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B-1348 Optimal border taxes in developing countries On the importance of a large informal sector

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

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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) suggest 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 for example Emran and Stiglitz (2005) reach another conclusion is that they assume that the informal sector is reimbursed for VAT paid on purchases of intermediate inputs, which does not 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 in terms of a Computable General Equilibrium (CGE) model and thus might be useful in trying to reach a consensus opinion on the issue.

The paper is organized as follows. In Section 2, we set up a general equilibrium model of a small open economy with representation of both domestic and border taxes which allows for the fact that different tax structures are associated with different levels of administrative costs. In Section 3, we define "the informal sector" and imbed a representation of the informal sector in a standard utility function of a representative household defined on the household's net trade and argue that when taxation is not associated with administrative costs, production efficiency and thus free trade is desirable, also with untaxed informal sector profit, whatever the size of the informal sector. In Section 4 we briefly review the arguments for whether or not it is desirable for developing countries to use border taxes to raise government revenue given that taxation is indeed associated with significant administrative costs. In Section 5, we specify a stylized CGE model, which represents the difference in administrative costs of different tax systems, and uses a CES-UT parameterisation of the household's utility function defined on traded commodities to represent informal sector production. In Section 6 we use this model to calculate the amounts of administrative costs

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

associated with a VAT which would justify diversions from free trade. A final section summaries and concludes the paper.

2. The model

We consider a small open economy with one domestically traded primary factor, indexed 0, and three internationally traded commodities, indexed 1, 2 and 3[2]. The government imposes border taxes, $\mathbf{t}^W \equiv \left(t_1^W, t_2^W, t_3^W\right)$, 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 $\mathbf{p}^W \equiv \left(p_1^W, p_2^W, p_3^W\right)$ and therefore market prices are $\mathbf{p} \equiv \left(p_0, p_1, p_2, p_3\right) = \left(p_0, p_1^W + t_1^W, p_2^W + t_2^W, p_3^W + t_3^W\right)$, 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 formal sector of the economy has the potential to produce any of the three goods using the primary factor and intermediate inputs of the three goods. Production 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 good *i*. The economy will therefore depending on the tax-tariff system chosen by the government specialise in the production of one good, say good *k*, which thus becomes the export good, while the two other goods 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, $i = 1, 2, 3$.

The household's endowment of the primary factor is ω_0. Its market transactions which at a cost may be observed by the government and made the basis for taxation are $\left(x_0, x_1, x_2, x_3\right)$. The untaxed consumption of the primary factor within the household sector is thus $\omega_0 + x_0$. The preferences of the household are represented by a utility function, $u\left(x_0, x_1, x_2, x_3\right)$ with standard properties.

Foreign trade (net imports) is $\left(y_1^W, y_2^W, y_3^W\right)$, and the government's resource requirement is $\left(x_0^G, x_1^G, x_2^G, x_3^G\right)$[3].

We assume, as in Munk (2008) , that the government's resource requirement depends on the tax system adopted rather than being exogenously given. 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 a number of restrictions on the tax instruments available to

[2] The model is an extension of the theoretical model used in Munk (2008) . In this model also represent intermediate consumption without which a VAT is equivalent to a system of consumer taxes.

[3] The sign conventions are: $y_k > 0$ and $v_i > 0, \left(i = 0,1,2,3\right)$; $x_0 < 0$ and $x_i > 0$ $\left(i = 1,2,3\right)$; $y_k^W < 0$ 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 government. The administrative costs for all tax-tariff systems belonging to a given tax-tariff structure j are $B(j)$. As the government's expenditures other than for tax administration are exogenously given, the government's total resource requirement may be written

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

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.

For tax-tariff system $\boldsymbol{\tau} \equiv (\mathbf{t}, \mathbf{t}^i, i=1,2,3, \mathbf{t}^W)$ to be feasible, it must satisfy the conditions of *profit maximisation, utility maximisation, material balance, external trade balance* and *government budget balance*.

The conditions for profit maximisation may be expressed as

- for the export sector

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

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

- for other sectors

$$p_i < c^i(p_0, p_1^i, p_2^i, p_3^i) \qquad i \neq k = 1,2,3 \tag{4}$$

$$y_i = 0 \qquad i \neq k = 1,2,3 \tag{5}$$

The conditions for utility maximisation are using the expenditure function approach

$$E(\mathbf{q}, u) = I \tag{6}$$

$$x_i = E_i(\mathbf{q}, u) \qquad i = 0,1,2,3 \tag{7}$$

where $E(\mathbf{q},u)$ is the expenditure function, $E_i(\mathbf{q},u)$ its partial price derivative, and $I = 0$ since the household receive no profit income.

Material balance requires

$$0 = v_0 + x_0 + x_0^G \tag{8}$$

$$y_k + y_k^W = v_k + x_k + x_k^G \tag{9}$$

$$y_i^W = v_i + x_i + x_i^G \qquad i \neq k = 1,2,3 \tag{10}$$

The balance of trade constraint is

$$\sum_{i=1,2,3} p_i^W y_i^W = 0 \tag{11}$$

and the government's budget constraint is

$$\sum_{i=0,1,2,3} t_i x_i + \sum_{i=1,2,3} t_i^k v_i + \sum_{i=1,2,3} t_i^W y_i^W - \sum_{i=0,1,2,3} p_i x_i^G = 0 \tag{12}$$

Except for the assumption that that taxation is associated with administrative costs, this is a standard public finance model[4]. If taxation had been assumed not to be associated with administrative costs the Diamond and Mirrlees *Production Efficiency Theorem* would therefore apply with the implication that government in maximising social welfare would only use consumer taxes $\mathbf{t} = \left(t_0, t_1, t_2, t_3\right)$ to finance its resource requirement.

The development of the Diamond and Mirrlees (1971) framework for optimal tax analysis was motivated by the realisation that it is administratively infeasible to achieve government objectives of income distribution and revenue generation by the use of lump sum taxes. However, it seems almost equally unrealistic to assume that costs of tax administration are the same whatever the tax system. From the outset it was pointed out by Stiglitz and Dasgupta (1971) that when all market transaction cannot be taxed at their optimal level, 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, almost without exceptions the maintained assumption in subsequent contributions to optimal tax analysis has been based on models where the government is able to tax all market transactions at no administrative costs. It is however generally recognised that for the design of optimal tax systems administrative costs are important[5]. We have therefore as indicated above (see (1)) chosen to divert from the standard Diamond and Mirrlees (1971) framework by assuming that different tax structures are associated with different administrative costs[6].

