On the Use of Border Taxes in Developing Countries

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Abstract

Contrary to what is implied by the so called "Washington consensus", Stiglitz (2003) has argued that in the least developed countries border taxes are superior to VAT. However, supported by much respectable research, the IMF and World Bank's recommend that developing countries substitute VAT for border taxes. The present paper provides an easy to implement parameterised general equilibrium model which may be used as the basis for empirical research, required to reach a consensus opinion within the profession on the issue. The model allows for the fact that different tax systems are associated with different administrative costs, and represents the informal sector as a parameterisation, the CES-UT, of a utility function with explicit representation of the use of time. By means of a quantitative example, it illustrates, on the one hand, that a large informal sector in itself does not justify the use of border taxes, but, on the other hand, when administrative costs of taxation are taken into account, that the size of the informal sector, as claimed by Stiglitz (2003), is indeed important for whether the use of border taxes is desirable or not.

Keywords: Optimal trade policy, VAT, tax-tariff reform, costs of tax administration, informal sector, developing countries

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1. Introduction

How to tackle underdevelopment in poor parts of the world is one of the most pressing challenges in economics today. In this context, the desirability of free trade, a treasured tenet of many economists, has in recent years come under attack. Prominently Stiglitz (2003) has implied that substituting VAT for border taxes is likely to reduce rather than improve social welfare. However, a highly influential body of research[1] has provided academic support for the IMF and World Bank recommendation for developing countries to use VAT rather than border taxes to raise government revenue. Yet the basis for the disagreement has remained elusive. Emran and Stiglitz' (2005) suggests that the key problem with the literature supporting the use of VAT in developing countries is that it neglects that these countries have large informal sectors. However, within what he admits is a restrictive model Keen (2006) shows that given an optimal VAT system a large informal sector in itself provides no justification for diversions from free trade. He further argues that the reason why Emran and Stiglitz (2005) reach another conclusion is that their model assumes that the informal sector is reimbursed for VAT paid on purchases of intermediate inputs, which does not seem to correspond to how VAT works in any country.

Governments in developing countries tend to finance a great part of their expenditures by border taxes. Whether developing countries benefit from the use of border taxes is thus an important policy issue with obvious relevance for policy makers in these countries, but also for policy makers in developed countries who in international and bilateral negotiations on trade and assistance tend to put pressure on developing countries to liberalise their economies in return for market access. It is thus a question of considerable importance whether policy-makers should be guided by the recommendations of Emran and Stiglitz or by those of the Bretton-Woods sister organisations.

The contribution of this paper is, firstly, to clarify why Emran and Stiglitz (2005) and Keen (2006, 2007) reach different conclusions while relying on what is essentially the same theory of optimal taxation, and, secondly, to contribute a parameterised theoretical model, which is relatively easy to implement empirically and thus might be useful in trying to reach a consensus opinion on the issue.

In the process we provide insight into why, due to problematic separability assumptions, simulations results based on the use of standard CGE models have misrepresented the cost of a differentiated tax and tariff structure in developing countries.

The paper is organized as follows. In Section 2, we set up a theoretical general equilibrium model which allows (i) the representation of a VAT to be different from a system of consumer taxes (by allowing for intermediate consumption), (ii) the representation of informal sector production by the use of a utility function with the explicit presentation of the use of time, and (iii) for the fact that

[1] See Ebrill et al. (2001), and references herein. Furthermore, it can be assumed that the book reflects the official view of the IMF.

different tax structures are associated with different levels of administrative costs. In Section 3, we review the theoretical arguments for whether it is desirable for developing countries to use border taxes to raise government revenue. In Section 4, we specify a stylized CGE model, which uses a CES-UT parameterisation of the informal sector consistent with how household behaviour is represented in the theoretical model. We calculate the amounts of administrative costs associated with a VAT which would justify diversions from free trade based on this model. A final section summaries and concludes the paper.

2. The general equilibrium setting with explicit representation of production in the informal sector

Extending the theoretical model used in Munk (2004) with the representation of intermediate consumption (without which a VAT is equivalent to a system of consumer taxes), we specify a general equilibrium model of a small open economy with three perfectly competitive production sectors, one representative household, and a government. In the economy there is one domestically traded primary factor, indexed 0, and three internationally traded commodities, indexed 1, 2 and 3. The government imposes border taxes, $\mathbf{t}^{\mathrm{W}} \equiv\left(t_1^W, t_2^W, t_3^W\right)$, household taxes, $\mathbf{t} =\left(t_0, t_1, t_2, t_3\right)$, and sector specific taxes on intermediate inputs, $\mathbf{t}^i \equiv\left(t_1^i, t_2^i, t_3^i\right)$, i=1,2,3. Exogenously given world market prices are $\mathbf{p}^W \equiv\left(p_1^W, p_2^W, p_3^W\right)$, market prices $\mathbf{p} \equiv\left(p_0, p_1, p_2, p_3\right)=\left(p_0, p_1^W+t_1^W, p_2^W+t_2^W, p_3^W+t_3^W\right)$, household prices $\mathbf{q} \equiv\left(q_0, q_1, q_2, q_3\right)=\left(p_0+t_0, p_1+t_1, p_2+t_2, p_3+t_3\right)$ and sector specific producer prices for intermediate inputs $\mathbf{p}^i \equiv\left(p_1^i, p_2^i, p_3^i\right)=\left(p_1+t_1^i, p_2+t_2^i, p_3+t_3^i\right)$, i=1,2,3. The economy is assumed to have the potential to produce any of the three commodities using the primary factor and intermediate inputs of produced commodities. The production in the formal sector exhibits constant returns to scale with $c^i\left(p_0, p_1^i, p_2^i, p_3^i\right)$ being the unit cost of producing commodity *i*. Hence, the economy will specialise in the production of one commodity, which thus becomes the export good, while the two other commodities become import goods. The output of the export sector is y_{k}, the use of the primary factor for its production v_0, and the use of intermediate inputs $v_i, i=1,2,3$[2].

