alpha)\,\frac{p(\overline{w})}{\overline{w}}\,x, \qquad \widehat{L} = (1-\alpha)\,\frac{p(\overline{w})}{\overline{w}}\,y, \\ K &= \alpha\; p(\overline{w})\; x, \qquad \widehat{K} = \alpha\; p(\overline{w})\; y. \end{aligned} \tag{9}$$

Substituting (**??**) and (**??**) into (**??**), we obtain workers demands for X, Y and Z in H under DP:

$$\begin{aligned} X_d = Y_d &= \frac{b-(1+t_d)\;p(\overline{w})}{a+c}, \\ Z_{j,d} &= I_j - p(\overline{w})(1+t_d)\,(X_d + Y_d)\,. \end{aligned} \tag{10}$$

The demands $\widehat{X}_d$, $\widehat{Y}_d$ and $\widehat{Z}_d$ in F are obtained in the same way. Similarly, we obtain the demands under OP:

[12] In fact, as the size of a continuum of firms is one, aggregate supply is x (y) for good X (Y).

$$X_o = \frac{1}{a+c}\left[b - \frac{a\ p(\overline{w})(1+t_o)}{a-c} + \frac{c\ p(\overline{w})(1+\widehat{t}_o)}{a-c}\right], \quad (11)$$

$$Y_o = \frac{1}{a+c}\left[b + \frac{c\ p(\overline{w})(1+t_o)}{a-c} - \frac{a\ p(\overline{w})(1+\widehat{t}_o)}{a-c}\right],$$

$$Z_{j,o} = I_j - p(\overline{w})\left[(1+t_o)X_o + (1+\widehat{t}_o)Y_o\right].$$

Again, $\widehat{X}_o$, $\widehat{Y}_o$ and $\widehat{Z}_o$ in F are obtained in the same way.

Substituting (**??**), (**??**) and (**??**) into (**??**), we obtain firms input requirements under DP and OP. Firms labour requirements are: [13]

$$L_d = \frac{(1-\alpha)\ p(\overline{w})}{\overline{w}}\left[\frac{2b - (2 + t_d + \widehat{t}_d)}{a+c}\right], \quad (12)$$

$$L_o = \frac{2(1-\alpha)\ p(\overline{w})}{\overline{w}}\left[\frac{b}{a+c} - \frac{a\ p(\overline{w})(1+t_o)}{a^2-c^2} + \frac{c\ p(\overline{w})(1+\widehat{t}_o)}{a^2-c^2}\right].$$

In the remainder of the paper we analyse only the case in which the fixed wage is binding. For this to hold we assume $(a+c)$ is large. This condition implies that a household obtains utility more from consumption of Z, leading to smaller labor demands. Hence, market clearing wage falls below the fixed wage and unemployment results i.e. $0 < L_k < 1\ k = d, o$.

(**??**) shows that commodity taxation affects both domestic and foreign employment. An increase in commodity tax rate always (both under DP and OP) increases domestic consumer prices, which reduces the demand for domestic product. This lowers domestic labour demand and employment ($\partial L_k/\partial t_k < 0$,

[13] we do not need to write the capital labour requirements as we do not use them in the welfare analysis given the assumption of global capital market.

$k = d, o$).

Lemma 1 *Domestic commodity taxation always has a negative effect on domestic employment.*

Moreover, commodity taxation under DP and under OP have an opposite effect on foreign employment, that is, an opposite spillover effect on employment. *Under DP, commodity taxation has a negative spillover on employment* ($\partial L_d/\partial \widehat{t}_d < 0$). An increase in the foreign tax rate $\widehat{t}_d$ lowers country F's demand for good X, leading to a reduction in employment in country H. In contrast, *under OP, commodity taxation has a positive spillover on employment* ($\partial L_o/\partial \widehat{t}_o > 0$). An increase in $\widehat{t}_o$ shifts demand in H from Y toward X and increases production of X and employment in H.

Put differently, whereas commodity taxation under DP amplifies labour market distortions by exporting unemployment, that under OP plays a corrective role by exporting employment.

Summarizing these arguments, we have

Proposition 1 *Under the destination principle, commodity taxation has a negative employment spillover, whereas under the origin principle, it has a positive employment spillover.*

The existence of an employment spillover stated in Proposition 1 have not been pointed out in existing studies regarding the comparison of destination and origin principle.

