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an Informal Sector**

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Tariffs Versus VAT in the Presence of Heterogeneous Firms and an Informal Sector*

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Abstract

The debate over the use of tariffs or value added taxes in developing countries has focused on the difficulty of collecting VAT from the informal sector of the economy. This paper contributes by considering this issue with heterogeneous firms and endogenous entry. This yields two new results. First, a cut in the tariff in and of itself can reduce the size of the informal sector. Second, the imposition of a VAT need not increase the number of informal firms. In fact, for many parameterizations of the model, higher VAT reduces informality. Despite this, whether a revenue neutral shift from tariffs to VAT increases or decreases welfare depends on the parametrization. Therefore while this move may be welfare improving in some cases, it is not a one-size fits all policy.

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1 Introduction

The list of challenges facing developing countries includes, like all nations, the need to raise government revenues to provide for public expenditures. Developing nations, more so than their wealthier counterparts, are hindered in this by the presence of a large informal sector from which it is difficult to collect taxes.¹ This has led them to seek alternative tax bases that are easier to target. Chief among these are imported goods since trading firms can be assessed tariffs as they enter the country through (relatively) well monitored ports. In contrast to developed countries, as shown in Table 1, tariffs in the developing world form a large part of their government revenues. In the current era of globalization, however, this has come under fire both from free trade proponents as well as those favoring potentially less distortionary taxes such as value added taxes (VAT). Since tariffs apply only to foreign firms but VAT applies evenly to domestic and foreign firms, authors such as Keen (2008) suggest that a movement from tariffs towards VAT would reduce distortions and increase welfare.² This has been countered by Piggott and Whalley (2001) and Emran and Stiglitz (2005), who suggest that an increase in the VAT would encourage domestic firms to switch from the formal to the informal sector, a move that reduces the effectiveness of the VAT in developing countries and causes distortions that lower overall welfare.

The goal of this paper is to compare these two effects in a model where imperfectly competitive firms differ in their productivities and where the number of firms is endogenous. This approach was popularized by Melitz (2003) and has been applied to a number of issues including optimal tariffs (Cole and Davies, 2009), subsidies for FDI (Chor, 2009), tax competition for FDI (Davies and Eckel, forthcoming), and payroll taxes with informal labor markets (Paz, 2009). Doing so has several advantages and yields additional insight into the impact a shift from tariffs towards VAT would have. In particular, we show three things.

¹Estimates provided by Schneider and Enste (2000) suggest that the informal sector in developing nations is 39 percent of GDP. In contrast, it amounts to 12 percent of GDP in developed countries.

²Ebrill, et. al (2001) and Bird and Gendron (2007) provide overviews of the use of VAT in developing countries.

First, a cut in the tariff leads to a contraction in the informal sector due to an influx of new foreign competitors.³ Second, when the VAT penalty is increasing in the VAT rate (as is done in practice), a rise in the VAT can further reduce the size of the informal sector due to an increase in the expected penalty. Therefore it need not be the case that a shift from tariffs towards VAT will increase the size of the informal economy. Finally, we show that even in the context of our model, that the impact of this shift is complex since these two instruments result in complex and conflicting impacts on the numbers and outputs of different types of firms. Therefore the welfare and revenue impacts of implementing such a change are likely to be country specific.

These new results come from three key aspects of our endogenous entry with heterogeneous firms model. First, in contrast to the perfectly competitive settings of Piggott and Whalley (2001), Emran and Stiglitz (2005), and Boadway and Sato (2009), this is a model of imperfect competition. This is important because, as discussed by Keen and Ligthart (2002), many of the welfare predictions regarding tariffs versus VAT can change dramatically when imperfect competition is introduced. One such impact is that we find that a tariff reduction lowers domestic VAT receipts because of the additional competition from foreigners reduces output from domestic firms. Second, with endogenous entry, changes in the set of firms active in a country (due, for instance to a change in tariffs or in the VAT) creates selection effects, changing the mass of firms and average productivities a heretofore unrecognized impacts of a shift from tariffs towards VAT. Analysis of these benefits has been a central part of the recent trade theory building from Melitz (2003). One implication of this is that a tariff reduction reduces entry of informal firms. This combined with the first result is why a tariff reduction reduces size of the informal sector, a factor that has not been discussed previously in the literature. Third, heterogeneity allows firms to self-select into the formal and informal sectors without a knife-edge result wherein all firms are indifferent between the two (such as Boadway and Sato (2009)) or an exogenous assignment of firms to

³Note that consistent with the debate, we consider a unilateral reduction in the developing, home country's tariff, not a coordinated tariff reduction resulting from a trade agreement.

formal or informal sectors (such as Emran and Stiglitz (2005)).⁴ If the probability that an informal firm is caught avoiding the VAT is increasing in output or profits, both of which are positively correlated with productivity, we find that the most productive, largest, and profitable firms will endogenously choose to be formal and pay their VAT with small, informal, low-productivity firms choosing the informal route. However, since even informal firms face a probability of detection, changes in the VAT still impacts their output decisions with higher VAT often leading to lower output. In fact, in some parameterizations, an increase in the VAT can itself reduce the size of the informal sector (a result found in many of our simulations), a possibility missing from the literature.

In addition to these results, the model highlights important differences between the effects of tariffs and VAT. Since tariffs only impact domestic firms through competition whereas VAT also impacts them directly, the various forces at play result in conflicting effects on competition and government revenues. For example, a revenue neutral increase in the VAT has two conflicting effects on domestic firms. First, a rise in the VAT increases the costs for domestic formal firms. Similarly, since an increase in the VAT increases the penalty should an informal firm be caught, it increases expected costs for informal firms. These effects lower output by all domestic firms, regardless of their formality. It also leads to the exit of low-productivity domestic firms. Similarly, the VAT increases the cost to foreign exporters, reducing the number of exporting firms and the selling price for those that remain. This reduction in foreign competition also has an indirect effect on domestic firms, however, tending to increase their output and profits. The net effect of a VAT increase is therefore ambiguous. Tariffs, however, only affect domestic firms through this second effect. Thus, as demonstrated by our simulation results, it is possible for a tariff reduction to decrease the size of the informal sector while a VAT increase could increase it. Therefore the impact of a revenue neutral shift from tariffs to VAT is a complex and theoretically ambiguous affair.

These changes in the number of firms and their output then feed directly into welfare

⁴Piggott and Whalley (2001) avoid the knife edge by considering agents that split time across sectors where decreasing returns yield internal solutions.

through three channels: the price consumers pay, the number of varieties available to them, and aggregate income. As noted by Cole and Davies (2009), more productive firms form a larger part of the consumer's consumption basket because their lower costs mean that they have lower prices. As a result, lowering tariffs benefits consumers because the price reduction on high-productivity imports outweighs the loss in the number of varieties. Chor (2009) provides a comparable rationale for FDI subsidies. Thus, consistent with the argument of Keen (2008), lowering the tariff reduces distortions. However, as asserted by Emran and Stiglitz (2005), a revenue neutral increase in the VAT is not without its own distortions. As with the tariff reduction, depending on the parameters of the model, the increase in the VAT can reduce the number of varieties available to consumers. Furthermore, unlike the tariff reduction, the VAT increase raises prices on all varieties, including those for domestic firms. This includes the most productive domestic firms, formal firms that comprise the bulk of the heterogeneous goods production. This has a negative welfare impact. Finally, it must be remembered that in addition to these changes, movements in tariffs or VAT also impact the profitability of domestic firms, resulting in changes to aggregate domestic income and welfare.