[2] The sign conventions are: $y_1>0$ and $v_i>0,\left(i=0,1,2,3\right)$; $x_0<0$ and $x_{\mathrm{i}}>0$ $\left(\mathrm{i}=1,2,3\right)$; $y_{\mathrm{k}}^{\mathrm{W}}<0$ and $y_i^W>0$, $\left(i \neq k=1,2,3\right)$,. Thus for the primary factor tax and the export tax, respectively, to generate a positive tax revenue, the tax rates must be negative.

The household's endowment of the primary factor is represented by ω_0, and its net demand vector by $\left(x_0, x_1, x_2, x_3\right)$. The household's untaxed consumption of the primary factor is thus $\omega_0 + x_0$. Foreign trade (net imports) is $\left(y_1^W, y_2^W, y_3^W\right)$, and the government's resource requirement x_i^G, $i = 0,1,2,3$.

The condition of profit maximisation is for sector *k*, the export sector, is that

$$v_i = \frac{\partial c^k}{\partial p_i^k}\left(p_0, p_1^k, p_2^k, p_3^k\right) y_k \qquad i = 0,1,2,3 \tag{1}$$

$$p_k = c^k\left(p_0, p_1^k, p_2^k, p_3^k\right) \tag{2}$$

and for other sectors, that

$$p_i < c^i\left(p_0, p_1^i, p_2^i, p_3^i\right) \qquad i \neq k = 1,2,3 \tag{3}$$

The balance of trade constraint is

$$\sum_{i=1,2,3} p_i^W y_i^W = 0 \tag{4}$$

The government's budget constraint is

$$\sum_{i=0,1,2,3} t_i x_i + \sum_{i=1,2,3} t_i^k v_i + \sum_{i=1,2,3} t_i^W y_i^W - \sum_{i=0,1,2,3} p_i x_i^G = 0 \tag{5}$$

Material balance requires

$$0 = v_0 + x_0 + x_0^G \tag{6}$$

$$y_k + y_k^W = v_k + x_k + x_k^G \tag{7}$$

$$y_i^W = v_i + x_i + x_i^G \qquad i \neq k = 1,2,3 \tag{8}$$

Had we represented household preferences by a standard utility function, $u\left(x_0, x_1, x_2, x_3\right)$, then we would have expressed the condition for $\left(x_0, x_1, x_2, x_3\right)$ to be consistent with the utility maximising condition for general equilibrium by

$$E\left(\mathbf{q}, u\right) = 0$$

$$x_i = E_i\left(\mathbf{q}, u\right) \qquad i = 0,1,2,3 \tag{9}$$

However, we add structure to the model by expressing this condition based on a utility function with explicit representation of time, $U\left(c_0^0, C_1\left(x_1, c_0^1\right), C_2\left(x_2, c_0^2\right), C_3\left(x_3, c_0^3\right)\right)$, where $c_0^0 = \omega_0 - \sum_{i=1,2,3} c_0^i - x_0$ is pure leisure, $C_i = C_i\left(x_i, c_0^i\right)$, *i*=1,2,3 concave functions representing how the purchases of produced commodities, x_i, $i = 1,2,3$ are combined with the time, c_0^i, $i = 1,2,3$, to produce goods C_i, *i*=1,2,3, which are traded and consumed only within the household sector. The utility function, $U\left(c_0^0, C_1, C_2, C_3\right)$, defined on consumption of the three commodities, C_i, *i*=1,2,3, and is assumed to have standard properties. The corresponding expenditure function

$\tilde{E}\left(q_0,Q_1,Q_2,Q_3,u\right)\equiv\left\{\underset{c_0,\,;C_i\,,\,i\in FC}{\text{Min}}\;q_0c_0+\sum_{i\in C}Q_i\,C_i\;\;s.t.\;u=U\left(c_0,C_1,..,C_N\right)\right\}$, where, Q_i, i=1,2,3, are the prices of C_i , i=1,2,3, therefore also have standard properties.

We define the informal sector as the production and consumption of the goods C_i , i=1,2,3. Informality thus involves that production and consumption, as well as transactions within the household sector, are not subject to taxation[3]. Profit in the informal sector is $\Pi\left(q_0,q_1,q_2,q_3\right)\equiv Max_{C_i,i=1,2,3}\sum_{i=1,2,3}Q_iC_i-\sum_{i=1,2,3}G^i\left(q_0,q_i,C_i\right)$, i=1,2,3, where $G^i\left(q_0,q_i,C_i\right)$, i=1,2,3 indicate the costs associated with informal sector production.

With this representation of the informal sector, the conditions for $\left(x_0,x_1,x_2,x_3\right)$ to be consistent with the utility maximising condition for general equilibrium we thus express by

$$\tilde{E}\left(q_0,Q_1,Q_2,Q_3,u\right)-q_0\omega_0=\Pi\left(q_0,q_1,q_2,q_3\right) \tag{10}$$

$$Q_i=G^i_{C_i}\left(q_0,q_i,C_i\right)\equiv\frac{\partial G^i}{\partial C_i}\left(q_0,q_i,C_i\right)\quad\text{i=1,2,3} \tag{11}$$

$$x_i=G^i_i\left(q_0,q_i,C_i\right)\equiv\frac{\partial G^i}{\partial q_i}\left(q_0,q_i,C_i\right)\quad\text{i=1,2,3} \tag{12}$$

$$c^i_0=G^i_0\left(q_0,q_i,C_i\right)\equiv\frac{\partial G^i}{\partial q_0}\left(q_0,q_i,C_i\right)\quad\text{i=1,2,3} \tag{13}$$

$$x_0=c^0_0+\sum_{i\in(1,2,3)}c^i_0-\omega_0 \tag{14}$$

As the informal sector is represented by adding structure to a standard utility function, the model specified so far is consistent with the standard Diamond and Mirrlees framework for optimal tax analysis, as explained in Munk (2008) with reference to Atkinson and Stern (1980, 1981). Standard theoretical results of optimal taxation, notably the Diamond and Mirrlees Production Efficiency Theorem therefore apply.