Notice that the nature of the spillover under OP and DP is different: under the DP the employment spillover is a 'by-product' of the effect that foreign taxation has on foreign consumption decisions. As we will see later in the welfare analysis this implies that under the DP, despite the employment externality, there cannot be any strategic interaction between gov-

ernments. Under the OP, on the other hand, the employment spillover modifies governments strategic interaction; in fact part of the employment spillover is due to the consumer price spillover *i.e.* to the effect that foreign taxation has on domestic consumer prices.

Our results are fully consistent with those of other studies in perfectly competitive markets. The general remark from this literature (Lockwood [**?**], Haufler and Pflüger [**?**] for reviews) is that under the DP no strategic interaction between governments exists as each country cannot influence consumption decisions in the other. This is no longer true under the OP as any tax increase changes the relative consumer prices in both countries triggering a consumer price spillover.

3 Welfare analysis of commodity taxation

Governments in both countries tax consumption according to either the destination or the origin principle. Each government redistributes the tax revenue to its workers as lump-sum transfer. Let h_k and T_k $(k = d, o)$ denote the level of lump-sum transfer to workers and the tax base, respectively. Government's budget constraint in H is given by

$$\begin{aligned} T_d &= p_x X_d + p_y Y_d, \\ T_o &= p_x \left(X_o + \widehat{X}_o \right), \\ h_k &= t_k T_k, \qquad k = d, o. \end{aligned} \tag{13}$$

When taxes are set non cooperatively, each government maximizes national welfare W_k, which is defined as the weighted sum

of utilities[14]:

$$W_k = L_k U(X_k, Y_k, Z_{e,k}) + (1 - L_k) U(X_k, Y_k, Z_{u,k}). \tag{14}$$

Each government determines its tax rate, taking the other government's tax rate as given and anticipating the resulting market equilibrium. Substituting (**??**), (**??**) (or (**??**)), (**??**), and (**??**) into (**??**), we obtain:

$$W_d = [2b - (a+c)X_d] X_d + \overline{K} + t_d T_d + \overline{w} L_d - 2p(\overline{w})(1+t_d)X_d, \tag{15}$$

$$W_o = -\frac{a(X_o^2 + Y_o^2)}{2} + b(X_o + Y_o) - cX_oY_o + \overline{K} + t_o T_o + \overline{w} L_o - p(\overline{w}) \left[(1+t_o)X_o + (1+\widehat{t}_o)Y_o\right],$$

in which derivation, we use the fact that $p_x = p_y = p(\overline{w})$.

3.1 Cooperative tax policy

Before turning to the non cooperative tax game, we derive the optimal cooperative tax rate as a benchmark. As countries are symmetric we derive the cooperative tax choice by maximising the Benthamite social welfare function $(W_d + \widehat{W}_d)$. We derive the cooperative tax rate under DP[15]. The first order conditions for the social welfare maximization are

$$\frac{\partial(W_d + \widehat{W}_d)}{\partial t_d} = \frac{\partial(W_d + \widehat{W}_d)}{\partial \widehat{t}_d} = 0.$$

Solving these yields the cooperative tax rates

[14] W_k can be interpreted also as the expected utility before the employment status of each worker is determined.

[15] However, as Haufler and Pflüger [**?**] notice, maximising world welfare in the two symmetric countries case can be interpreted as maximising welfare of one large economy. This renders immaterial the distinction between OP and DP at the cooperative equilibrium.

$$t_d^{**} = \widehat{t}_d^{**} = -(1-\alpha) \equiv t_c. \tag{16}$$

Proposition 2 *The cooperative tax rate is negative and its level is* $t_c = -(1-\alpha)$ *under both the destination and origin principles.*

Governments subsidise consumption to correct unemployment produced by inefficiently high producer prices and low demand for consumption and levy a lump-sum tax on workers ($h_c < 0$) to finance the subsidies[16].

If we allowed for flexible wages and full employment in this framework there would be no scope for taxation and governments would set $t_c = 0$ (see also Haufler and Pflüger [**?**] equation (13)).

Before turning to the analysis of the non cooperative equilibrum notice that in order to ensure demands for X and Y under the cooperative tax rate to be nonnegative, we have to impose the fixed wage rate $\overline{w}$ to be lower than some threshold level $\overline{w}_{th} \equiv b^{1/(1-\alpha)}(1-\alpha)/\alpha$. From now onward in our analysis we assume that the inequality $\overline{w} < \overline{w}_{th}$ holds.