3. The informal sector and why untaxed informal sector profit does not compromise the desirability of production efficiency and free trade

We define "*the informal sector*" as the production and consumption processes within the household sector, as well as transactions between households, which cannot be made the object of taxation[7]. We add structure to the model specified so far by incorporating a representation of the household sector's use of the primary factor, c_0, for informal sector production.

[4] In international trade theory the expenditure function approach is standard, but domestic taxes are rarely represented, whereas optimal tax models for no good reasons still in general adopt the indirect utility function approach and seldom represents border taxes.

[5] E.g. 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.

[6] 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 or not the use of border taxes is desirable in developing countries.

[7] 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 Congress in commenting on papers by Boadway and Sato (2009) and Dreher, Méon and Schneider (2007) in the middle of the 20th century in Belgium as in many other countries in Europe farm output and farm income were exempt from taxation with no suggestion that farming was an illegal activity. In fact at that time a large part of the agricultural sector in Europe with up to 50% of total employment would have been covered by our definition of 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. For a more realistic representation of the informal sector we may without changing the insight derived from the present analysis extend the definition of an informal sector to allow for output produced in the informal sector being used as intermediate inputs in the formal sector, as long as a similar product is not produced in the formal sector. An example of this will be where small agricultural producers deliver a cash crop for processing in the formal economy without being taxed. However, we do not consider this possibility in the present paper.

The informal sector production functions, $C_i = C_i(x_i, c_0^i)$, i=1,2,3, are concave functions representing how the purchases of produced commodities, $x_i,\ i = 1,2,3$, are combined with amounts of the primary factor, $c_0^i,\ i = 1,2,3$, to produce informal sector goods, C_i, i=1,2,3, which are traded and consumed only within the household sector. The residual use of the primary factor is $c_0^0 = \omega_0 - \sum_{i=1,2,3} c_0^i + x_0$. In the case where the primary factor is interpreted as labour, c_0^0 may be defined as "*Pure leisure*" indicating the household's use of time not associate with the consumption of any specific purchased good. We assume that the household's preferences defined on pure leisure and the three goods produced in the informal sector may be represented by a utility function $U\left(c_0^0, C_1, C_2, C_3\right)$ with standard properties. Substituting into this utility function we have

$$u\left(x_0, x_1, x_2, x_3\right) = U\left(c_0^0, C_1\left(x_1, c_0^1\right), C_2\left(x_2, c_0^2\right), C_3\left(x_3, c_0^3\right)\right) \tag{13}$$

where $x_0 = \sum_{i=0,1,2,3} c_0^i - \omega_0$.

Since $U\left(c_0^0, C_1\left(x_1, c_0^1\right), C_2\left(x_2, c_0^2\right), C_3\left(x_3, c_0^3\right)\right)$ is a utility function with standard properties, the corresponding expenditure function, $\tilde{E}\left(q_0, Q_1, Q_2, Q_3, u\right) \equiv \left\{ \underset{c_0^0,\ ;C_i,\ i=1,2,3}{\text{Min}}\ q_0 c_0^0 + \sum_{i=1,2,3} Q_i C_i \ \ s.t.\ u = U\left(c_0^0, C_1, C_2, C_3\right) \right\}$, where Q_i, i=1,2,3 are the (shadow) prices of the informal sector goods, therefore also have standard properties. Informal sector profit is $\Pi\left(q_0, q_1, q_2, q_3\right) \equiv \sum_{i=1,2,3} Max_{C_i}\left(Q_i C_i - G^i\left(q_0, q_i, C_i\right)\right)$, i=1,2,3, where $G^i\left(q_0, q_i, C_i\right)$, i=1,2,3 are cost functions indicating the costs associated with informal sector production. Using the expenditure function approach, the conditions for the household's vector of market transactions $\left(x_0, x_1, x_2, x_3\right)$ to be consistent with the utility maximisation may, replacing (6) and (7) above, be expressed as

$$\tilde{E}\left(q_0, Q_1, Q_2, Q_3, u\right) - q_0\omega_0 = \Pi\left(q_0, q_1, q_2, q_3\right) \tag{14}$$

$$Q_i = G_{C_i}^i\left(q_0, q_i, C_i\right) \equiv \frac{\partial G^i}{\partial C_i}\left(q_0, q_i, C_i\right) \quad \text{i=1,2,3} \tag{15}$$

$$x_i = G_i^i\left(q_0, q_i, C_i\right) \equiv \frac{\partial G^i}{\partial q_i}\left(q_0, q_i, C_i\right) \quad \text{i=1,2,3} \tag{16}$$

$$c_0^i = G_0^i\left(q_0, q_i, C_i\right) \equiv \frac{\partial G^i}{\partial q_0}\left(q_0, q_i, C_i\right) \quad \text{i=1,2,3} \tag{17}$$

$$x_0 = c_0^0 + \sum_{i\in(1,2,3)} c_0^i - \omega_0 \tag{18}$$

As the informal sector is represented by adding structure to a standard utility function, the model with the added structure is a special case of the standard model specified in Section 2. As pointed out by Atkinson and Stern (1980) standard theoretical results of optimal taxation, and thus by implication the Diamond and Mirrlees *Production Efficiency Theorem*, apply in a model with the explicit representation of the use of time within the household with the implication that free trade is desirable if taxation is not associated with administrative costs.

However, although it follows from this simple argument, it may be worthwhile to explain in more detail why untaxed informal sector profit does not compromise the *Production Efficiency Theorem,* whereas untaxed formal sector profit is assumed to do.

First, as is not always realised, in fact even when formal sector profit cannot be taxed, production efficiency is desirable when no restrictions are imposed on the taxation of commodity trade. In the absence of a 100% tax on profit and in the case where the government's requirement exceeds the value of the profit at producer prices, the optimal tax system involves 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, but maintaining production efficiency (cf. Munk 1978). It is therefore not possible as in Dasgupta and Stiglitz (1971) and in number of subsequent contributions (for example Boadway and Sato 2009) in a model with untaxed formal sector profit to assume one commodity as untaxed as a matter of normalisation without loss of generality. One can naturally consider it an factual assumption, but as such it is not supported by empirical evidence[8]. However, the analysis of the optimal tax system given this artificial restriction (see e.g. Dasgupta and Stiglitz 1971 and Munk 1980) provides insight into why production efficiency is desirable in the presence of untaxed informal sector profit. When the government cannot raise the required tax revenue by a proportional tax system (taxing produced commodities and subsidizing the market supply of labour) the social value of a unit of income to the government is larger than to the household. Increasing producer taxes, $\mathbf{t}^i \equiv \left(t_1^i, t_2^i, t_3^i\right)$, i=1,2,3, which reduce the household's profit income and to increase government revenue causing production inefficiency, is therefore desirable to the point where the marginal net benefit in terms of social welfare of this transfer is equal to the marginal cost due to the distortion of production. The important point now is that in the case of untaxed informal sector profit there is no such trade-off. In the presence of informal sector profit, but no formal sector profit, the set of model equations is homogenous of degree zero in consumer prices. Producer taxes applied to the formal sector production has no effect on informal sector decisions, as these depend only on consumer prices which the government by the assumption of no administrative costs can set independently of producer prices at no costs. Therefore in this case one commodity can be assumed untaxed without loss of generality.