The development of the Diamond and Mirrlees (1971) framework for optimal tax analysis was motivated by the observation that it is administratively infeasible to achieve government objectives of income distribution and revenue generation by the use of lump sum taxes. It is seems almost equally unrealistic to assume that systems of commodity taxation are not associated with any costs. From the outset it was pointed out by Stiglitz and Dasgupta (1971), and later elaborated by Munk (1980) using a dual approach, that when all market transaction cannot be taxed at their optimal level,

[3] Our notion of informality thus differs from the notion of a black economy where agents evade taxation. As pointed out by Pierre Pestieau at the IIPF 2007, where papers of Boadway and Sato (2007) and Dreher, Méon and Schneider (2007) were also presented, in many European countries at the middle of the 20th century, large part of the agricultural sector, with up to 50% of total employment, was exempt from taxation and by this definitions could be described as an informal sector. It seems that today a large part of the agricultural sector in many developing countries equally can be characterised in this way.

the Diamond and Mirrlees (1971) Production Efficiency Theorem does not apply with the implication that in the real world production efficiency and free trade may not be desirable. Nevertheless, the maintained assumption in subsequent contributions to optimal tax analysis has almost without exception been based on models where all market transactions can be taxed by the government at no costs. It is however generally recognised that for the design of optimal tax systems administrative costs are important[4]. We therefore choose to divert from the standard Diamond and Mirrlees (1971) framework by modifying the model by assuming that different tax structures are associated with different administrative costs[5]. We assume that the government's resource requirement depends on the tax system, $\boldsymbol{\tau} \equiv \left(\mathbf{t},\ \mathbf{t}^{i},\ i=1,2,3,\ \mathbf{t}^{W}\ \right)$, rather than being exogenously given. To make precise this notion, we extend the definition of a tax structure employed in Munk (2004) to include also taxes on intermediate inputs and assume that the government's choice of a tax-tariff system, $\boldsymbol{\tau}^{*} \equiv \left(\mathbf{t}^{*}, \mathbf{t}^{i*},\ i=1,2,3,\ \mathbf{t}^{W*}\right)$, is constrained to be an element in the set of tax-tariff structures, $\Xi^{j},\ j \in \mathbb{F}$, where each tax structure j is defined by restrictions imposed on the tax instruments available to the government, and where the administrative costs for all tax-tariff systems belonging to a given tax-tariff structure j are $B(j)$. Since we assume the government's resource requirement for other expenditures than for tax administration as exogenously given, the government's total resource requirement is thus

$$x_i^G = x_i^G\left(j\right) \qquad i = 0,1,2,3 \tag{15}$$

where j is endogenous to the government's problem of maximising social welfare and thus depend on the level of administrative costs associated with the different tax structures associated considered by the government.

3. Review of the rationale for the use of VAT and border taxes to raise government revenue

In this section, we based on standard optimal tax theory review the justification for to use of border taxes, either as the sole source of government revenue or as a supplement to a VAT system.

The Diamond and Mirrlees' Production Efficiency Theorem says that although lump-sum taxation is not feasible, optimal taxation requires production efficiency. It therefore follows directly from this theorem that in economy which may be represented by the general equilibrium conditions (1) to (14)

[4] Ebrill et al. (2001) in the Preface at p xii, p75 and in Chapter 16 stress the importance of taking administrative concerns into account. Although they do not explicitly represent such costs in their model, Emran and Stiglitz (2005) also put great emphasis on the importance of administrative costs for tax design in developing countries.

[5] Administrative costs include both the costs of tax collections and the cost of tax compliance of private agents, which here for convenience is assumed reimbursed by the government. This may not be a realistic assumption, but of little consequence for the issue at hand, whether the use of border taxes is desirable in developing countries.

if all market transactions can be taxed at no costs, then production efficiency and thus free trade is desirable. Furthermore, as for $\mathbf{t}^i = 0$, i=1,2,3, the whole system of equations is homogenous of degree zero in consumer prices, $\mathbf{q} \equiv (q_0, q_1, q_2, q_3)$, and in producer prices, $\mathbf{p} \equiv (p_0, p_1, p_2, p_3)$, the domestic consumption of one commodity and the border transactions in one commodity can be assumed untaxed without loss of generality, for example by assuming that the export good is untaxed at the border and that the supply of labour to the market is untaxed, i.e. that $t_k^W = 0$ and $t_0 = 0$ (cf. Munk 2004). We have assumed that production in the informal sector take place under constant returns to scale and therefore is associated with no profit; had we alternatively assumed that production in the formal sector was associated with decreasing returns to scale and thus profit, then the optimal solution in the absence of a 100% tax on profit would involve the value of the profit to the household to be wiped out by the level of consumer prices being set infinitely higher than the level of producer prices (cf. Munk 1978 and 1980)[6]. One might therefore expect that a similar result would obtain in the presence of untaxed profit in informal sector. However, as we have seen, this is not the case. The reason is that the government is not able to influence the value of the profit in the informal sector by manipulating the level of consumer prices relative to producer prices, as the informal sector profit is homogenous of degree 1 in consumer prices (cf. Munk 2008). Therefore, whether or not informal sector production is associated with profit, when all transactions in the formal economy can taxed at no cost, then there is no justification for the use of border taxes.

Furthermore, it has been widely accepted in the literature, that a progressive income tax combined with a VAT at a uniform rate without the use of border taxes is the best system of taxation in developed countries. This position has found its justification mainly based on two arguments. First, that with a progressive income tax the scope for increasing social welfare by a differentiated system of commodity taxation is small compared with the administrative costs involved; and second, that the use of border taxes will introduce production inefficiency. The first argument is often justified with reference to Atkinson and Stiglitz (1978), who in a simplified model show that there is no need for differentiated commodity taxation with an optimal income tax. The second argument refers to the Diamond and Mirrlees (1971) Production Efficiency Theorem, mentioned above.

However, there is also a consensus opinion in the profession supported by research by the IMF and the World bank (cf. Ebrill et al 2001), that taxation in developing countries is associated with high administrative costs, making it de facto impossible to raise tax revenue by income taxation, and also very costly to differentiate VAT rates. The IMF and World Bank recommendations with respect to

[6] It is therefore not possible without loss of generality in a model with untaxed profit in the formal sector to assume one commodity untaxed. One can naturally as Dasgupta and Stiglitz (1971), and as Boadway and Sato (2007) assume that one commodity cannot be taxed as a restriction on the government's problem of maximising social welfare, but a justification would then be required for why it is realistic to assume that the government's choice of tax instruments is subject to this restriction (cf. Munk 1980).

taxation in *developing* countries to implement a VAT at uniform rate[7] without the use of border taxes may therefore be seen as the application of what is widely considered a reasonable system of taxation for *developed* countries.