3.2 Non cooperative taxation under the destination principle

In this section, we analyze the non cooperative tax policy under DP. The central question here is whether governments that choose tax rates to maximise national welfare produce spillovers on the foreign economy leading to non optimal commodity tax choices.

[16]Notice that the cooperative equilibrium in this framework is not Pareto-efficient as it is consistent with some involuntary unemployment. In fact, inefficiently high unit costs constrain firms production scale and labour requirements. This fact is captured by the term $(1-\alpha)\ p(\overline{w})/\overline{w}$ in (**??**).

We first examine the effect of an increase in the foreign tax rate on domestic welfare, and evaluate this expression at the cooperative tax rate t_c. Notice here that in W_d, only L_d depends on $\widehat{t}_d$. From (**??**), we have

$$\left.\frac{\partial W_d}{\partial \widehat{t}_d}\right|_{t_d=\widehat{t}_d=t_c} = \overline{w}\left.\frac{\partial L_d}{\partial \widehat{t}_d}\right|_{t_d=\widehat{t}_d=t_c} = -\frac{(1-\alpha)p(\overline{w})^2}{a+c} < 0.$$

The above equation tells us that *the non cooperative taxation under DP has a negative wage income spillover*, which comes from the negative employment spillover described in Proposition 1.

Notice that despite the existence of a wage income externality under the DP there is not any strategic interaction between governments. As the externality on domestic employment passes through foreign consumption that is affected exclusively by foreign taxes, H cannot react to the F's tax choice.

Solving the first-order conditions for the national welfare maximization ($\partial W_d/\partial t_d = 0$ and $\partial \widehat{W}_d/\partial \widehat{t}_d = 0$), we obtain the non cooperative tax rates under DP:

$$t_d^* = \widehat{t}_d^* = -\frac{1-\alpha}{2} < 0. \tag{17}$$

Comparing (**??**) with (**??**), we can see that countries set the subsidy rate at an inefficiently low level ($0 > t_d^* = \widehat{t}_d^* > t_c$).[17]

Proposition 3 *The non-cooperative taxation under the destination principle leads to subsidies for consumption. The subsidy rate is lower than the optimal level.*

[17]Notice that under the DP the condition $w < wth$ is not enough to guarantee positive demands; we have to impose a more restrictive condition $w < (2\alpha/(1+\alpha))^{1/(1-\alpha)}wth$

In order to reduce domestic unemployment, each government subsidizes consumption, which boost aggregate demand and thus employment in the foreign country. However, each government does not recognize this effect, leading to inefficiently low consumptions subsidies. Hence, harmonization for higher subsidy rate is welfare enhancing.

Proposition 3 makes sharp contrast with results under competitive labor markets (see Lockwood [**?**] (Proposition 1), and Haufler and Pflüger [**?**]). If we allow for wage flexibility (thus the economy has no unemployment), no net externality arises from commodity taxation under DP and the non-cooperative tax rate is set at the optimal level.

The result that non-cooperative tax rate is not optimal can be obtained in models with other types of market imperfection. Examples include Keen and Lahiri [**?**], Keen and Wildasin [**?**], Lockwood [**?**]. Whereas we focus on labour market imperfection, they focused on product market imperfection. Therefore, non-optimality of non-cooperative taxation under DP can be said to be a common feature of models with market imperfection[18].

3.3 Non cooperative taxation under the origin principle

As we can see from (**??**), under OP, changes in the foreign tax rate affect the demand in H, thus creating a wider range of externalities than under DP[19]. From (**??**), we obtain

[18] A relevant exception is Haufler and Pflüger [**?**]. They in fact show that DP delivers the first best in a setting with monopolistic competition and international firms mobility.