Because of the conflicting impacts of the VAT and the complexity of the model, we use simulation results to compute the effects arising from a revenue neutral shift from tariffs to VAT. First, we find that the size of the informal sector is generally falling in the VAT, i.e. the direct cost effect of a VAT increase outweighs the indirect competition effect. This demonstrates that it is not always the case that a movement from tariffs to VAT increases informality. Second, the move from a tariff to a VAT causes an ambiguous change in welfare. When this switch leads to increases in imports and improvements in consumer surplus arising from more and cheaper imported varieties, this outweighs the negative effects caused by VAT distortions and welfare improves. When those benefits are small, welfare tends to fall. This latter case tends to dominate when countries are closed, VAT rates are initially low, and the elasticity of substitution among varieties is high. This then suggests that although the move

recommended by Keen (2008) and others can indeed increase welfare, it is not a one size fits all policy. Therefore care must be exercised when applying it to a given country.

The paper proceeds as follows. Section 2 lays out the model and describes the equilibrium for given tariffs and VAT. Section 3 discusses how this equilibrium changes in the two policies. Section 4 utilizes simulations of the model to analyze the impact of a revenue neutral shift from tariffs towards VAT. Finally, Section 5 concludes.

2 The Model

Consider a setting with two countries, Home and Foreign. Foreign variables will be denoted by *. Our goal is an analysis of a shift from tariffs to VAT in the home country. Since the situation in foreign is analogous to that in home and not our primary focus, we will refer to the foreign case only insofar as it influences the equilibrium in home. Also, for expositional purposes, we will use the term “domestic” to refer to home. Each country produces two goods, Y , a numeraire, and X , a differentiated good. In addition, each country provides a publicly-provided good G to its citizens.

2.1 Consumers

Preferences are identical across consumers and countries. The normative representative consumer maximizes a quasi-linear utility function that is additively separable in Y , X , and G . Furthermore, for X preferences exhibit the Dixit-Stiglitz “love for variety”. This utility function is:

$$U_k = \mu \ln(X) + \mu_G \ln(G) + Y, \quad X = \left(\int_{i \in \Omega} x(i)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}} \quad (1)$$

where μ and μ_G are positive, $\sigma > 1$ is the elasticity of substitution, and Ω is the set of varieties available to home consumers (either from domestic production or imports). ⁵Aggregate

⁵One interpretation of the publicly provided good is that the government uses revenues to purchase the numeraire which is then converted into a consumption good under constant returns to scale. This more complex setup would amount to this formulation for utility.

demand is equivalent to maximizing the representative consumer's utility subject to a budget constraint:

$$\int_{i \in \Omega} p(i)x(i)di + Y_k \leq I \quad (2)$$

where I is the aggregate income arising from wages and the profits of domestically-owned firms. We assume that parameter values are such that in equilibrium both the differentiated product X and the numeraire Y are consumed in positive amounts.⁶ The solution to this problem yields a demand function for the differentiated good of variety i :

$$x(i) = P^{\sigma-1}p(i)^{-\sigma}\mu \quad (3)$$

where $P = (\int_{i \in \Omega} p_k(i)^{1-\sigma} di)^{\frac{1}{1-\sigma}}$ is the home price index. Intuitively, this is the cost of buying one unit of X , taking into account the optimal amount purchased of each variety. Further, the quasi-linearity of the utility function is such that total expenditure on the differentiated good is equal to μ . This constant expenditure on the differentiated good is a useful property of the quasi-linear preference relationship since it eliminates feedback income effects from changes in tariffs and taxes. This allows us to focus exclusively on how they impact the market through firm choices while setting aside the differing income effects arising from the fact that the VAT directly affects the profit of domestic firms whereas tariffs do so only indirectly.⁷ A foreign demand curve can be derived that is analogous to (3).

2.2 The Numeraire Sector

The numeraire sector, Y is produced under constant returns to scale where units are normalized so that the unit labor requirement is equal to one. The good is freely traded and sold under perfect competition at a constant price of one. This results in an equilibrium

⁶Note that with quasi-linear preferences and a representative consumer, this assumes that all consumers have at least a minimal level of income.

⁷The simplifying properties of the quasi-linear preference structure have been exploited by Chor (2009), Cole and Davies (2009), and others.

wage rate equal to one. For simplicity we assume that in equilibrium, parameter values are such that the numeraire is produced in each country.

2.3 The Differentiated Product Sector

The differentiated product sector is characterized by a continuum of monopolistically competitive firms. This differs considerably from Piggott and Whalley (2001), Emran and Stiglitz (2005), and Boadway and Sato (2009) who assume perfect competition. In a model with homogeneous but imperfectly-competitive firms, Keen and Ligthart (2002) demonstrate that the welfare effects of tariffs and VAT can be quite different than when perfect competition is assumed. Therefore we too utilize imperfect competition. Each firm i is exogenously assigned a productivity parameter $a(i)$ which is distributed according to a c.d.f. function $G(i)$ with associated p.d.f. $g(i)$.⁸ ⁹ This productivity parameter is equal to the unit labor requirement, and thus the marginal unit cost, of the firm. This is increasing in i . In addition to production costs, firms require labor to cover fixed costs. With knowledge of its productivity parameter, the firm must make two choices: which markets to serve (the local market, the overseas market through exports, both, or neither) and whether to do so formally (i.e. pay the VAT rate v) or informally (and run the risk of being caught out).¹⁰ Since firm decisions are analogous in both countries, we will derive the home firm results and note the differences when necessary.

⁸For expositional purposes, we will often refer to an index i as representing a single firm rather than a mass of firms, however, this is just to make for a smoother, more intuitive discussion of the model's components.

⁹It is common in heterogeneous firm models to have entrepreneurs draw from this distribution of productivities at a cost. The advantage to this is that potential entrepreneurs continue to take draws until the expected profit of doing so is zero, implying that in equilibrium, total firm profits sum to zero. This, however, adds complications to the model impeding tractability. Since our quasi-linear preferences remove some of the burden that positive equilibrium profits create, we use this alternative approach. Nevertheless, as discussed by Cole (2008) and Jørgensen and Shröder (2009) the two approaches yield generally comparable results.

¹⁰Some models of this type (e.g. Helpman, Melitz, Yeaple (2004) also include the choice to engage in foreign direct investment. Since developing countries receive little FDI, and to simplify the analysis, we ignore this option.

Supposing that firm i is formal, its profit from serving the domestic market is:

$$\pi_{dom}^{formal}(i) = (1 - v)p(i)q(i) - (a(i)q(i) + F). \quad (4)$$

where F is its fixed cost and v is the VAT. Note that since the firm's only input is labor, the VAT amounts to a revenue tax. Using (3), this yields equilibrium price, quantity and profits of:

$$p_{dom}^{formal}(i) = \Psi(1 - v)^{-1}a(i) \quad (5)$$

$$q_{dom}^{formal}(i) = (\Psi(1 - v)^{-1}a(i))^{-\sigma} P^{(\sigma-1)}\mu \quad (6)$$

$$\pi_{dom}^{formal}(i) = (1 - v)^\sigma \sigma^{-1} (\Psi a(i))^{1-\sigma} P^{(\sigma-1)}\mu - F \quad (7)$$

where $\Psi \equiv \frac{\sigma}{(\sigma-1)}$. Note that both quantity and profit are decreasing in i , i.e. the most productive firms are the largest and most profitable. In addition, note that the equilibrium domestic output of a formal firm is decreasing in the price index.