But, as pointed out by Stiglitz (2003), there are important differences between developed and less developed countries which need to be taken into account in providing policy advice on taxation. As emphasised by Emran and Stiglitz (2007), and also recognised in Ebrill et al (2001, p71), the fact, that developing countries cannot raise a significant amount of tax revenue by income taxation, means that the insight by Atkinson and Stiglitz (1978) cannot be used to provide a rationale for the application in developing countries of a VAT at uniform rate. However with a VAT at uniform rate, the Diamond-Mirrlees (1071) Production Efficiency Theorem cannot be used to justify that it is desirable to suppress border taxes. Furthermore, if a VAT at uniform rate is assumed superior to a VAT at differentiated rates due to the administrative costs involved, then, as Emran and Stiglitz (2005) point out, and as supported by the theoretical analysis in Munk (2004), the size of the formal sector plays an important role for whether the use of border taxes is desirable or not.

It seems therefore that there is an inconsistency between, on the one hand, the World Bank and the IMF's position with respect to the importance of administrative costs in developing countries, and, on the other hand, their position on the use of border taxes by these countries. If a differentiated VAT is considered desirable, then free trade is indeed also desirable, but if a VAT at uniform rate is desirable for administrative reasons, then the use of border taxes may also be desirable.

However, the answer to the question of whether in practice it is desirable in developing countries to use border taxes to raise government revenue either without a VAT or to supplement a VAT depends not only on how one assesses the administrative costs associated with different tax-tariff structures, it also depends on how one defines VAT, and there has been some ambiguity in that respect. As emphasised by Keen (2006), in practice VAT is not, as in as in Munk (2004), only a tax on final consumption, even less a tax only on formal sector sales as in Pigout and Walley (2001) and in Emran and Stiglitz (2005). In general, a VAT exempt from taxation intermediate inputs used in the formal sector, but not purchases used for inputs in informal sector production.

When a VAT, in line with what is the case in practice, within the framework of our model is defined as $\boldsymbol{\tau} \equiv \left(\mathbf{t},\ \mathbf{t}^i,\ i=1,2,3,\ \mathbf{t}^{\mathrm{W}}\ \right)$ where $\mathbf{t}^i=0,\ i=1,2,3$, then as we have seen it follows directly from the Diamond and Mirrlees Production Efficiency theorem, that when taxes on final consumption may be differentiated between produced commodities at no cost, no improvement in welfare can be achieved neither by taxes on border transactions nor on the use of sector specific taxes on intermediate consumption whether or not informal production is associated with profit. If a VAT is defined in this

[7] World Bank and the IMF for distributional reasons recommend zero rating for basic food stuff and taxation of certain luxury articles in addition to a uniform VAT.

way, and if it is assumed that VAT rates can be differentiated at no cost, Keen (2006, 2007) is therefore right that there is no justification for the use of border taxes whatever the size of the informal sector. It is an illustration of the benefits of embedding informal sector production in the household utility function, rather than representing it as a separate production sector, that we are able to reach the same conclusion as Keen (2006) just with reference to a general theorem of optimal taxation.

In contrast, if taxation is assumed to be associated with administrative costs and depend how the tax rates are set, then the use of border taxes as the only source of government revenue or to supplement a VAT may be desirable. As established in Munk (1980), and in Munk (1998) with explicit reference to administrative costs, in the case of a closed economy, sector specific taxes on inputs creating production inefficiency may be justified, and in an open economy, as elaborated in Munk (2004), a case may be made for using border taxes to raise government revenue in particular in developing countries with large informal sector.

Pigout and Whalley (2001) and Emran and Stiglitz (2005) in their models assume that neither the informal nor the informal sectors the consumption of intermediate inputs is subject to taxation. As this is equivalent in our framework to impose restrictions on household taxes, it is not surprising that with a VAT defined in this way, the use of border taxes may improve welfare. However, as pointed out by Keen (2006), in the case of real world VAT systems, VAT paid on the purchase of inputs used for informal production is not reimbursed in practice.

However, as just mentioned in all cases where restrictions are imposed on VAT rates, as for example where VAT is levied at a uniform rate, i.e. where $t_i = T, i = 1,2,3$, there may be a case for using border taxes. There may indeed also be a justification for using sector specific intermediate input taxes, $\mathbf{t}^{i^*}, i=1,2,3$. As pointed out by Keen (2006) such taxed are used in certain developing countries to discourage the use of resources in the informal sector. This issue has within a closed economy model been analysed in some length in Munk (1998). Although our present model provides an appropriate framework for extending this analysis to a small open economy, we will in order to maintain the focus on border taxes delay the analysis of how intermediate input taxes can be used to improve social welfare in developing countries for consideration in another context.

4. The CES-UT parameterisation of household preferences and a quantitative illustration

It is one thing theoretically to establish that administrative costs may justify diversions from free trade; it is another matter whether such costs do in fact justify the use of border taxes. There is still relative little empirical evidence available on the administrative costs associated with different tax