Keen (2006) has devoted a paper to prove that production efficiency and free trade is desirable in the presence of untaxed informal sector profit. As we have seen, this proposition follows from application of a well establish theorem of public economics, and illustrates the benefits of embedding the informal sector production in the household utility function in terms of facilitating interpretation and derivation of results, as was pointed out by Atkinson and Stern (1980).[9]

[8] The fact that the optimal solution based on a model with untaxed profit involves infinite tax rates is an indication, which has largely been ignored in the literature that it is highly problematic to provide tax advice based on a model, which does not represents the administrative costs of taxation.

[9] In *Annex 1* we explain that Keen's (2007) partial equilibrium model is indeed a special case of the general equilibrium model set out in Section 2 and 3 of this paper.

4. Brief review of the arguments for whether border taxes or VAT is the best way to raise government revenue?

In this section we briefly review the justification, pro and contra, for whether or not the use of border taxes is a desirable alternative to VAT to generate government revenue taking into account that taxation in developing countries is associated with high administrative costs.

We have assumed that production in the formal sector takes place under constant returns to scale and therefore is associated with no profit. The Diamond and Mirrlees *Production Efficiency Theorem* says that in an economy without untaxed profit, although lump-sum taxation is not feasible, optimal taxation requires production efficiency when taxation is not associated with any administrative costs. It therefore, as already mentioned, follows directly from this theorem that in economy, which may be represented by the general equilibrium conditions (1) to (5), (8)-(12) and (14)-(18), if all market transactions can be taxed at no costs, then production efficiency and thus free trade is desirable. The optimal tax system in general involves a differentiated commodity tax system $\mathbf{t} = (t_0, t_1, t_2, t_3)$ with tax rates differentiated such that goods complementary with the use of labour in the informal sector is taxed at relative high rates, and with no use of sector specific taxes on intermediate inputs or of border taxes, i.e. with $\mathbf{t}^i \equiv \mathbf{0}$, i=1,2,3 $\mathbf{t}^w \equiv \mathbf{0}$. Ignoring administrative costs of taxation there is therefore on this basis, on the one hand, no theoretical justification why a VAT at uniform rate, as proposed by the IMF and the World Bank, should be optimal for developing countries, and, on the other hand, when a differentiated commodity tax system can be implemented at no additional cost, no justification for the use of border taxes whatever the size of the informal sector, in contrast to what seems to have been suggested by Stiglitz (2003).

It is 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 rather than proportional 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 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. With restriction on the tax system due to administrative costs, production efficiency is not any longer desirable, whereas the use of border taxes may be desirable. 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. When nevertheless a VAT at uniform rate is advocated with reference to the administrative costs of a differentiated VAT, reference to the Diamond-Mirrlees (1971) *Production Efficiency Theorem* cannot be used to justify the suppression

of border taxes, and then, as Emran and Stiglitz (2005) point out, the size of the formal sector plays an important role for whether the use of border taxes is desirable or not.

It therefore seems inconsistent when the World Bank and the IMF, on the one hand, recognise that tax administration in developing countries involve substantial administrative costs, and, on the other hand, maintain that the use of border taxes cannot be desirable. If a differentiated VAT is desirable, then free trade is indeed also desirable, but if a VAT at uniform rate is desirable for reasons of costs of tax administration, then there is no a priori reason why the use of border taxes should not also be desirable. The IMF and World Bank recommendations with respect to taxation in *developing* countries to abolish border taxes and to implement a VAT at uniform rate[10] may therefore be seen as the application to *developing countries* of what is widely considered a reasonable system of commodity taxation for *developed* countries, but neglecting important differences between developed and less developed countries, in particular with respect to administrative costs of taxation and the relative size of the informal sector.

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 as a supplement to a VAT, depends also on how one defines VAT, and there has been some ambiguity in that respect (cf. Keen 2006). As emphasised by Keen (2006), VAT as used in practice cannot realistically be represented in a model without intermediate consumption[11], and it definitely is not equivalent to a tax only on formal sector sales as in Pigout and Walley (2001) and in Emran and Stiglitz (2005). In practice under a VAT system intermediate inputs used in the formal sector are exempt from taxation, but not purchases used for inputs in informal sector production. When a VAT, in line with what is the case in practice is defined as tax structure, $\boldsymbol{\tau} \equiv \left(\mathbf{t},\ \mathbf{0},\ i=1,2,3,\ \mathbf{t}^{W}\right)$, where intermediate consumption in the formal sector is untaxed, but intermediate consumption in the informal sector taxed at the same rate as final consumption, then it follows directly from the Diamond and Mirrlees *Production Efficiency Theorem*, that no improvement in social welfare can be achieved by taxes on border transactions whether or not informal production is associated with profit, i.e. that optimality requires $\mathbf{t}^{W} = 0$. With a VAT defined in this way, if VAT rates can be differentiated at no cost, then Keen (2006, 2007) is therefore right that there is no justification for the use of border taxes whatever the size of the informal sector. In contrast, if taxation is assumed to be associated with administrative costs and these costs depend on 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.

In fact as pointed out by Keen (2006) also sector specific taxes on inputs creating production inefficiency may be justified as an instrument to reduce the use of resources in the informal sector[12].

[10] 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.

[11] The results reached in Munk (2008) were no due to the omission of intermediate consumption, but we have included intermediate consumption in model in this paper to be able to represent the difference between a VAT system and tax system where intermediate and final consumption is taxed at the same rate.

[12] The optimal use of producer taxes when restrictions are imposed on VAT rates, as for example where VAT is levied at a uniform rate, has been analysed within a closed economy model framework in Munk (1998). The present model provides the appropriate framework for also analysing the question in a small open economy. However in order to maintain the focus on the controversy mentioned in the introduction we leave the analysis of this issue for future research.