In addition to serving the domestic market, firm i can choose to export to the foreign market.¹¹ In order to do so, the firm must pay a fixed cost $F_x > F$. In addition, following standard practice, an exporter is exempt from the domestic VAT but must pay the foreign VAT v^* . Furthermore, they face an ad valorem tariff τ^* on their exports. Using the foreign version of (3), this results in an equilibrium price, quantity, and profit of:

$$p_{exp}^{formal}(i) = \Psi(1 + \tau^*)(1 - v^*)^{-1}a(i) \quad (8)$$

$$q_{exp}^{formal}(i) = (\Psi(1 + \tau^*)(1 - v^*)^{-1}a(i))^{-\sigma} P^{(\sigma-1)}\mu \quad (9)$$

$$\pi_{exp}^{formal}(i) = (1 - v^*) (1 + \tau^*)^{-1} \sigma^{-1} \left(\Psi \frac{(1 + \tau^*)}{(1 - v^*)} a(i) \right)^{1-\sigma} P^{*(\sigma-1)}\mu - F_x. \quad (10)$$

¹¹Munk (2008) considers a small country Ricardian model where the home country completely specializes in the production of one good. As the country is small and markets are perfectly competitive, he concludes that VATs dominate tariffs depending on the costs of implementation. This analysis differs from ours in many ways, not the least of which is that we do not have complete specialization even for a small country.

We assume that the home country is small in the Flam and Helpman (1987) sense that it cannot influence the number of foreign firms. Given that our focus is on developing countries, we feel this is appropriate in the present context. For future use, we also present the analogous condition for foreign exporters to home:

$$\pi_{exp}^{*formal}(i) = (1 - v)(1 + \tau)^{-1} \sigma^{-1} \left(\Psi \frac{(1 + \tau)}{(1 - v)} a(i) \right)^{1-\sigma} P^{(\sigma-1)} \mu - F_x \quad (11)$$

Alternatively, a firm can choose to be informal. In this case, they do not pay the VAT unless they are caught, which happens with probability $\eta(i)$ which is decreasing in their index.¹² Since firms with low indexes produce more and have higher profits, this means that the largest, most productive, most profitable firms are also the most likely to be caught. For simplicity, we assume that $\eta(0) = 1$, i.e. the most productive firm is caught with certainty if they attempt to avoid the VAT. In addition, we assume that firms that engage in international trade (be they home or foreign exporters) are also caught with certainty should they attempt to avoid the VAT. This is functionally comparable to Keen (2008) who assumes that informal goods are by definition non-tradable.¹³ If a firm is caught attempting to evade the VAT, consistent with common practice, they must pay their taxes as well a penalty that is proportional to the VAT.¹⁴ Thus, an informal firm i 's expected VAT rate is $v_I(i) = \eta(i)\phi v$ where $\phi > 1$.¹⁵ Thus, an informal firm's profits from the domestic market are:

$$\pi_{dom}^{informal}(i) = [(1 - v_I(i))p(i)q(i) - (a(i)q(i) + F)] - \theta(i) \quad (12)$$

¹²We could also make $\eta(i)$ a function of some costly government enforcement and then endogenize this choice. One way to interpret our given results would be to introduce a loss to government revenues representing the cost of a fixed level of government revenue. This would not change any of our results. When endogenized, this cost of enforcement would change the optimal mix of VAT and tariffs. Nevertheless, the impacts isolated here - namely the changes in productivity from switching - would remain.

¹³Boadway and Sato (2009) consider tradable informal goods in a homogenous firm model, however, they do not simultaneously consider tariffs and VAT.

¹⁴Typical values for the penalty are between ten and fifteen percent of the VAT owed

¹⁵Thus, informal firms pay positive VAT in an expected sense. This informal firm VAT payment is quite different from that analyzed by Keen (2008) in which informal firms pay VAT on some of their inputs which are themselves produced by formal firms.

which yield equilibrium prices, quantities, and profits of:

$$p_{dom}^{informal}(i) = (1 - v_I(i))^{-1} \Psi a(i) \quad (13)$$

$$q_{dom}^{informal}(i) = (1 - v_I(i))^\sigma (\Psi a(i))^{-\sigma} P^{(\sigma-1)} \mu \quad (14)$$

$$\pi_{dom}^{informal}(i) = (1 - v_I(i))^\sigma \sigma^{-1} (\Psi a(i))^{1-\sigma} P^{(\sigma-1)} \mu - F \quad (15)$$

Note that as with formal firms, the equilibrium domestic output of an informal firm is decreasing in the price index. We assume that

$$\eta'(i) \phi v \Psi^{-1} p(i) + a'(i) > 0 \quad (16)$$

and

$$\xi(i) = \sigma(1 - v_I(i))^{-1} a(i) \eta'(i) \phi v + (\sigma - 1) a'(i) > 0 \quad (17)$$

which ensure that informal firm quantities and profits are falling in i , that is, the expected VAT does not fall sufficiently as firms become less efficient so as to outweigh the increase in marginal production costs. This seems reasonable since it eliminates any incentive to operate at less the full productivity. Since exporters are caught with certainty, we do not derive profits for an informal exporter.

It is worth noting that since our VAT applies equally to all firms and the same tariff applies to all foreign exporters, a change in either variable is a comprehensive one, not the selective tax reform studied by Emran and Stiglitz (2005). Given that international convention is that taxes should be non-discriminatory, we adopt this approach. ¹⁶

2.4 Equilibrium Firm Cutoffs

With these equilibrium conditions, we can now describe the equilibrium cutoff indexes for each of the firm types. The home firm that is indifferent between being formal and informal

¹⁶For example, Article 24 of the OECD's model tax convention (2003) rules out discriminatory VAT.

is λ_f . This firm is the one such that the expected punishment for evading the VAT is equal to the VAT itself. We assume that this firm is sufficiently unproductive so that it would not choose to export even if it were formal.¹⁷ Therefore, equating the domestic profits of being a formal firm and the expected profits from being an informal firm, we find that:

$$\eta(\lambda_f)\phi = 1. \tag{18}$$

Note that λ_f depends only on ϕ , i.e. the proportion by which the penalty relates to the VAT, not on the level of the VAT. This is because the marginal firm is presumed to be viable as either a formal or an informal firm, i.e. an increase in the VAT does not increase the marginal firm's costs so much that it shuts down entirely. It is important to recognize that this implies that the index of this firm will not change with the VAT, not that the firm's output (or the size of the formal and informal sectors) does not change. Given the above assumptions, firms with indexes below λ_f will be formal while the rest will be informal. This implies that the most productive, largest, and most profitable firms will be formal while the smallest and least productive firms will operate informally. This is consistent with our anecdotal priors. Note that in our model, the driving force of firms to choose formality over informality is the likelihood of their being caught cheating, which is a function of their productivity which itself does not change with formality. Boadway and Sato (2009) alternatively assume that sectors (in which all firms are identical) face a productivity decrease if they become informal.¹⁸ Thus, in their model, sectors with the smallest productivity penalty are the most likely to become informal.

Using this, we can now describe firm N , an informal firm which is the last home firm to

¹⁷One could certainly consider the case where a firm would be indifferent between being a purely domestic informal firm or an exporting formal one. In this more complicated case, among other things, the foreign tariff would influence the formality decision. However, since in practice domestic formal firms do exist, we assume that this simpler holds in our model.

¹⁸Keen (2008) considers a single firm's choice, where the tradeoff is between the ability to reclaim VAT on purchased inputs versus the cost of paying the VAT itself. Since we do not have intermediate inputs in this model, this facet does not appear.

open for production. From (15), this is:

$$(1 - v_I(N))^\sigma \sigma^{-1} (\Psi a(N))^{1-\sigma} P^{(\sigma-1)} \mu = F. \quad (19)$$

We assume that in equilibrium, $N > \lambda_f$, i.e. there is a positive mass of informal firms. Also, from (19), note that if N is fixed, so too is P . As a result, our small country assumption that home cannot influence the number of foreign firms N^* requires that the foreign price index P^* is exogenous to home decisions.