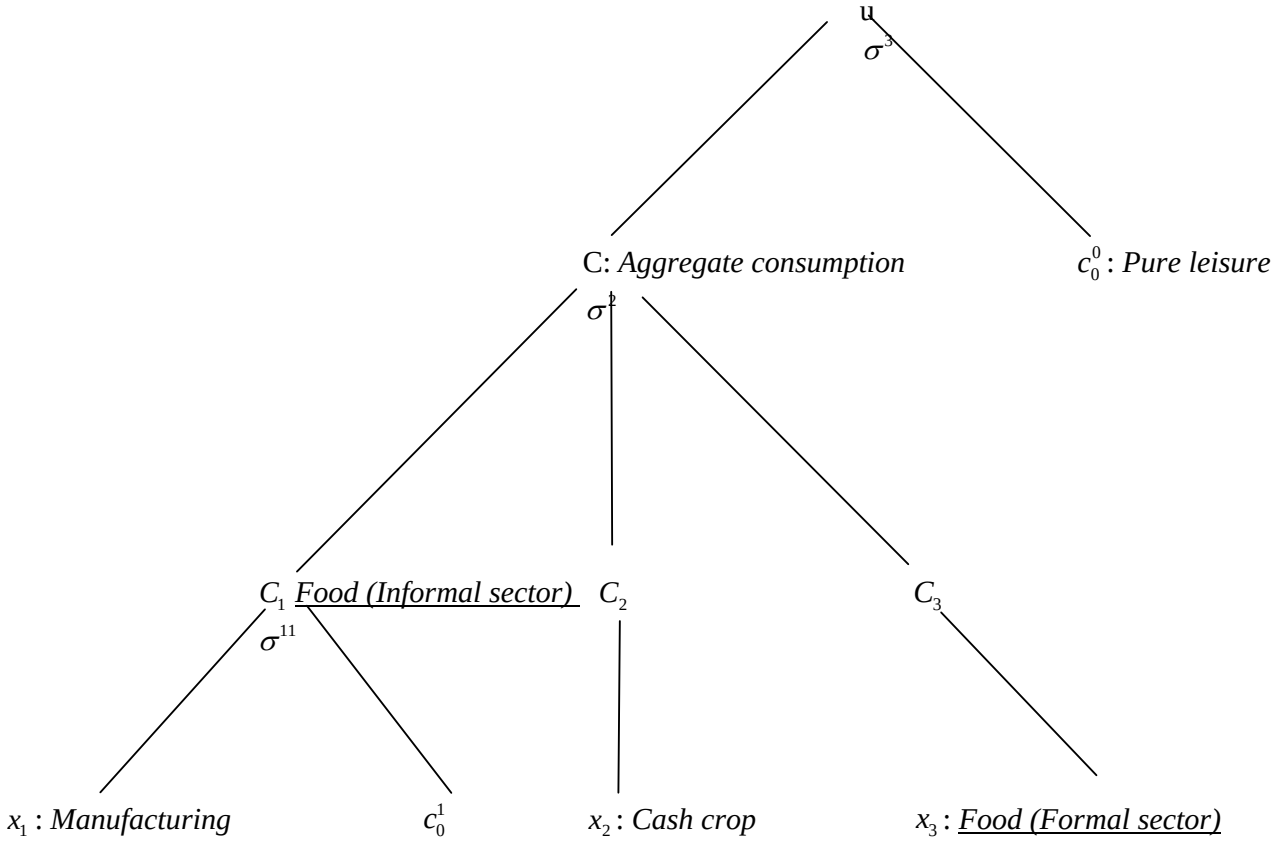
systems in developing countries, and the data required to fully specify general equilibrium models to represent developing country economies, are not readily available. There seems therefore not yet to be sufficient empirical evidence to conclusively settle the dispute on whether it is desirable or not for developing countries to use border taxes.

However, we want here to approach an answer to the question by a quantitative example involving the use of a stylized CGE model. By constructing a stylized CGE model based on data representing a prototype developing country we put numbers to the theory with the objective to get a better idea of the potential importance of administrative costs for the choice of an optimal tax-tariff system. At this stage we therefore do not attempt to reach a conclusive answer to the question whether in developing countries border taxes are desirable or not, as this would require empirical evidence which is very difficult, if not impossible to obtain. We leave the task of gathering the relevant data, and of estimating the parameters of the model for future research, an important justification for the present effort being to provide guidance for such an endeavour.

We consider a prototype developing country where the informal sector is large, as is manifestly the case in most developing countries, the formal part of the economy involves transaction in three produced commodities: *Manufacturing (1), Cash crop (2)* and *Food (Formal sector) (3),* all traded both domestically and internationally, and where at world market prices the economy is competitive in the production of *Food (Formal sector)*, but not in *Cash crop* and in particular not in *Manufacturing*. Furthermore, we assume that *Food (Formal sector)* is a close substitute to *Food (Informal sector)*. We represent the production technology of *Food (Formal sector)* by a CES unit cost function $c^3\left(p_0, p_1; s^3\right)$, where s^3 is the elasticity of substitution between inputs of *Labour* and of *Manufacturing,* and parameterised the cost function $G^1\left(q_0, q_1, C_1\right)$ in the theoretical model by a CES cost function, $G^1\left(q_0, q_1, C_1; \sigma^{11}\right)$, where σ^{11} is the elasticity of substitution between time and *Manufacturing* in the production *Food (Informal sector)*.

We represent household behaviour, and thus the behaviour of the informal sector, as the result of maximisation of a simplified version of the CES-UT utility function (see Munk 1998 and 2008), $U\left(c_0^0, C\left(C_1\left(x_1, c_0^1; \sigma^{11}\right), x_2, x_3; \sigma^2\right); \sigma^3\right)$ subject to the budget constraint, $\sum_{i=0,1,2,3} q_i x_i$. $C_1\left(x_1, c_0^1; \sigma^{11}\right)$, $C\left(C_1, x_2, x_3; \sigma^2\right)$ and $U\left(C, c_0^0; \sigma^3\right)$ are CES functions characterised by elasticities of substitution σ^{11}, σ^2 and σ^3, respectively. A graphical illustration of the CES-UT utility function used is provided in *Figure 1*.

Figure 1: The structure of household preferences imbedding the formal sector



The parameters and data used to fully specify the model are provided in *Table 1 and Table 2, respectively.*.