[19] Differently from the DP, under the OP there is strategic interaction between governments; in fact demands in each country depend on both domestic and foreign tax rates.

$$\left.\frac{\partial W_o}{\partial \widehat{t}_o}\right|_{t_o=\widehat{t}_o=t_c} = \underbrace{(b - aX_o - cY_o)\frac{\partial X_o}{\partial \widehat{t}_o} + (b - aY_o - cX_o)\frac{\partial Y_o}{\partial \widehat{t}_o}}_{\text{effect on consumption of } X \text{ and } Y\ (<0)} \tag{18}$$

$$\underbrace{- p_x \left[(1 + t_c)\left(\frac{\partial X_o}{\partial \widehat{t}_o} + \frac{\partial Y_o}{\partial \widehat{t}_o}\right) + Y_o\right]}_{\text{effect on expenditure on } X \text{ and } Y}$$

$$\underbrace{t_c \frac{\partial T_o}{\partial \widehat{t}_o}}_{\text{effect on public consumption } (<0)} + \underbrace{\overline{w}\frac{\partial L_o}{\partial \widehat{t}_o}}_{\text{effect on wage income } (>0)}$$

where all partial derivatives are evaluated at $t_o = \widehat{t}_o = t_c$.

The first two terms in (**??**) capture the *private consumption spillover*. An increase in $\widehat{t}_o$ makes Y relatively more expensive for residents in H, shifting demand from Y toward X. This negatively affects consumers as they prefer a balanced consumption of both goods (first term) and increases the total expenditure for X and Y if the demand is relatively inelastic (second term)[20].

The third term is the *public consumption spillover*. Shifting demand toward consumption of X, a $\widehat{t}_o$ rise increases T_o. As $t_c < 0$ the lump-sum taxes used to finance consumption subsidies increase; this has a negative impact on consumers welfare.

The net effect of private and public consumption spillover[21] is negative and is counteracted by a positive *wage income spillover* (the fourth term in (**??**)):

$$\left.\frac{\partial L_o}{\partial \widehat{t}_o}\right|_{t_o=\widehat{t}_o=t_c} = \frac{2c(1-\alpha)p(\overline{w})^2}{a^2 - c^2} > 0.$$

[20] this is true when it holds $p(\overline{w}) < b/2\alpha$

[21] Private and public consumption spillover are already well known in the literature (see Mintz and Tulkens [**?**]). Lockwood [**?**] aggregates them in a *consumer price spillover* (see Lockwood [**?**], page 281). A $\widehat{t}_o$ rise negatively affects consumers welfare as it increases the relative consumer price of Y with respect to X in country H.

The wage income spillover is a direct consequence of the employment spillover described in Proposition 1 and gets stronger with $p(\overline{w})$: in fact at higher prices demand for consumption is more elastic to taxation and the employment effects of a tax increase are stronger.

Solving the first-order conditions for the national welfare maximization ($\partial W_o/\partial t_o = 0$ and $\partial \widehat{W}_o/\partial \widehat{t}_o = 0$), we obtain H's and F's reaction functions. Solving for the non cooperative tax rates obtain:

$$t_o^* = \widehat{t}_o^* = -1 + \frac{\alpha}{3a - c}\left[2a + (a - c)\left(\frac{b}{\alpha\ p(\overline{w})}\right)\right] \tag{19}$$

which is larger than t_c since $p(\overline{w}) < b/\alpha$ holds under the assumption $\overline{w} < \overline{w}_{th}$. It holds the following:

Proposition 4 *Non-cooperative taxation under the origin principle leads to inefficiently high (low) consumption taxes (subsidies) when the fixed wage is low (high).*

(**??**) is interesting as it shows that in our model the level of the fixed wage affects governments tax policies via the price level. When $\overline{w}$ and $p(\overline{w})$ are low, the wage income spillover is relatively weaker than the consumer price spillover. The chosen tax policy can be a consumption tax when $\overline{w}$ falls below some treshold. i.e. $t_o^* \geq 0$ when $\overline{w} \leq \Gamma\overline{w}_{th}$.[22] However, when when the fixed wage is sufficiently high (*i.e.* $\overline{w} \geq \Gamma\overline{w}_{th}$) the wage income spillover gets relatively stronger than the consumer price spillover and the optimal tax policy becomes a subsidy that corrects unemployment in the economy. however, as $\overline{w} < \overline{w}_{th}$, it is always $t_o^* > t_c$ and harmonization for lower tax rate is welfare enhancing.[23]

[22] where $0 \leq \Gamma \equiv [\alpha(a - c)/(3a - c - 2\alpha a)]^{1/(1-\alpha)} < 1$

[23] with other kinds of market imperfetions, harmonization may or may not be welfare improving depending on principles of taxation. See Keen et. al. [**?**].