Turning to the export decision, λ_x is the index of the firm for whom the variable profits from exporting just cover the fixed cost of doing so, i.e.:

$$(1 - v^*) (1 + \tau^*)^{-1} \sigma^{-1} \left(\Psi \frac{(1 + \tau^*)}{(1 - v^*)} a(\lambda_x) \right)^{1-\sigma} P^{*(\sigma-1)} \mu = F_x. \quad (20)$$

Note that since the foreign price index is a constant, λ_x is also non-responsive to the domestic policy variables.¹⁹ In addition, given our assumption on that the last formal firm λ_f does not export, $\lambda_x < \lambda_f$. Foreign exporters, however, do respond to home policies. Denote the index of the last foreign exporter with λ_x^* which, from 11, is given by:

$$(1 - v) (1 + \tau)^{-1} \sigma^{-1} \left(\Psi \frac{(1 + \tau)}{(1 - v)} a(\lambda_x^*) \right)^{1-\sigma} P^{(\sigma-1)} \mu = F_x. \quad (21)$$

Finally, using these cutoffs and the equilibrium prices, the equilibrium price index in home is:

$$P = \Psi \left((1 - v)^{\sigma-1} \beta(\lambda_f) + \beta_I(\lambda_f, N) + (1 - v)^{\sigma-1} (1 + \tau)^{1-\sigma} \beta(\lambda_x^*) \right)^{\frac{1}{1-\sigma}} \quad (22)$$

¹⁹This cutoff would depend on home policies if, for instance, the home government applied an export tax. As discussed by Piermartini (2004), export taxes are an important feature of developing country trade policy. We do not discuss them here for three reasons. First, given the independence of the export decision, their inclusion would not change the comparison of tariffs on imports and VAT. Second, export taxes are often applied to extract rent from foreign owned multinationals, a firm structure absent in our model. Third, for brevity's sake, in line with the literature we focus on tariffs and VAT.

where

$$\beta(\lambda) \equiv \int_0^\lambda a(i)^{1-\sigma} di$$

$$\beta_I(\lambda; N) \equiv \int_\lambda^N [(1 - v_I(i))^{-1} a(i)]^{1-\sigma} di$$

2.5 Government Revenues

Government revenues come from three sources: VAT payments from formal firms, VAT payments and penalties from caught informal firms, and VAT payments and tariffs collected on imports from foreign exporters. These are used to provide the publicly-provided good G under a balanced budget constraint. Thus, in equilibrium,

$$G = \int_0^{\lambda_f} vp(i)q(i)di + \int_{\lambda_f}^N \eta(i)\phi vp(i)q(i)di + \int_0^{\lambda_X^*} (v + \tau)p(i)q(i)di \quad (23)$$

or, plugging in the equilibrium prices and quantities:

$$G = \Psi^{1-\sigma} P^{(\sigma-1)} \mu \left[v(1-v)^{\sigma-1} \beta(\lambda_f) + \phi v \int_{\lambda_f}^N \eta(i)(1-v_I(i))^{\sigma-1} a(i)^{1-\sigma} di + (\tau+v)(1+\tau)^{-\sigma} (1-v)^{\sigma-1} \beta(\lambda_X^*) \right]$$

3 The Impact of Taxes on Firms

The policy debate has centered on a revenue neutral shift from tariffs towards VAT. In this section, we consider how a change in either home tariffs or the home VAT rate will affect the size of the formal sector, the size of the informal sector, and the number of exporters.

We do this to develop intuition on how these changes affect the different types of firms. In the next section, we utilize these results to analyze the welfare impact of a revenue neutral shift from tariffs towards VAT.

Since the export decision for home exporters depends on the foreign tariff, the foreign VAT and the number of foreign firms, the home export decision is independent of home tax policy. Furthermore, the marginal formal home firm depends on ϕ , the proportional penalty, not on the level of the VAT nor the tariff. Therefore the equilibrium in the home market is described by three variables, namely the last informal firm to enter (19), the last foreign exporter (21), and the home price index (22), and all three depend on the home VAT and tariff.

3.1 Tariffs

First, we consider the impact of a marginal reduction in the tariff rate.

Proposition 1. *A reduction in the tariff increases the mass of foreign exporters, reduces the mass of domestic informal firms, and lowers the home price index. This lowers the size of both the formal and informal sectors.*

Proof. For notational simplicity, define:

$$\begin{aligned}\Delta &= -(\sigma - 1)a'(\lambda_X^*)a(N)\Psi^{1-\sigma}P^{\sigma-1}\frac{d\beta_I(\lambda_f, N)}{dN} \\ &\quad - \xi(N)a(\lambda_X^*)\Psi^{1-\sigma}P^{\sigma-1}(1-v)^{\sigma-1}(1+\tau)^{1-\sigma}\frac{d\beta(\lambda_x^*)}{d\lambda_x^*} \\ &\quad - (\sigma - 1)a'(\lambda_X^*)\xi(N) < 0\end{aligned}$$

and

$$\kappa = \sigma \left(1 - \frac{(\sigma-1)}{\sigma} \frac{(1-v)^{\sigma-1}(1+\tau)^{1-\sigma}\beta(\lambda_x^*)}{[(1-v)^{\sigma-1}\beta(\lambda_f) + \beta_I(\lambda_f, N) + (1-v)^{\sigma-1}(1+\tau)^{1-\sigma}\beta(\lambda_X^*)]} \right) > 0$$

By direct calculation from the total differentials of (19), (21), and (22), we find that:

$$\frac{d\lambda_X^*}{d\tau} = \Delta^{-1}a(\lambda_X^*)(1 + \tau)^{-1}\sigma\{a(N)\Psi^{1-\sigma}P^{\sigma-1}\frac{d\beta_I(\lambda_f, N)}{dN} + \xi(N)\kappa\} < 0 \quad (24)$$

and

$$\frac{dN}{d\tau} = -\Delta^{-1}a(N)\Psi^{1-\sigma}P^{\sigma-1}(1-v)^{\sigma-1}(1+\tau)^{-\sigma}\{(\sigma-1)a'(\lambda_X^*)(\sigma-1)\beta(\lambda_x^*) + \sigma a(\lambda_X^*)\frac{d\beta(\lambda_x^*)}{d\lambda_x^*}\} > 0 \quad (25)$$

Further:

$$\frac{dP}{d\tau} = -\Delta^{-1}\xi(N)\Psi^{1-\sigma}P^\sigma(1-v)^{\sigma-1}(1+\tau)^{-\sigma}\left\{\frac{\sigma a(\lambda_X^*)}{\sigma-1}\frac{d\beta(\lambda_x^*)}{d\lambda_x^*} + (\sigma-1)a'(\lambda_X^*)\beta(\lambda_x^*)\right\} > 0 \quad (26)$$

Thus, a reduction in the tariff increases the number of firms exporting. This increases competition increasing the price index. In turn, the rising price index lowers profits for all home firms, driving the least productive informal firms from the market. Since the home firm that is indifferent between being formal and informal remains the same, this implies a decline in the mass of informal firms operating in home.