Table 1: Parameter values of the parameterised model

Elasticity of substitution between pure leisure and consumption, σ^3	0,8
Elasticity of substitution between composite commodities, σ^2	1
Elasticity of substitution within the production of food in the informal sector : σ^{11}	0,1
The primary factor costs as a share of the purchase of input to produce *Food (Informal sector)*	3
Elasticity of substitution within the production of food in the informal sector : s^3	1

The benchmark data set representing the hypothetical situation, where the government's revenue requirement is financed by a lump-sum tax, is provided in the form of supply utilisation accounts for the formal part of the economy. The total time endowment is assumed to be 138 of which 24 is used for production of *Food (Informal Sector)*[8] and thus 91 for non-productive purposes, leaving 23 (as shown in *Table 2*) to be supplied to the market in the form of *Labour*. Defining National Income as the value added in the production of *Food (Formal sector)* and *Food (Informal sector)*, and the

[8] In the benchmark, the value of time is assume to be three times the value of the input of *Manufacturing* in the production of *Food (Informal sector)* ,i.e. 3x8=24 (see *Table 1*)

Government's use of *Labour*, the share of the informal sector in terms of National Income in the bench mark is thus 54%[9], which seems not to be a particular big figure for what we intend to be a represent a prototype developing country.

Table 2: Supply utilisation accounts for the formal economy

		Output			**Intermediate consumption in the formal sector**			**Net trade**		
		Manu.	Cash c.	Food	Manu.	Cash c.	Food	Household	Gov.	RW
Produced commodities	Manu.	0			0,00	0,00	-2,00	-8,00		10,00
	Cash c.		0		0,00	0,00	0,00	-3,00		3,00
	Food			20,00	0,00	0,00	0,00	-7,00		-13,00
Primary factor	Labour	0	0	0			-18,00	23,00	-5,00	

The corresponding matrix of consolidated, compensated demand elasticities is provided in *Table 3* (for how to calculate such elasticities, see Munk 2008). If available for a specific developing country, systems of demand elasticities estimated based on flexible functional forms may be compared directly with these elasticities.

Table 3: Consolidated compensated price elasticities for the parameterised utility function for the chosen parameter values

ε_{ij}	*Manufacturing*	*Cash crop*	*Food (Formal sector)*	*Labour*
Manufacturing	-0,239	0,032	0,075	0,131
Cash crop	0,086	-0,968	0,075	0,806
Food	0,086	0,032	-0,925	0,806
Labour	-0,046	-0,105	-0,245	0,396

Note: The elasticities have been calculated based on the parameters specified in *Table 1* and the benchmark dataset specified in *Table 2*

For reference, we notice that the compensated price elasticity of the untaxed use of the primary factor in the household sector with respect to the demand for *Manufacturing* at 0,131 is smaller than with respect to the demand for *Cash crop* and *Food (Formal sector)*, both equal to 0,806; and that the compensated elasticities of demand for *Manufacturing* and *Cash crop* with respect to the price of the export good, *Food (Formal sector)*, are the same, both equal to 0,075.

We assume that the government considers four different tax structures:

Ξ^1: Only VAT at uniform rate,

Ξ^2 : No restrictions on the set of feasible tax instruments,

Ξ^3 : VAT at uniform rate and border taxes, and

Ξ^4 : Only border taxes;

[9] 0.54=24/(24+23)

The corresponding optimal tax systems, $\boldsymbol{\tau}^{j*}$, $j=1,2,3,4$ calculated based on the assumption that taxation does not involve administrative costs are provided in *Table 4.*

Table 4: Optimal tax-tariff systems and administrative costs

Optimal tax-tariff system		$\boldsymbol{\tau}^1 \in \Xi^1$	$\boldsymbol{\tau}^{*2} \in \Xi^2$	$\boldsymbol{\tau}^{*3} \in \Xi^3$	$\boldsymbol{\tau}^{*4} \in \Xi^4$
Domestic tax rates					
Manufacturing	t_1	0,32	0,45	0,19	0,00
Cash crop	t_2	0,32	0,15	0,19	0,00
Food (Formal sector)	t_3	0,32	0,15	0,19	0,00
Labour	t_0	0,00	0,00	0,00	0,00
Border tax rates					
Manufacturing good	t_1^W	0.00	0.00	0,18	0,52
Cash crop	t_2^W	0.00	0.00	0,00	0,19
Food (Formal sector)	t_3^W	0.00	0.00	0,00	0,00
Factor income (formal sector)		20,67	21,48	20,80	20,91
EV compared with $\boldsymbol{\tau}^1 \in \Xi^1$ (as share of benchmark factor income in the formal sector)		0	0,58%	0,43%	-0,31%

For Ξ^1, which serve as benchmark for the comparisons of the maximum social welfare achievable under the different tax-tariff regimes, the uniform rate of the VAT required to finance the government's revenue requirement of 5, is 32%.

For Ξ^2, where there are no restrictions on the government's use of commodity tax instruments, as a matter of normalisation without loss of generality, we assume the export of *Food (Formal sector)* and the supply of *Labour* to the market to be untaxed. The optimal tax system involves production efficiency and hence $\mathbf{t}^i=0$, $i=1,2,3$ and $\mathbf{t}^W=0$. The optimal differentiation of commodity tax rates represents a trade-off between the objective of encouraging the supply of labour to the formal sector, and the objective of not distorting the consumer prices of produced commodities (cf. Munk 2008). As *Manufacturing* is complementary with the (untaxed) use of the primary factor in the informal sector *(see Table 3)*, the optimal tax on the consumption of *Manufacturing* is thus taxed at the relatively high rate of 45%, whereas the consumption of *Cash crop* and *Food (Formal sector)* is only taxed at 15%.

For Ξ^3, where the government's revenue requirement is financed by a VAT at a uniform rate supplemented by border taxes, production efficiency is in general not desirable. We can here as for Ξ^2 as a matter of normalisation without loss of generality assume the export of *Food (Formal sector)*

untaxed. The optimal tax system now involves a three way trade-off between the same two objectives as in the case of Ξ^2, and in addition the objective of limiting the distortion of the input price of *Manufacturing* in the production of *Food (Formal sector)* (cf. Munk 2004). The optimal solution involves a VAT at a uniform rate of 19% supplemented by a tariff on the imports of *Manufacturing* of 18%. Because of the objective of limiting the distortion of inputs in the production of *Food (Informal sector)* the price wedge between the consumer price and the world market prices, reflecting the combined effect of the VAT at uniform rate and the tariff, is at 40%[10] lower than the VAT rate for *Manufacturing* for optimal tax system $\boldsymbol{\tau}^{*2} \in \Xi^2$ which is 45%.