This explains why Piggott and Whalley (2001) and Emran and Stiglitz (2005) by the way they define a VAT find that the use of border taxes may improve welfare in models without the representation of the administrative costs of taxation. In their models they assume that informal sectors intermediate inputs are not subject to taxation. This is equivalent in our framework to impose restrictions on household taxes. With a VAT defined in this way, production efficiency may therefore not be desirable. As correctly 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. When a VAT is defined in this way when disregarding administrative costs, border taxes will not improve welfare when a VAT with optimally differentiated tax rates has already been implemented.

It is becoming increasing recognised that for a model to be relevant to address the problems facing developing countries, it has to represent the specificity of the informal sector which in general operates quite differently than the formal sector, and which is very significant as it employs up to 80 % of the labour force. Firms in the informal sector which produce similar products as firms in the formal sector, in general use different technology, and they are under a VAT system taxed differently. In this paper we provide a model framework which will make it possible to explore empirically the importance of differences in production technology and taxation between the formal and the informal sector for answering the question of whether the use of border taxes is desirable or not. There are clearly also other considerations with respect to the differences between the formal and the informal sector which are important for the answer to this question. Production in the informal sector may be guided by social norms reflecting group preferences rather than entirely by the profit motive of owners with well defined property rights. Furthermore, the information and financial constraints under which firms in the informal sector operate are different from those facing firms in the formal sector (a point emphasised by Gordon and Li 2005). Information about opportunities in the job market and in product markets differ, and the opportunities for job related human capital accumulation is typically smaller in informal sector firms compared to larger firms in the formal sector, in particular those engaged in foreign trade and benefiting from foreign direct investment and increasing returns to scale. Informal sector firms which typically do not have access to financial intermediation also are likely to be more adversely affected by fluctuations in market prices, climate change and unpredictable changes in other exogenous factors.

5. Parameterisation and calibration of the theoretical model

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. The data required to fully specify general equilibrium models to represent developing country economies, are not readily available and in particular, there is still little empirical evidence on the administrative costs associated with different tax systems and on informal sector production. It seems therefore not worthwhile to attempt to settle the dispute on whether it is desirable or not for developing countries to use border taxes before more data on the administrative costs of taxation and on informal sector production have become available. However, we want here to contribute to provide an answer to this question eventually by presenting a quantitative example involving the use of a stylized CGE model with explicit representation of the informal sector. By constructing a stylized CGE model based on hypothetical 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 of taxation and of the

size and production technology in the informal sector for the choice of an optimal tax-tariff system, and to provide guidance for future research for how to gather the relevant data, and for how to use such data to estimate the relevant model parameters.

We formulate a parameterised model corresponding to the theoretical model specified in Section 3 and Section 4 using the CES-UT utility function to represent informal sector production (see Munk 1998 and 2008b), and then with reference to *Annex 2* we detail the benchmark data set and parameter values required to fully specify the model as a tool for quantitative policy analysis.

We assume that the formal part of the economy involves transaction in three produced commodities: *Manufactured good (1), Cash crop (2) and Food(F) (3),* all traded both domestically and internationally, and that at world market prices the economy is competitive only in the production of *Food(F),* but not in *Cash crop* and in particular not in the *Manufactured good*. We represent the formal sector production technology for *Food(F)* by a 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 inputs of the *Manufactured good.* Furthermore, we assume that *Food(I)* produced in the informal sector is a close substitute to *Food(F),* and that the informal sector production technology for *Food(I)* may be represented 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 *Labour* and the *Manufactured good.* We represent household behaviour, and thus the behaviour of the informal sector, as the result of the maximisation subject to the budget constraint, $\sum_{i=0,1,2,3} q_i x_i = 0$, of a simplified version of a CES-UT utility function $U\left(c_0^0, C\left(C_1\left(x_1, c_0^1; \sigma^{11}\right), x_2, x_3; \sigma^2\right); \sigma^3\right)$, where $C_1(x_1, c_0^1; \sigma^{11})$, $C\left(C_1, x_2, x_3; \sigma^2\right)$ 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 utility function is provided in *Figure 1.*

To construct a computable model requires in addition to the specification of the parameterised model the estimation of 1) a bench mark data set, and of 2) a set of parameter values. We derive the bench mark data set from a stylised DUAL SAM[13] where the informal and the formal production of the close substitutes Food(F) and Food(I), are represented by separate activities with different cost structures. The DUAL SAM (see *Annex 2*) has been constructed to represent a typical developing country. Defining *National Income* as the value added in formal and informal production of 23 and 30.5, respectively, plus the value of the Government's consumption of the primary factor of 5, the share of the value of informal production in terms of National Income is 57% [14], representative of the share of the labour force being employed in the informal sector in many developing countries.

The DUAL SAM may be divided into two accountancy matrices, a traditional SAM for the formal economy, SAM(F), and an accountancy matrix for the household sector, HAM. The SAM(F) can be constructed based on National Account data of the type which statistical offices routinely produce according to the UN SNA based on data collected about market transactions and generated in the process of tax collection and other administrative tasks. The HAM would have to be estimated based

[13] This framework is similar to that used e.g. Piggott and Whalley (2001) and by Gordon and Li (2005).
[14] 0.57=30.5/(30.5+23) where

on survey data to the extent it represents consumption and production processes in the informal sector which by definition are not monitored by the government for tax purposes. For convenience of exposition, we have specified the DUAL SAM for the model to represent a hypothetical situation where the government's requirement is financed by a lump sum tax. In reality, the DUAL SAM would have to be estimated to be consistent with the actual taxes in a given reference period.

The SAM(F) represents the value of market transactions organised in 7 types of accounts (see *Annex 2*).

Accounts 1F: The formal sector production accounts indicate that the formal production sector produces 20 units of *Food(F)* using as input 2 units of the *Manufactured good* and 18 units of *Labour*.

Accounts 2F: The supply-utilisation accounts for goods produced in the formal sector, indicate that
- of the imports of 10 units of the *Manufactured good* 2 units are used as intermediate input in the production of *Food(F)* and 8 units in the household sector
- of the imports of 3 units of Cash Crop, all units are used by the household sector, and
- of the production of *Food(F)* of 20 units, 7 units are used in the household sector and 13 units are exported

Accounts 3: Commodity tax accounts aggregate the tax revenue from taxation of produced commodities for intermediate and final consumption. In the bench mark these taxes are equal to zero as the governments resource requirement is financed only by a lump sum tax.