In addition, since the equilibrium quantities for formal and informal home firms are increasing in the price index, the decline in the price index lowers output by all home firms that remain open. Since the mass of formal firms remains constant but each produces less, a fall in the tariff lowers the size of the formal sector. Since both the mass and the output of informal firms decline, the tariff reduction shrinks the size of the informal sector.²⁰ \square

The intuition here is straight forward. When the tariff falls, this increases the variable profit of a foreign exporter operating in the home market. As a result, foreign exporters who formerly did not find the home market sufficiently profitable to warrant the fixed cost of entering home will now choose to do so. This increases competition in home, reflected in

²⁰Note that here we are specifically referring to informality in the differentiated goods sector. Thus, we are not considering changes in production of the numeraire which, since it is untaxed, could be interpreted as informal as well.

a decline in the price index. This increase in competition lowers the profits and output of all domestic firms, both formal and informal. For those informal firms that were just covering their costs before the decline in tariffs, this change leads them to exit the market.

This result highlights an aspect of the debate that has heretofore been unrecognized - a decline in the tariff itself can reduce the size of the informal sector. Note that it does this both by reducing the number of informal firms operating in home and by reducing the quantity produced by the informal firms that remain. Thus, the absolute size of the informal sector shrinks as the tariff declines. It is not possible, however, to analyze the size of the informal sector as a percentage of home production without additional assumptions. This is because the increased competition from lower tariffs also decreases output by formal firms. Thus, depending on the mass of formal and informal firms, i.e. the distribution of types, the net impact on the share of domestic production by the informal sector is contingent on the parametrization of the model.

Turning to government revenues, the net impact is equally ambiguous. This is the result of several conflicting effects. First, consider tax payments by the foreign exporters who were present in home before the tariff drop. The decline in the tariff obviously means that less is collected on their initial level of exports. However, the tariff drop also stimulates their exports, leading to a rise in VAT revenues from this group. In addition, the tariff decline encourages additional foreign firms to begin exporting to home, resulting in a further increase in both the tariff and VAT tax base. The net effect of these changes depends on the shape of $a(i)$, which affects the responsiveness the index of the last exporter (which has a further effect on the extent of competition and thus output by other firms), the distribution of productivities $G(i)$, which governs the relative masses of these different groups, and the level of the markup which depends on the elasticity of substitution σ . Thus, the net change in revenues from foreign firms is ambiguous (a result confirmed in the simulations of the next section).

Regardless of the net change in tax revenues from foreign firms, a decline in tariffs

will lower the tax take from domestic firms. The increased competition caused by the tariff reduction impacts domestically generated tax revenues through two channels. First, it drives out some domestic informal firms, some of which are caught and pay VAT and associated penalties. This effect would not arise in a model with a fixed number of firms, highlighting the importance of endogenous entry. Second, the decline in the price index lowers production by all domestic firms. This in turn lowers the VAT collected from both formal firms and those informal firms that remain. This impact would be missing in a model of perfect competition, illustrating the role of imperfect competition.²¹ Thus, when considering the total revenue impact of a tariff decline, for it to be positive, it not only requires that the additional VAT payments by foreign firms outweigh any decline in tariff revenues, it must be the case that this effect outweighs the decline in domestic VAT receipts. This may help to explain the findings of Devarajan, et. al (1999) and Baunsgaard and Keen (2005) which find that many countries experience net declines in tax revenues following trade liberalization.

3.2 VAT

Relative to the tariff, the implication of a VAT change is less clear because it has both a direct effect on domestic firms as well as an indirect one that results from the VAT's impact on foreign exporters. This is discussed in our second proposition.

Proposition 2. *An increase in the VAT reduces the mass of foreign exporters. It has an ambiguous effect on the mass of domestic informal firms and the price level. Finally, it reduces the size of the home formal sector but has an ambiguous effect on the size of home's informal sectors.*

²¹Keen and Ligthart (2002) also make this point in a simpler model.

Proof. By direct calculation from the total differentials of (19), (21), and (22), we find that:

$$\begin{aligned} \frac{d\lambda_X^*}{dv} &= \Delta^{-1} (1 - \eta(N)\phi) (1 - v_I(N))^{-1} (1 - v)^{-1} \sigma a(N) a(\lambda_X^*) \Psi^{1-\sigma} P^{\sigma-1} \frac{d\beta_I(\lambda_f, N)}{dN} \\ &+ \Delta^{-1} \xi(N) a(\lambda_X^*) (1 - v)^{-1} \\ &\left\{ 1 + (\sigma - 1) \Psi^{1-\sigma} P^{\sigma-1} \left(\int_{\lambda_f}^N [(1 - v_I(i))^{-1} a(i)]^{1-\sigma} di - \int_{\lambda_f}^N \left[\frac{(\phi\eta(i) - v_I(i))}{(1 - v_I(i))} (1 - v_I(i))^{\sigma-1} a(i)^{1-\sigma} \right] di \right) \right\} < 0 \end{aligned} \quad (27)$$

i.e. a marginal increase in the VAT drives away the last foreign exporter from the home market. Note that because λ_X^* falls from an increase in v , implying an increase in the productivity of the last foreign exporter, (21) implies that the equilibrium value of $(1 - v)^\sigma P^{(\sigma-1)}$ must fall as well. Note that this in turn reduces the quantity sold in home by foreign exporters, all of which are formal.

Turning to the last informal firm, and utilizing the ratio of (19) and (21) we see that:

$$\frac{dN}{dv} = \frac{\sigma a(N)}{\xi(N)} \left(\frac{\eta(N)\phi - 1}{(1 - \eta(N)\phi v)(1 - v)} \right) + \frac{(1 - \sigma)a(N)}{\xi(N)} \frac{a'(\lambda_X^*)}{a(\lambda_X^*)} \frac{d\lambda_X^*}{dv}. \quad (28)$$

The first term on the right-hand side is negative and represents the direct effect of the VAT. Since the VAT increase increases the penalty if caught and therefore expected costs, this reduces profits and tends to drive low productivity firms out of the market. This is somewhat offset, however, by the second term which captures changes in competition. Since the VAT hike drives exporters from the market this reduces competition and increases profits for home firms. This tends to encourage entry by low productivity firms just as it did in the tariff case. The net effect is in general ambiguous (a result confirmed by simulations in the next section).²² This ambiguity results in an ambiguous change in the price level. Inspection of (22) shows that the price index is decreasing in the VAT for a given set of firms.

²²One way to resolve the ambiguity is to assume that $\eta(i)$ is a step function under which above a certain i a firm has zero probability of detection, i.e. there comes a point at which a firm is so small and unprofitable that the government no longer bothers keeping an eye on them. In this case, the first term would be zero. Since $\frac{d\lambda_X^*}{dv} < 0$, this would imply that the mass of informal firms is strictly increasing in the VAT. However, since one of our contributions is to illustrate the conflicting effects the VAT has on informality, we maintain the assumption that all informal firms face some positive probability of detection.

However, it also depends on the masses of the different types of firms changes in which is ambiguous since dN/dv is also ambiguous. Note that although we know that $(1 - v)^\sigma P^{(\sigma-1)}$ falls from the VAT increase, this does not preclude a small rise in P .

Since the index of the last formal firm λ_f does not change with the VAT, to determine the change in the size of the formal sector, we need only consider the change in the output of a formal firm. Recall that from the change in the index of the last foreign exporter, we know that the equilibrium value of $(1 - v)^\sigma P^{(\sigma-1)}$ falls as the VAT rises. Recalling that a home formal firm's quantity for domestic sales is $q_{dom}^{formal}(i) = (\Psi(1 - v)^{-1}a(i))^{-\sigma} P^{(\sigma-1)}\mu$, this implies that the output of all home formal firms falls, shrinking the size of the formal sector.