For Ξ^4, where the government's revenue requirement is financed only by border taxes, we can as for Ξ^2 and Ξ^3, as a matter of normalisation without loss of generality assume the exports of *Food (Formal Sector)* as untaxed. The optimal solution involves differentiation of tariff rates motivated by the following objectives (cf. Munk and Rasmussen 2005): the two objective which determine the optimal tax system in a closed economy

- to encourage the supply of labour to the formal sector (*Objective 1*), and
- not to distort the consumer prices of produced commodities (*Objective 2*)

and in addition the objective

- to encourage the export of *Food* (*Objective 3*)[11]

Objective 2 draws, as in the case of Ξ^3, in the direction of a relatively high tariff on the imports of *Manufacturing*. *Objective 3* suggests on the one hand, that it is desirable to strive for a relatively high tariff on the imports of commodities which in household consumption is complementary with the consumption of *Food (Formal sector)*, the export good, and on the other hand, that a relatively low tariff on *Manufacturing* is desirable as it is used as intermediate inputs in the production of *Food(Formal sector)*. With the current parameterisation we have assumed additive separability in consumption between the three produced commodities. This implies that that *Manufacturing* and *Food (Formal sector)* are equally complementary with the consumption of *Food (Formal sector)* (see *Table 3*, $\varepsilon_{13} = \varepsilon_{23} = 0.075$). It is thus not possible by differentiation of tariff rates to discourage the household consumption of *Food (Formal sector)*, however this is an artefact of the parameterisation of the model[12]. A relative low tariff on *Manufacturing* will thus encourage the production, and thus the export of *Food (Formal sector)*. *Objective 2* of encouraging the supply of labour to the market dominates *Objective 3* of encouraging the exports of *Food (Formal sector)* with the result that the optimal tariff on the imports of *Manufacturing* at 52% is considerably higher than

[10] 0,40 = (1+0,18)x(1+0,19) - 1

[11] For border taxes to raise revenue to the government the tax system $\boldsymbol{\tau}^{*4}$ must discouraged the exports of *Food (Formal sector)*. *Objective 3* does not apply in the case of Ξ^3 since under this tax structure the justification for the use of border taxes is not to raise government revenue directly, but to encourage the supply of labour to the market.

[12] The CGE model may easily be modified to represent this possibility.

the tariff on *Cash Crop* at 19%. This result contrasts with results calculated using of standard CGE models, as for example Dahl et al. (1994) and Mitra (1992), where the welfare loss caused by imposing a uniform tariff rather than the optimal tariff is negligible. The difference in results may be explained by the fact that standard CGE models impose separability between household consumption of produced commodities, and sometimes even quite unrealistically that the supply of labour is fixed, whereas the CES-UT specification used in the present model allows for differences in the degree of complementarity with the use of the primary factor in the informal sector. It seems hardly realistic, in particular in developing countries, to assume additive separability between consumption of different commodities and the use of the primary factor in the informal sector. One would therefore expect a non-proportional tariff structure to represent the optimal solution in practise, even when based as here only on efficiency considerations[13]. Our simulation results are consistent with this insight. We therefore at this point for the reasons elaborated in Munk and Rasmussen (2005) reach a different conclusion than Hatta and Ogawa (2007) who suggest that in practice the optimal tariff structure will be close to proportionality.

To give an idea of the size of administrative costs required to balance the benefits in terms of the resource allocation of the different tax structures, we calculate the savings in administrative costs required to make the optimal tax systems $\boldsymbol{\tau}^{j*}$, $j = 2,3,4$ equivalent in welfare terms to $\boldsymbol{\tau}^{*1}$. These results are reported in *Table 5.* [14]

Table 5: Administrative costs making $\boldsymbol{\tau}^{*i} \sim \boldsymbol{\tau}^{*1}$

Optimal tax-tariff system	$\boldsymbol{\tau}^{1} \in \Xi^{1}$	$\boldsymbol{\tau}^{*2} \in \Xi^{2}$	$\boldsymbol{\tau}^{*3} \in \Xi^{3}$	$\boldsymbol{\tau}^{*4} \in \Xi^{4}$
Required saving of administrative costs as share of factor income in formal sector in benchmark	0	0,48%	0,29%	-0,35%

The increase in administrative costs associated with Ξ^2 compared with Ξ^1 which makes $\boldsymbol{\tau}^{*2}$ equivalent to $\boldsymbol{\tau}^{*1}$ in welfare terms, is 0.48% of the factor income in the formal sector. The increase in administrative costs associated with Ξ^3 which makes $\boldsymbol{\tau}^{*3}$ equivalent to $\boldsymbol{\tau}^{*1}$ is 0.29%, whereas the administrative costs associated with Ξ^4 need to be at least 0.35% lower to make $\boldsymbol{\tau}^{*4}$ equivalent to $\boldsymbol{\tau}^{*1}$. Therefore, border taxes are desirable as an alternative or as a supplement to a VAT system if compared with the administrative costs associated with Ξ^1 the administrative costs associated with

[13] Taking distributional aspects into account naturally provides an additional reason for non-proportionality. For more detailed arguments with respect to this point, see Emran and Stiglitz (2007).

[14] The figures of course differ from the EVs reported in *Table 4* , as they have been calculated taking the administrative costs of taxation into account.

Ξ^2 are more than 0.48% greater, and either 1) those associated with Ξ^3 less than 0.29% more costly, or 2) those associated with Ξ^4 at least 0.35% less costly than those associated with Ξ^1.

The cost of financing the government's revenue requirement by border taxes rather than domestic taxes increases progressively with the government's revenue requirements. If for example the share of the government's requirement increases from 5 (see Table 2) to 10, the saving in administrative costs needed to finance the government's revenue requirement solely by border taxes rather than by a VAT at uniform rate increases more than threefold from 0.35% to 1.15% of the factor income in the formal sector.[15]

The model simulations thus highlights that one cannot a priori exclude that border taxes are desirable based only on theoretical considerations. The important factors for whether or not free trade is desirable are 1) the relative size of the informal sector, 2) the differences in complementarity with the untaxed use of primary factors in the informal sector of different commodities, 3) the costs associated with tax administration, and 4) the size of the government resource requirement as a share of GNP.