Account 4F: Formal sector primary factor supply utilisation account indicates that of the household sector's supply of labour to the market of 23 units, 18 units are used in the production of *Food(F)* and 5 units are consumed by the government.

Account 5F: The household's income expenditure account for formal sector transactions indicates that the households income derived from the supply of labour to the formal sector of 23units, 8, 3 and 7 units are spent on the purchases of the *Manufactured good*, of *Cash crop* and of *Food(F)*, respectively, and 5 units are paid to the government.

Account 6: The government's income expenditure account indicates that the government's purchase of 5 units of the primary factor is financed by a lump sum tax of the same amount.

Account 7: The rest of the world's income expenditure account indicates that import of 13 units (10 units of the *Manufactured good* and 3units of *Cash crop*) is financed by exports of 13 units of *Food(F).*

The HAM represents 7 accounts of which 6 are directly derived from the DUAL SAM and one is an auxiliary balancing account for the rest of the economy.

Accounts 1I: The informal sector production accounts indicate that the informal sector produces 38.5 units of *Food(I)* using as input 8 units of the *Manufactured good* and 30.5 units of *Labour.*

Accounts 2IF: The supply-utilisation accounts for goods produced in formal sector and used in the household sector, indicate that
- purchases of 8 units of the *Manufactured good* is used as input in informal sector production
- purchases of 3 units of *Cash crop* is used by the household for final consumption

- purchases of 7 units of *Food(F)* is used by the household for final consumption.

Accounts 2II: The supply-utilisation accounts for goods produced in informal sector, indicate that 38.5 units of *Food(I)* is used by the household for final consumption.

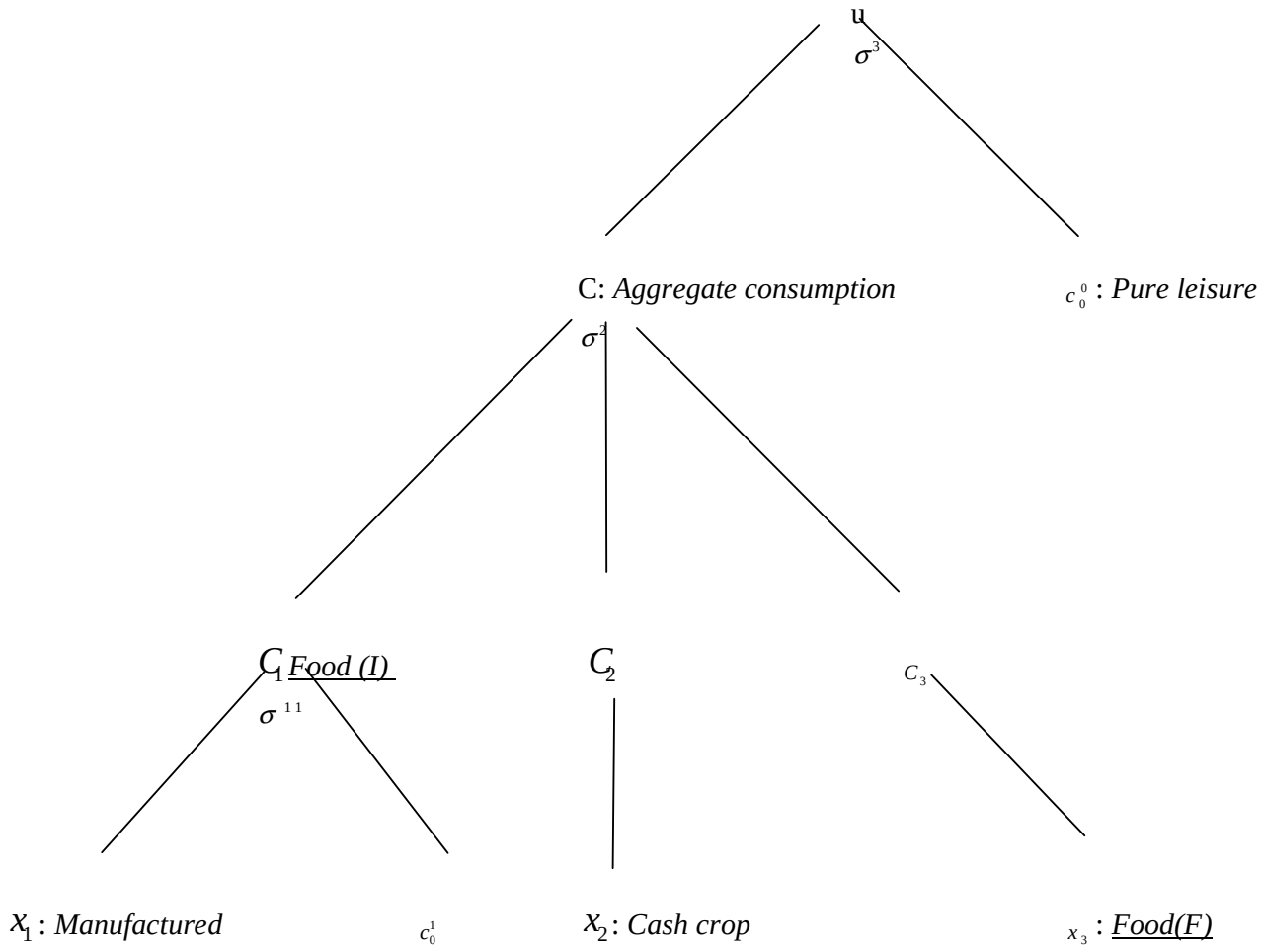
Accounts 3I: Commodity tax accounts for the informal sector aggregates the tax revenue from taxation of produced commodities used as intermediate input in informal sector production and for final consumption in the household sector. In the bench mark this is equal to zero as the governments resource requirement is financed by a lump sum tax.

Account 4: Primary factor supply utilisation account indicates that of the household sector's total supply of labour of 53.5, the amount used for informal sector production is 30.5 units and the amount supplied to the market is 23 units.

Account 5, The household's income expenditure account indicates that the household's income of 53.5 units, 10 units are spent on the consumption of formal sector produced goods (3 units of *Cash Crop* and 7 units of *Food(F)*) and 38.5 units on informal sector produced goods(*Food(F))*, and 5 units are paid to the government.

External balance account indicates that the household's formal sector income of 23 units is used to purchase 18 units of formal sector goods and to pay 5 units to the government.