Results for the informal sector are less clear and depend on three effects. Recall the output of an informal firm: $q_{dom}^{informal}(i) = (1 - v_I(i))^\sigma (\Psi a(i))^{-\sigma} P^{(\sigma-1)}\mu$. From this, we see the first effect, namely the direct effect of the VAT which increase costs for an informal firm, reducing its output. Second, changes in competition will affect the price index P thereby affecting output. As noted above, this effect is ambiguous. Unlike home formal firms, we cannot bypass this by relying on the fact that equilibrium value of $(1 - v)^\sigma P^{(\sigma-1)}$ falls with the VAT increase. The reason is that an informal firm only pays an expected VAT, not the full VAT. Thus the direct marginal effect on an informal firm from a VAT increase is less than it is for a formal firm. Further, more productive informal firms (who face a greater chance of detection) will respond more than less productive informal firms. If the probability of detection is sufficiently low, since we cannot rule out a small increase in the price index, we cannot rule out an increase in output by some informal firms. Third, there is the ambiguous change in the mass of informal firms. Therefore, we cannot determine the net effect of a VAT increase on the size of the informal sector. Likewise, the output of a formal firm depends on these first two effects. Thus, just as it is unclear how these conflicting effects work in the informal sector, it is unclear how they will impact the formal one.

□

Thus, as discussed and warned by Emran and Stiglitz (2005) an increase in the VAT reduces the size of the formal sector, both by reducing output of home formal firms and by restricting formal foreign firms. This does not, however, necessarily increase the size of the informal sector. This will depend on how the direct effect of an increase in the expected VAT payment (which reduces informal firm output) balances out against the indirect effects (which can increase informal firm output and/or the number of such firms). Whether or not an increase in the VAT will actually lead to a decrease in the size of the informal sector depends on the responsiveness of foreign exporters to the VAT. This ambiguity translates into ambiguity over the change in P with respect to v as well, leaving us unable to sign changes in the output of either formal or informal firms.

These results imply that a change in either policy has several impacts on home welfare above and beyond the obvious changes in government revenues and the publicly provided good. Cole and Davies (2009) and Chor (2009) consider the impact of tariffs in heterogeneous firm models similar to the current one but without a VAT (and thus no informal firms). They find that, depending on the parameterization of the model, unilaterally optimal tariffs can be negative. This result arises for two reasons. First, trade liberalization encourages a selection effect that shifts resources away from low productivity firms to high productivity firms, creating a large boost in output for the varieties that remain. Second, since exporters are productive they have lower prices and form a large part of the consumer's consumption bundle. Therefore a reduction in tariffs that lowers the price of imported goods removes a large consumption distortion. In our model, trade liberalization will have similar effects. Increases in the VAT work much the opposite. First, changes in prices create consumption distortions, both between domestic and foreign varieties and between formal and informal varieties (as discussed by Piggott and Whalley (2001) and Emran and Stiglitz (2005)). Second, there is the potential for an adverse selection effect. This arises because the full VAT applies to a formal firm while only a detection probability weighted-VAT applies to informal firms. Furthermore, since high-productivity informal firms face a greater chance of being

caught, even within the informal sector the distortion will be greater for more productive firms. As such, the implied increase in the VAT will be greatest for the high-productivity firms which form a greater part of the consumer's consumption basket. This then heightens the distortions Emran and Stiglitz highlight. Thus, there is no clear cut welfare results from a revenue neutral shift between the two.

Nevertheless, two clear results stand out. First, trade liberalization itself can reduce the size of the informal sector. This is a result that has not been discussed previously in the literature. Second, an increase in the VAT has several conflicting effects on informal local firms. Because of the ambiguity resulting from the direct and indirect effects of the VAT as well as the complexity of the model, we now turn to numerical simulations both to show that the ambiguities are actual ambiguities rather than an inability to sign the comparative statics as well as to consider the welfare impacts of a shift from tariffs to VAT.

4 A Revenue Neutral Shift

In this section, we further parameterize the above model in order to discuss the ambiguities regarding the VAT and informal firms and consider the impacts of a revenue neutral shift from tariffs to VAT.²³ To begin with, we must pick specific forms for three key functions, the mapping from i to unit costs, the mapping from i to probability of detection, and the distribution of firm types ($H(i)$). Specifically, we assume that

$$a(i) = a + \zeta i \tag{29}$$

$$\eta(i) = \frac{1}{1 + \vartheta i} \tag{30}$$

$$H(a(i)) = 1 - e^{-\Phi i} \tag{31}$$

²³Since the debate on the literature has been over the relative merits of these two policy instruments, we do not consider changes in other policies such as ϕ , i.e. the penalty if caught, or $\eta(\cdot)$, the probability of detection. This is not to imply that these are not worth considering, however, in order to compare our model with the existing literature, we focus on tariff and VAT changes.

Furthermore, we must also parameterize several key variables in the model. Our baseline values are listed in Table 2. Of particular note are two baseline values: the tariff which is set at .08 and the VAT which is set at .001. This latter value is set to a positive amount so that not all firms are initially indifferent to being formal or informal, yet is sufficiently small for us to consider the implementation of the VAT. We will also present results for a higher level of the VAT for comparison.

Before considering the impact of a revenue neutral shift, we first return to the ambiguity on the effect of a rise in the VAT on the number of informal firms. Recall that there were two competing effects. The first was the direct effect wherein an increase in the VAT increased the expected penalty if caught, thereby driving the least productive informal firms from the market. The second is an indirect effect that, because of the decline in competition as the VAT rises, encourages entry by low productivity informal firms. This latter term particularly hinges on the distribution of firm types, i.e. on Φ , since this governs the rate of exit by foreign exporters. Figure 1 illustrates how the sign of dN/dv changes as we change Φ . For low values of the shape parameter, an increase in the VAT reduces the cutoff for informal firms, i.e. the direct effect dominates. For relatively high values of the shape parameter the competition effect dominates and an increase in the VAT reduces the number of importers sufficiently to permit entry by low productivity informal firms. This indicates that our ambiguity is a true ambiguity and not simply an inability to sign the comparative static. For our analysis, we will focus on values the shape parameter for which the direct effect dominates.²⁴

We now turn to the impacts of a revenue neutral shift. Figure 2 illustrates the required change in the VAT to keep revenues constant following a one percentage point decline in the tariff for a range of tariff values. As can be seen, when the tariff is relatively high, even for the low baseline VAT of .1 percent, a reduction in the tariff can actually require the VAT to fall to keep revenues neutral. This is because the decline in the tariff leads to an

²⁴We did not find a positive effect of the VAT on N for alternative values of our other parameters, at least within the ranges we simulated. This suggests that changes in the mass of exporters is of particular importance.

influx of imports which generate VAT revenues. When this influx is large, these new VAT revenues more than offset the decline in tariff revenues. This suggests that the interaction of tariffs and VAT are important when considering the potential revenue impacts, especially for developing nations where tariff levels are high relative to that in the developing world. Since Boadway and Sato (2009) contrast VAT only and tariff only situations, this interplay is missing from their analysis. Note that in our baseline values, the VAT must increase in response to the tariff. Thus, as in Emran and Stiglitz (2005), we assume that the VAT is below the peak of the Laffer curve and the tariff is not greater than the Laffer curve's peak. This has two implications. First, consistent with the estimates of Devarajan, et. al (1999) a reduction in the tariff leads to a net revenue loss for home. This has been confirmed for low income countries by Baunsgaard and Keen (2005). Second, to offset this, it requires an increase in the VAT. This then places our simulations in the context of the current debate. It is worth noting, however, that the required VAT changes are generally fairly small. This is important in interpreting our simulated welfare changes because these small VAT changes imply small price changes for firms and therefore smaller changes in consumer surplus.