As knowledge about these aspects are largely insufficient to settled the disagreement between Stiglitz and the Bretton-Woods sister organisations on whether the use of border taxes is desirable in developing countries, there is clearly a need for empirical research on the administrative costs associated with different tax structures and on the structure of the economy (in our model represented by the benchmark data set and the value of the elasticities of substitution).

5. Summary and concluding remarks

We have considered Stiglitz' (2003) claim that in developing countries border taxes are a better instrument to raise government revenue than a VAT. We have for this purpose specified a parameterised model where the informal sector is represented by a CES-UT utility function, where production in the informal sector is assumed to generate an untaxed profit to the household, and where different tax structures are associated with different administrative costs. We have shown that Keen's partial equilibrium model is a special case of this model. His analysis therefore amounts to restating the Diamond-Mirrlees efficiency theorem for this special case. Keen is thus right that a large informal sector in itself does not provide an argument against free trade.

However, as was already many years ago pointed out by Stiglitz and Dasgupta (1971), but which has largely been neglected, presumably as analytically and ideologically inconvenient, the Diamond-

[15] Just with reference to the increasing size of the government's share of consumption in GNP, Kimbrough and Gardner (1992) explain why the importance of tariff revenue in the US has diminished over time. The present model may thus also be used to illustrate explain why because the size of government is smaller in developing countries the use of tariffs to raise government revenue is more attractive than in developed countries.

Mirrlees (1971) efficiency theorem does not apply when all commodities cannot be taxed at no cost. We have illustrated this insight using a parameterised model and a set of data and parameter values representing a prototype developing country with a large informal sector resulting in a plausible matrix of compensated demand elasticities. We have produced simulation results which illustrate that when taxation is associated with administrative costs, whether border taxes are desirable or not depends critically on the size of informal sector, as has been pointed out by Emran and Stiglitz (2005, 2007). When a VAT at uniform rates is the only source of domestic taxation, the complementarity between the consumption of the traded goods and the use of the primary factor in the informal sector plays an import role for whether, based on efficiency considerations, it is desirable to supplement a VAT with border taxes. In the case where border taxes are the only source of government revenue, the desire to discourageof the consumption of the export good and the to encourage its production also influence the optimal tax structure, as identified in Munk and Rasmussen (2005). Furthermore, contrary to what has been suggested in the literature, a proportional tariff structure is unlikely to be optimal in practice. When distributional considerations, which for reasons of exposition we have ignored in this paper, are taken into account it becomes even more unlikely that the optimal tariff system used in developing countries to maximise social welfare should be proportional.

The simulation results have highlighted that the question of whether border taxes are desirable or not is complex depending on a number of factors which can only be assessed based on empirical evidence which is difficult to obtain. Evidence on the distortionary and administrative costs of various tax arrangements is essential in order for a given country at a given point in time to identify the tax-tariff system which is optimal for that country given its social objectives.

As pointed out by Keen (2006), evidence suggests that the introduction of VAT over time may serve as a catalyst for reduction in the costs of tax administration, and thus facilitate the adoption of free trade. It is therefore important that recommendations for VAT are made not only with reference to text book models which ignore administrative costs as has often been the case, as this may result in the recommendations be seen as based on ideology, rather than facts.

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Annex: The partial equilibrium model employed by Keen

The purpose of this Annex is to detail the assertion that the partial equilibrium model employed by Keen (2006), which underpins his 2006 presidential address to the IIPF congress (Keen 2007), may be seen as a special case of the general equilibrium model we have specified in Section 2 of the main paper.

Keen considers an economy with an informal and formal sector, but, as his analysis is conducted within a partial equilibrium framework, he does not explicitly represent the use of the primary factor in neither the informal sector nor the formal sector and represents only two commodities. However, assuming that the first commodity corresponds to *Manufacturing* and the second to *Food (Formal sector)*, Keen's model may be interpreted as a special case of our model, explicitly representing *Manufacturing* imports and the domestic production of *Food (Formal sector),* as well as the competing production of *Food (Informal sector)*. Keen (2006) assumes the production of *Food (Informal sector)*, (C_1 in our notation and *Y* in Keen's notation), to be a perfect substitute for *Food (Formal sector)*, (y_3 in our notation and *y* in Keen's notation), whereas in our model *Food (Formal sector)* and *Food (Informal sector)* are imperfect substitutes. However, this is not an important difference as Keen's model at this point may be interpreted as a limiting case of our model.

The consumer price of manufacturing, q_1 in our notation, is in Keen's notation $\rho \equiv \left(\frac{P + T_M + T_W}{1 - T_V} \right)$ with P being the world market price of *Manufacturing*, T_M and T_W the tariff rate and the VAT rate, respectively, applied to *Manufacturing* imports (the latter, T_W, by Keen called a withholding tax), and T_V the VAT rate applied to sales of domestically produced goods. When ρ $T_V = T_W$, such that the tax-inclusive import price of *Manufacturing* faced by informal producers is $\rho = P + T_M$, this corresponds to a VAT at uniform rate, (in our notation to a consumer tax vector, $\left(t_1, t_2, t_3\right)$, where $\left(t_i + p_i\right) / p_i = \overline{T}, i = 1,2,3$).

The price of *Food (Formal sector)*, (q_3 in our notation, Q plus the VAT rate in his notation), is in Keen's model equal to the price of *Food (Informal sector)*, (in our notation $Q_1 = G^1_{C_1}\left(q_0, q_1, C_1\right)$). The cost function for the production of *Food (Formal sector)*, is in Keen's notation $C\left(\rho, Y\right)$, in our notation $c^3\left(p_0, p_1; s^3\right) y_3$.

Notice that both in the model employed in Munk (2004) and in this paper, the consumption in the informal sector of commodities produced in the formal sector are purchased at consumer prices. This is in contrast to what is assumed in Piggott and Whalley (2001) and in Stiglitz and Emran (2005). However, in the model used in Munk (2004), contrary to in the present one, there are no intermediate inputs in formal sector production. A VAT is therefore in Munk (2004) similar to a consumption tax system.

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