Figure 1: The structure of household preferences imbedding the informal sector production



The parameter values for the fully specified model are provided in *Table 1.*

Table 1: Parameter values of the parameterised model

Elasticity of substitution for the formal sector food production technology s^3	1
Elasticity of substitution for the informal sector food technology: σ^{11}	0,1
Elasticity of substitution between composite commodities, σ^2	1
Elasticity of substitution between pure leisure and consumption, σ^3	0,8

The corresponding matrix of consolidated, compensated demand elasticities is provided in *Table 2*. These elasticities may be compared with elasticities obtained from estimating complete demand systems on market data using standard econometric methods.

Table 2: Consolidated compensated demand and supply price elasticities

$\mathcal{E}_{ij}$	*Manufacturing*	*Cash crop*	*Food (F)*	*Labour*
Manufacturing	-0,239	0,032	0,075	0,131
Cash crop	0,086	-0,968	0,075	0,806
Food (F)	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 substitution elasticities specified in *Table 1* and the benchmark data on informal sector production and household consumption provided in *Annex 2 Table 7 and 8.*

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

We make no assumptions about the administrative costs associated with each tax structure as there is little empirical evidence on which to base such assumptions, but we expect on theoretical grounds $B(2) > B(3) > B(1)$ and $B(2) > B(4)$ (see Munk 2008).

The optimal tax systems for each of the tax structures, $\boldsymbol{\tau}^{j*}$, $j = 1, 2, 3, 4$, provided in *Table 3*, leave open the question of which tax system is the overall optimal. For Ξ^1, where the government's expenditures of 5 must be financed by a VAT at a uniform rate this rate is 32%. This tax system serves as benchmark for the comparisons of the social welfare achievable under the different tax-tariff regimes.

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(F)* 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. As the *Manufactured good* is complementary with the large (untaxed) use of the primary factor in the informal sector, the optimal tax on the consumption of the *Manufactured good* is at the relatively high rate of 45%, whereas the consumption of *Cash crop* and *Food(F)* is only taxed at 15%.

For Ξ^3, where the government's revenue requirement can be financed by a VAT at a uniform rate supplemented by border taxes, production efficiency is not desirable. We can here as for Ξ^2 as a matter of normalisation without loss of generality assume the export of *Food(F)* to be 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 the *Manufactured good* in the production of *Food(F)* . The optimal solution involves a VAT at a uniform rate of 19% supplemented by a tariff on the imports of the *Manufactured good* of 18%; this represent price wedge between the consumer price and the world market prices of 40%[15]. This due to the objective of limiting the distortion of the use of inputs in the production of *Food(F)*, lower than for $\boldsymbol{\tau}^{*2} \in \Xi^2$ where optimal VAT rate for the *Manufactured good* is 45%.

Finally, for Ξ^4, where the government's revenue requirement can be 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(F)* to be 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(F)* (*Objective 3*)[16]

Objective 2 draws, as in the case of Ξ^3, in the direction of a relatively high tariff on the imports of *Manufactured good. 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(F)*, the export good, but, on the other hand, that a relatively low tariff on the *Manufactured good* is desirable as it is used as intermediate inputs in the production of *Food(F).* With the current parameterisation we have assumed additive separability in

[15] 0,40 = (1+0,18)x(1+0,19) - 1

[16] 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.

consumption between the three produced commodities. This implies that that the *Manufactured good* and *Food(F)* are equally complementary with the consumption of *Food(F)* (see *Table 3,* $\varepsilon_{13} = \varepsilon_{23} = 0.075$) [17]. *Objective 2* of encouraging the supply of labour to the market dominates *Objective 3* of encouraging the exports of *Food(F)* with the result that the optimal tariff on the imports of *Manufactured good* at 52% is considerably higher than the tariff on *Cash crop* at 19%.

Table 3: Optimal tax-tariff systems and administrative costs

Optimal tax-tariff system		$\tau^1 \in \Xi^1$	$\tau^{*2} \in \Xi^2$	$\tau^{*3} \in \Xi^3$	$\tau^{*4} \in \Xi^4$
Domestic tax rates					
Manufactured good	t_1	0,32	0,45	0,19	0,00
Cash crop	t_2	0,32	0,15	0,19	0,00
Food (F)	t_3	0,32	0,15	0,19	0,00
Labour	t_0	0,00	0,00	0,00	0,00
Border tax rates					
Manufactured 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 (F)	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 $\tau^1 \in \Xi^1$ ***(as share of benchmark factor income in the formal sector)***		0	0,58%	0,43%	-0,31%

To give an idea of the size of administrative costs required to balance the benefits in terms of a more efficient resource allocation, we calculate the savings in administrative costs required to make the optimal tax systems under the tax structures Ξ^j, $j = 2,3,4$ respectively, equivalent in welfare terms to that with a proportional VAT, τ^{*1}. These results are reported in *Table 4*. [18] The increase in administrative costs associated with Ξ^2 compared with Ξ^1 which makes τ^{*2} equivalent to τ^{*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 τ^{*3} equivalent to τ^{*1} is 0,29%, whereas the administrative costs associated with Ξ^4 need to be at least 0,35% lower to make τ^{*4} equivalent to τ^{*1}. Therefore, border taxes are desirable as an alternative or as a supplement to a VAT system if compared with Ξ^1 the administrative costs associated with 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.

Table 4: Administrative costs making $\tau^{*i} \sim \tau^{*1}$

Optimal tax-tariff system	$\tau^1 \in \Xi^1$	$\tau^{*2} \in \Xi^2$	$\tau^{*3} \in \Xi^3$	$\tau^{*4} \in \Xi^4$

[17] However, this is an artefact of the parameterisation of the model. The CGE model may easily be modified to represent that a relative low tariff on the *Manufactured good* will be desirable to encourage the production, and thus the export of *Food(F)*.

[18] The figures differ from the EVs reported in *Table 3*, as they have been calculated taking the administrative costs of taxation into account.

Required saving of administrative costs as share of factor income in formal sector in benchmark	0	0,48%	0,29%	-0,35%

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 government's requirement increases from 5 units of labour (as has been assumed in calculating the results reported above) to 10 units, the saving in administrative costs needed to finance the government's revenue requirement solely by border taxes rather than by a VAT at a uniform rate increases more than threefold from 0,35% to 1,15% of the value added in the formal economy.[19] As the share of the government budget in GNP is far greater in developed countries than in developing countries the cost of financing government expenditures only by border taxes would be far higher in developed countries than in developing countries, explaining why developed countries do not use tariffs to raise government revenue whereas developing countries do.