Figure 3 illustrates the change in welfare from the revenue neutral change in the VAT for differing levels of σ , the elasticity of substitution. Differing σ s imply two different things. First, higher elasticities of substitution move the market closer to perfect competition, changing the impact of a tariff or VAT change on firms. In our simulations, this serves to make firm cutoffs less sensitive to policy changes. As by Keen (2008), one of the benefits of a revenue neutral shift is that it reduces distortions in the relative consumption of home and foreign products. In the context of heterogeneous firms, as discussed by Chor (2009) and Davies and Cole (2009), an additional benefit of tariff reduction is that trade liberalization is that it increases the availability of foreign varieties to the home market and shifts resources towards more productive firms (a selection effect). Here, the selection effect is strengthened by the corresponding VAT increase which drives away low-productivity informal firms from the market. As σ rises and firms move closer to perfect competition, however, this benefit

declines. The second impact of a higher σ is that it results in a lower equilibrium G for the same baseline tariff and VAT. As such, fewer revenues need to be maintained by increasing the VAT. Therefore, the associated VAT increases are small, implying only small distortions of the type highlighted by Emran and Stiglitz (2005). Therefore, for this parametrization and range of values, as proposed by Keen (2008) a shift from tariffs towards VAT increases welfare.

It is important to recognize, however, that this is contingent on the parametrization of the model. Figure 4 shows the situation for a slightly different baseline where $\tau = .13$ and $v = .01$. As can be seen, for higher elasticity of substitutions, welfare falls as the tariff is replaced by a VAT. This is because with higher baseline taxes, the revenues that must be maintained during the shift from tariffs to VAT are larger. Therefore the associated VAT increase are also higher, increasing the distortions warned of by Emran and Stiglitz (2005). For low σ this is still dominated by the influx of imports and the selection effect. When the elasticity of substitution is high, however, these other benefits are smaller yielding a net negative effect. This implies that, although the policy prescription of Keen (2008) works in some cases, including the baseline parametrization, it does not hold for all cases. Therefore this is not a "one size fits all" policy and it is critical to analyze factors such as the initial tariff level, the size of the cut, and the anticipated increase in imports before applying it to a given country.

Figure 5, which illustrates how the change in welfare depends on the initial level of the tariff (returning to the baseline VAT and σ), presents an alternative method of evaluating the sensitivity of the welfare changes to the chosen parameters. When tariffs are initially low, there is a welfare gain from switching from the tariff to the revenue equivalent VAT. As the tariff rises, the change in welfare becomes negative. The reason for this is that $\frac{d\lambda_X^*}{d\tau}$ is falling in the initial tariff, i.e. when the initial tariff is high, the ability to increase imports is slight. Therefore the benefits of Keen (2008) are outweighed by the distortions caused by the VAT. Therefore, the welfare changes for very closed economies may well differ from

relatively open ones.

Finally, Figure 6 illustrates how the change in welfare depends on the initial level of the VAT. As with Figure 5 the increase in welfare is greater for higher VATs. This is due to the fact that, as the tariff falls from its baseline level, the increase in imports raises additional revenues through the VAT, thus requiring a smaller increase (or even a decrease) in the VAT to replace those lost funds and smaller distortions to home production. This highlights an important difference of such a shift for countries that already have established VATs and those that do not.

5 Conclusion

The goal of this paper was to explore the impact of a shift from tariffs to VAT in the presence of an informal sector. By using firm heterogeneity, unlike other treatments of the subject, we neither exogenously assign firms to one sector or the other nor consider an equilibrium in which all firms must be indifferent between sectors. This leads to several useful insights. First, a tariff cut itself can be useful in reducing informality. Second, it is not the case that a shift from tariffs to VAT must lead to an increase in the size of the informal sector. This is because the penalty associated with non-payment is typically proportional to the VAT itself. This then impacts both the output of all informal firms as well as the number of informal firms that choose to stay in the market. For many parameter values, the net effect of a VAT increase is actually to decrease the size of the informal sector. Third, the welfare impact of a shift from tariffs to VAT is sensitive to the chosen parameters. This is because the parameters affect the benefits proposed by Keen (2008), namely the increase in imports, relative to the VAT distortions warned of by Emran and Stiglitz (2005). In particular, when countries are initially relatively closed, do not have high initial VAT levels, or have preferences that yield nearly perfect competition, a revenue neutral shift from tariffs to VAT can lower welfare. Thus, although there are some cases in which this shift can indeed improve welfare, caution

must be exercised when deciding whether or not to implement such a policy.

In addition to the differing effects within the context of our model, we do not consider other issues surrounding the use of VAT such as the role of trade in intermediate goods, political economy, or the cost of enforcement. We leave these for future research. Nevertheless, it is our hope that by considering the roles of heterogeneity and endogenous entry help to enrich the current debate and future research.

Table 1: International Trade Taxes as a Percent of Total Revenue by Region (1996-2002)

Region	Trade Revenue as percent of Total Revenue
North America	1.8
Latin America	12.8
Western Europe	.3
Asia	12.3
Africa	32
Central and Eastern Europe and Middle East	14.2

Source: Bird and Ghendron (2007)

Table 2: Baseline Values for Simulations

Variable	Interpretation	Baseline Value
F	Fixed Cost of a Domestic Plant	3
F_x	Fixed Cost of Exporting	6
μ	Utility Function Parameter/Amount Spent on Differentiated Good	2
σ	Elasticity of Substitution	4
τ	Ad-valorem Tariff	.08
ρ	Lower Bound of Marginal Cost	.3
Φ	Shape Parameter in Exponential Distribution	.25
v	VAT Rate	.001
ϑ	Parameter of Detection Function	1
ζ	Parameter of Unit Cost Function	1
μ_G	Utility Function Parameter/Amount Spent on Public Good	2