4 Effects of commodity taxation on unemployment

The typical feature of our model is the presence of a fixed wage that increases market prices and reduces aggregate demand. Firms that face lower demand for consumption reduce their labour requirements producing some unemployment in the economy.

In such a framework the optimal tax policy is a consumption subsidy t_c that boosts consumption and employment. We have seen that non cooperative tax policy under either principle delivers suboptimally high taxes leaving employment below the optimal level[24].

Equilibrium tax policies under DP and OP can be Pareto ranked. From (**??**) and (**??**):

$$t_d^* > t_o^* \quad \Leftrightarrow \quad \overline{w} > \Omega \overline{w}_{th},$$

where $\Omega = \{2\alpha(a-c)/\left[3a-c-\alpha(a+c)\right]\}^{1/(1-\alpha)} < 1$.
When the degree of rigidity in the economy is high enough (*i.e.* the wage income spillovers in the economy are strong enough) non cooperative tax policy ensures lower tax rates (higher subsisidies) under the OP than under the DP. Therefore:

$$L_d^* < L_o^* \quad \Leftrightarrow \quad \overline{w} > \Omega \overline{w}_{th},$$

where from (**??**), (**??**), and (**??**) we have:

$$L_d^* = \frac{(1-\alpha)(1+\alpha)\ p(\overline{w})}{(a+c)\ \overline{w}} \left[\frac{2\ b}{(1+\alpha)} - p(\overline{w})\right]$$
$$L_o^* = \frac{4a\ \alpha(1-\alpha)\ p(\overline{w})}{(a+c)(3a-c)\ \overline{w}} \left[\frac{b}{\alpha} - p(\overline{w})\right]. \tag{20}$$

[24]It is useful to stress again that as optimality here does not ensure Pareto Efficiency, the optimal employment level in this paper is not full employment.

As the unemployment rate is $1 - L$, we can summarize these results in the following proposition:

Proposition 5 *The unemployment rate is lower (higher) under the origin principle than under the destination principle if the fixed wage is high (low).*

Notice that we focus on the case in which the fixed wage is binding. However, when the fixed wage is not binding, our model becomes a standard perfect competitive model of commodity taxation. In models of commodity taxation in a competitive setting, OP leads to a higher non-cooperative tax rate than does DP when lump-sum taxes exist (Lockwood [**?**], Propositions 1 and 2 and Haufler, A. and M. Pflüger [**?**], Proposition 1). Hence, when wage is flexible, DP leads to higher labor demand, hence, a higher wage than does OP. Then, it is more likely that the fixed wage is binding under OP than under DP. Thus, we can guess that, OP is more likely to produce unemployment than DP.

In contrast, Proposition 5 states that, when unemployment is already present in the economy, the unemployment rate is higher under DP (OP) when the fixed wage is high (low).

5 Concluding remarks

This paper investigates the possible connections between commodity taxation and unemployment by constructing a commodity taxation model with wage rigidities. The distinctive feature of our model is the existence of an employment spillover: the destination (origin) principle causes a negative (positive) employment spillover. Non-cooperative tax rates under both destination and origin principles are shown to be inefficiently high, implying that harmonization for lower (higher) tax (subsidy)

rate is welfare enhancing. Also, we argue that switching the tax regime from one to the other affects the equilibrium unemployment rate and how it affects depends on the level of fixed wages.

These results give policy implications concerning the design process of the new VAT in Europe. In an area characterized by widespread wage rigidities such as the EU countries, sticking to a destination based VAT can be costly not only in terms of higher administrative costs and lower tax compliance but also in terms of higher unemployment. As a corollary, if European national authorities want to stuck to the destination principle, they should encourage policies aimed to recover wage flexibility.

Our model is very simple and can be extended to many directions. Here, we give some examples. First, it would be interesting to introduce firms' international market power or some degree of price flexibility into our model. This would add some interesting 'side effects' over employment due to terms of trade effects identified by Lockwood et al.[**?**]. Second, considering other sources of unemployment such as the efficiency wages, trade unions, and job search and recruiting friction would also be important. Third, it would be worth considering asymmetries between countries in many aspects such as population size and technology. Finally, endogenizing the fixed wage rate would be also an very important extention. This will allow us to examine whether or not governments have incentives to maintain the fixed wage rate that entails unemployment. Because commodity taxation has different externalities under the destination and origin principles, the resulting tax choice would be different under these two principles. All these are important and interesting topics for future research.

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