The model simulations thus highlights that one cannot a priori based solely on theoretical considerations exclude that border taxes are desirable. 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 value added in the formal economy. As knowledge about these aspects are largely insufficient to settled the disagreement between Stiglitz and the Bretton-Woods sister organisations on whether or not 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).

6. Summary and concluding remarks

We have considered Stiglitz' (2003) proposition 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 embedded in the utility function 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 (1971) Production 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 when a VAT is defined as the term is used in practice, even if informal sector production is associated with profit.

However, when administrative costs are taking into production efficiency and free trade may not be desirable. We have provided a quantitative illustration of 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

[19] 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.

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, a point which has been elaborated 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 important role for whether, based on efficiency considerations, it is desirable to supplement a VAT with border taxes.

The simulation results have highlighted that the question of whether border taxes are desirable or not is very complex with the answer 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. This suggests assistance to developing countries to reduce the costs of tax administration has a double impact on growth. Recommendations for VAT made on this basis will however be less convincing if free trade is mainly justified with reference to text book models which ignore the administrative costs of taxation, as has often been the case. For the economic advice to be credible, it is important that recommendations are seen as based on facts, rather than ideology.

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Annex 1: The partial equilibrium model employed by Keen

The purpose of this Annex is to document 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 the main text.

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 the *Manufactured good* and the second to *Food(F)*, Keen's model may be interpreted as a special case of our model, explicitly representing the *Manufactured good* imports and the production of *Food(F)* in the formal sector and the competing production of *Food(I)* in the informal sector. Keen (2006) assumes the production of *Food(I)*, (C_1 in our notation and *Y* in Keen's notation), to be a perfect substitute for *Food(F)*, (y_3 in our notation and *y* in Keen's notation), whereas in our model they 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 the *Manufactured good*, 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 the *Manufactured good*, T_M and T_W the tariff rate and the VAT rate, respectively, applied to the *Manufactured good* 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 $\rho T_V = T_W$, such that the tax-inclusive import price of the *Manufactured good* 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 $\left(t_i + p_i\right)/p_i = \bar{T}$, $i = 1, 2, 3$). The price of *Food(F)*, (q_3 in our notation, Q plus the VAT rate in Keen's notation), is in Keen's model equal to the price of *Food(I)*, (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(F)*, in Keen's notation $C(\rho, Y)$, is in our notation $c^3\left(p_0, p_1; s^3\right) y_3$.

As pointed out in the main paper, also in the case of untaxed profit in the informal sector, production efficiency and thus free trade is desirable if all domestic market transactions can be taxed at no cost. In contrast to what is assumed in Piggott and Whalley (2001) and in Stiglitz and Emran (2005), both the model employed in Munk (2008) and in this paper, the informal sector consumption of commodities produced in the formal sector are purchased at consumer prices. However, in Munk (2008) no intersectional consumption is assumed; a VAT is therefore in that article, in contrast to in the present paper, similar to a consumption tax.

Annex 2: The DUAL SAM

We define a DUAL SAM as a Social Accountancy Matrix (SAM) which allows the representation of the production technology and taxation for similar products, e.g. food produced in the informal economy and in the formal economy to differ. The DUAL SAM provides the bench mark data required to calibrate the theoretical model specified in the main text. The DUAL SAM organizes a number of sub-matrices (see *Table 1*) defined on sets indicating production sectors, institutions and transactions (see *Table 2*).

Annex 2 Table 1: **SAM sub-matrices**

OUT-F(ACTF,COMF)	Outputs produced in formal sector at market prices (reference prices)
OUT-I(ACTI,COMF)	Outputs produced in informal sector at market prices (reference prices)
INP-FF(COMF,ACTF)	Intermediate inputs from the formal sector used in the formal sector at market prices (reference prices)
INP-IF(COMF,ACTI)	Intermediate inputs from the formal sector used in the informal sector at market prices (reference prices)
INP-II(COMI,ACTI)	Intermediate inputs from the informal sector used in the informal sector at market prices (reference prices)
INPT(COMF,ACTI)	Taxes on intermediate inputs from the formal sector used in the informal sector
PRIM-F(FAC,ACTF)	Domestic use of primary factors used in the formal sector at market prices (reference prices)
PRIM-I(FAC,ACTI)	Domestic use of primary factors used in the informal sector at market prices (reference prices)
CON-F(COMF,INSTP)	Households' consumption of commodities produced in the formal sector at market prices (reference prices)
CON-I(COMF,INSTP)	Households' consumption of commodities produced in the informal sector at market prices (reference prices)
CONT(COMF,INSTP)	Taxes on household consumption of commodities produced the in formal sector
PRIMG(FAC,INSTG)	Government consumption of primary factors at at market prices (reference prices)
TAR(INSTG,COMF)	Import tarifs
WIMP(RW,COMF)	Imports at world market prices
TAXC(INSTP,COMF)	Government revenue from commodity taxes
EXP(COMF,RW)	Exports at market prices (reference prices)
EXPT(COMF,RW)	Taxes on exports
INC(INSTP,FAC)	Factor income at household prices
TAXY(INSTG,FAC)	Government revenue from income taxes
TRGH(INSTP, INSTG)	Transfers from government to private institutions

***Annex 2 Table 2*: Set on which SAM sub-matrices are defined**

ACT-F	Formal sector production activities (Sectors)
ACT-I	Informal sector production activities (Sectors)
COM-F	Commodities produced in the formal sector
COM-I	Commodities produced in the informal sector
FAC	Primary factors
INSTP	Private institutions (Households)
INSTG	Government institutions
RW	Foreign institutions (Rest of the World)

The DUAL SAM (see Table 3) defines the following 9 account types:

1F Formal sector production accounts
1I Informal sector production accounts
2F Supply-utilization accounts for commodities produced in the formal sector
2I Supply-utilization accounts for commodities produced in the informal sector
3 Commodity tax accounts
4 Primary factor accounts
5 Income-expenditure accounts of private households
6 Income-expenditure accounts of government institutions
7 Foreign accounts

***Annex 2 Table 3:* The DUAL SAM framework**

			1F	**1I**	**2F**	**2I**	**3**	**4**	**5**	**6**	**7**
			ACT-F	ACT-I	COM-F	COM-I	COM	FAC	INSTP	INSTG	RW
Production,	**1F**	ACT-F			**OUT-F**						
Supply	**1I**	ACT-I				**OUT-I**					
Utilization	**2F**	COM-F	**INP-FF**	**INP-IF**					**CON**		**EXP**
And	**2I**	COM-I		**INP-II**					**CONI**		
Tax Accounts	**3**	COM	**INPT-FF**	**INPT-IF**					**CONT**		**EXPT**
	4	FAC	**PRIM-F**	**PRIM-I**						**PRIMG**	
Income and	**5**	INSTP						**INC**			
Expenditures	**6**	INSTG			**TAR**		**TAXC**	**TAXY**	**TRNHG**		
Accounts	**7**	RW			**WIMP**						

An account type with a given number corresponds to the row and the column with the same number in the DUAL SAM. Each account type consists of one or more individual accounts. For example, the supply-utilization accounts 2F consist of accounts for each commodity produced in the formal sector, i.e. for each element in COM-F.