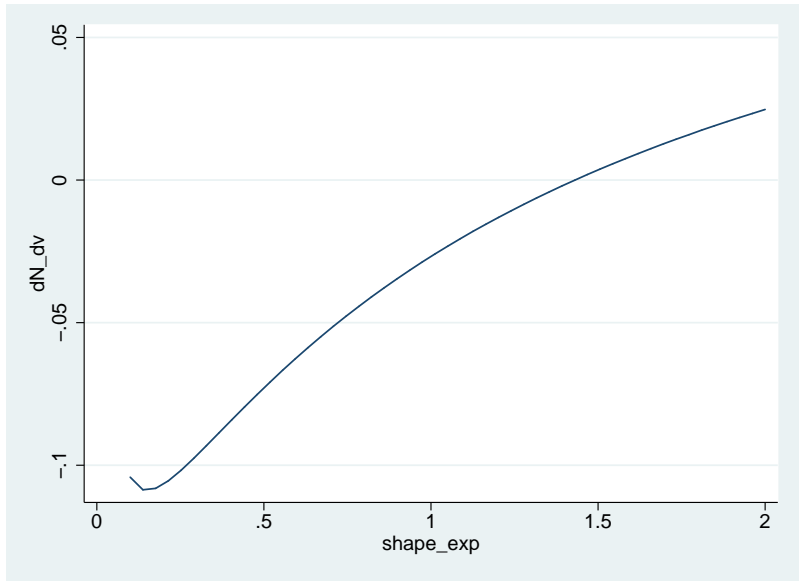


Figure 1: dN/dv as it depends on the distribution of types

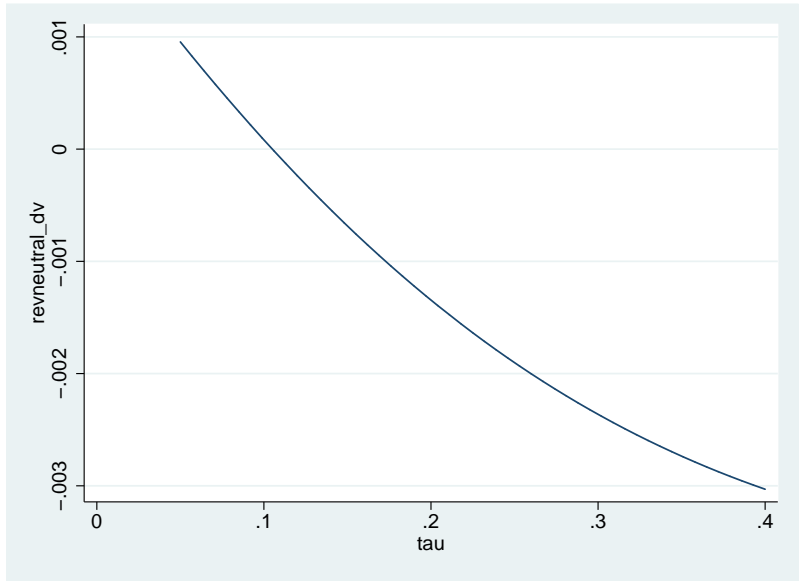


Figure 2: The Revenue Neutral Change in the VAT depending on the initial tariff

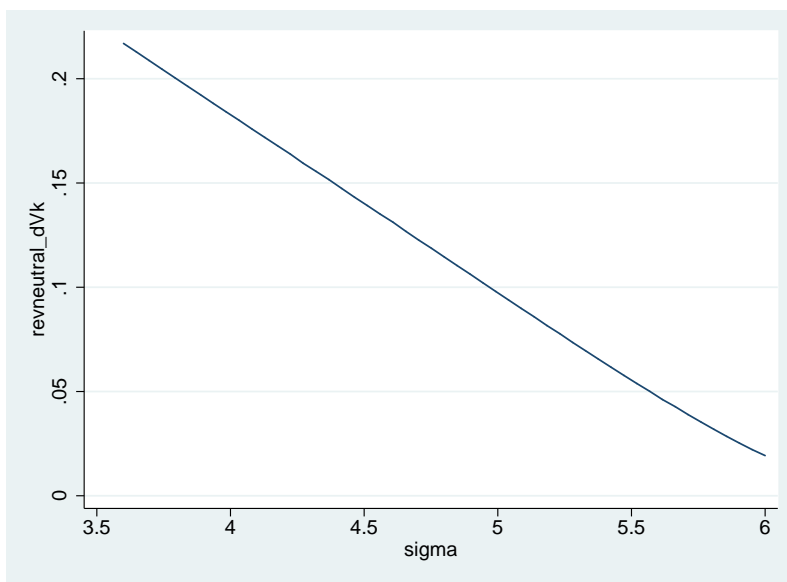


Figure 3: The Change in Welfare from a Revenue Neutral Shift as it depends on the Elasticity of Substitution

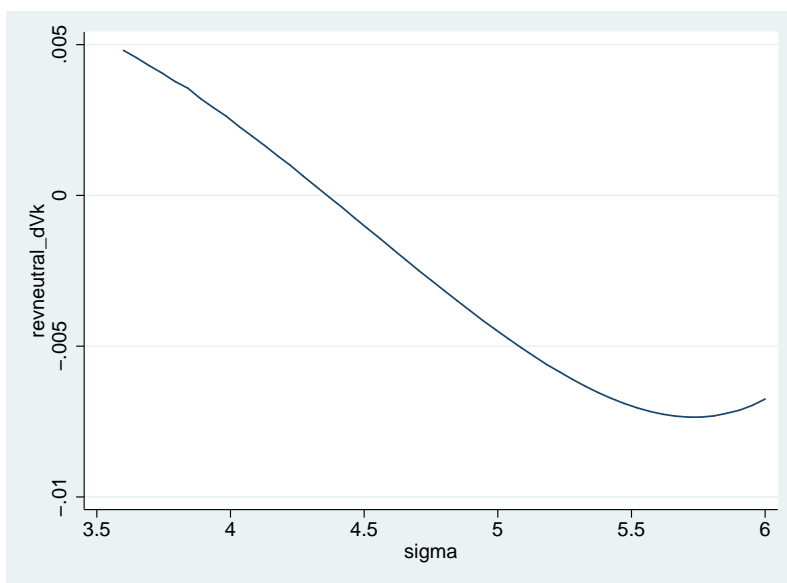


Figure 4: The Change in Welfare from a Revenue Neutral Shift as it depends on the Elasticity of Substitution, Alternate Baseline Tariff and VAT

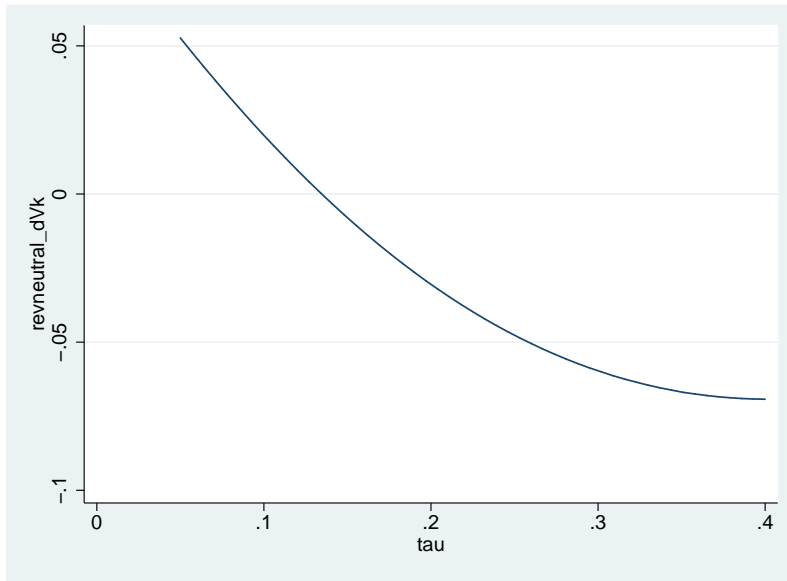


Figure 5: The Change in Welfare from a Revenue Neutral Shift as it depends on the initial tariff

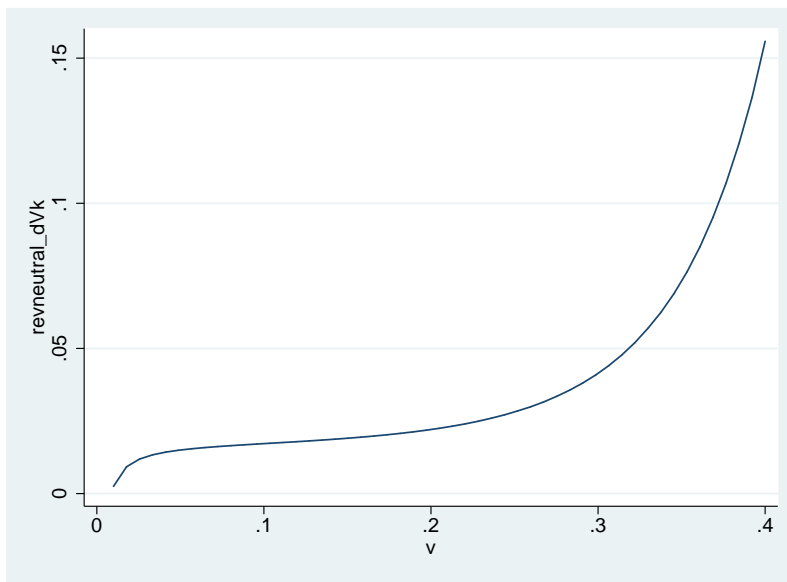


Figure 6: The Change in Welfare from a Revenue Neutral Shift as it depends on the initial VAT

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