From the DUAL SAM we are able to derive a SAM for the formal economy *SAM-F* (see *Table 4*) which represents production of firms which may be taxed, and accountancy matrix for the household sector *HAM* (see *Table 5*) which represents the production of firms and households which are not subject to taxation.

The SAM-F may be derived from the DUAL SAM by

1. Deleting the *Accounts 1I* which represent informal sector production
2. Redefining *Accounts 2F,* defining **TCON-F** = **INP-IF + CON-F** as the purchases of intermediate input for informal production and household consumption, produced in the formal sector, such that

   OUT-F+TAR+WIMP= INP-FF + TCON-F + **CONG** + **EXP**
3. Redefining *Accounts 3,* defining **TCONT-F** = **INPT-IF + CONT-F** as the tax on purchases of intermediate input for informal production and household consumption, produced in the formal sector, such that

   TAXC= **TCONT-F** + **EXPT**
4. Redefining *Accounts 4,* defining **INC-F** as the income derived from primary factors employed in the formal economy net of income tax, such that

   PRIM-F=**INC-F + TAXY**

Annex 2 Table 4: **SAM-F, the SAM for the Formal Economy**

			1F	**2F**	**3**	**4F**	**5**	**6**	**7**
			ACT-F	COM-F	COM-F	FAC	INSTP	INSTG	RW
Production,	**1F**	ACT-F		**OUT-F**					
Supply-	**2F**	COM-F	**INP-FF**				**TCON-F**	**CONG**	**EXP**
utilisation and	**3**	COM-F	**INPT-FF**				**TCONT-F**		**EXPT**
Tax accounts	**4F**	FAC	**PRIM-F**						
Income and	**5**	INSTP				**INC-F**			
Expenditures	**6**	INSTG		**TAR**	**TAXC**	**TAXY**	**TRNHG**		
Accounts	**7**	RW		**WIMP**					

Annex 2 Table 5: **The data for SAM-F (Aggregate)**

			1F	2F	3	4F	5	6	7
			ACT-F	COM-F	COM-F	FAC	INSTP	INSTG	RW
Production	**1F**	ACT-F		**20**					
and	**2F**	COM-F	**2**				**18**	**0**	**13**
Supply	**3**	COM-F	**0**				**0**		
Utilisation	**4F**	FAC-F	**18**					**5**	
Income and	**5**	INSTP				**23**			
Expenditures	**6**	INSTG			**0**	**0**	**5**		
	7	RW		**13**					

Annex 2 Table 6: Supply utilisation accounts data for the formal economy (Accounts 2F)

	Formal Sector Output			**Formal Sector Intermediate Consumption**			**Net trade**		
	Manu factured	**Cash crop**	**Food(F)**	**Manu factured**	**Cash crop**	**Food(F)**	**House hold**	**Govern ment**	**RW**
Manufactured good	0			0	0	-2	-8	0	10
Cash crop		0		0	0	0	-3	0	3
Food(F)			20	0	0	0	-7		-13

The HAM may be derived from DUAL SAM by

1. Deleting the *Accounts 1F* which represent formal sector production
2. Redefining *Accounts 2F* such that

   TCON-F = INP-IF + CON-F
3. Redefining *Accounts 3*, such that

   TCONT= INPT-F + CONT
4. Redefining *Accounts 4*, such that

   INC= PRIM-I+INC-F

5. Defining an auxiliary *Accounts* representing the household/informal sectors transactions with the rest of the economy

   INC-F= TCONF+TCONT+TRNHG

Annex 2 Table 7: **HAM, the Accountancy Matrix for the Household Sector**

			1I	2IF	2II	3I	4	6	AUX
			ACT-I	COM-F	COM-I	COM-F	FAC	INSTP	
Production,	**1I**	ACT-I			**OUT-I**				
Supply utilization	**2IF**	COM-F	**INP-IF**					**CON-F**	
and tax	**2II**	COM-I	**INP-II**					**CON-I**	
accounts	**3I**	COM-F	**INPT-IF**					**CONT**	
	4	FAC	**PRIM-I**						**INC-F**
Income and	**6**	INSTP					**INC**		
expenditure	**AUX**			**TCON-F**		**TCONT**		**TRNHG**	

Annex 2 Table 8: **The data for HAM**

			1I	2F	2I	3	4	6	AUX
			ACT-I	COM-F	COM-I	COM	FAC	INSTP	
Production	**1I**	ACT-I			38,5				
Supply	**2IF**	COM-F	8					10	
utilization	**2II**	COM-I						38,5	
and	**3**	COM	0					0	
Taxation	**4**	FAC	30,5						23
Income and	**6**	INSTP					53,5		
expenditure	**AUX**			18		0	0	5	

Annex 2 Table 6: Supply utilisation accounts data for the informal economy (Accounts 2I)

	Informal Sector Output	**Informal Sector Intermediate input**	**Household**	**Rest of the economy**
	Food (I)	**Food (I)**	**Final Consumption**	**Net trade**
Manufactured good	0	-8	0	8
Cash crop	0		-3	3
Food (F)			-7	7
Food (I)	38.5		-38.5	0

The data used to establish SAM-F and HAM are in general obtained by quite different methods. In general, tax collection and other administrative tasks generate data which may be used to estimate SAM-F, whereas the construction of the HAM requires statistical surveys.

The behaviour generating the data represented in SAM(F) may also be quite different from that represented in the HAM. Production in the formal economy may be guided mainly by the profit motive, whereas production in the informal economy may be influenced by social norms, e.g. norms to secure the provision of local public goods and the internalisation of externalities. It may thus be appropriate for a given economy first to estimate the SAM(F) and the HAM separately, and only then impose consistency between the two in the form of a DUAL SAM.