The (Non-)Neutrality of Value Added Taxation[1]

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Abstract

This paper employs a structural gravity model for final goods trade and novel value-added tax (VAT) regime data to investigate the impact of VATs on final goods imports and domestic production of final goods. We show that the VAT is both non-neutral and discriminatory. A VAT increase does not only reduce imports and internal trade of final goods but also leads to a relative increase in internal trade compared to aggregate imports. This result can only be explained by changes in pre-tax pricing behavior. A quantification shows that the welfare effects for an average country in the European Union are substantial.
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1 Introduction

Throughout the past decades value-added taxes (VATs) have become the most commonly applied form of commodity taxation around the globe. One reason for this development is that the VAT is commonly regarded as neutral and non-discriminatory. Neutrality in this case implies that consumer and/or firm behavior is unaffected by VAT changes. Non-discrimination, on the other hand, indicates that domestic production and imports should not be affected differently by the VAT. In line with WTO guidelines of non-discrimination, the VAT follows the destination principle such that the same rate is applied to both imports and domestic production of goods and services for the domestic market and affects final consumption only. Imported goods are subject to a border-adjustment process where the VAT is levied, while exports are exempt in most countries. Given neutrality and non-discrimination, the VAT is usually not considered to be a trade policy instrument. In fact, early theoretical contributions by Grossman (1980) and Feldstein and Krugman (1990) have developed conditions under which any border adjustment is neutral, meaning that it will not affect c.i.f. values of imports and the value of internal trade. Other papers, however, have demonstrated that commodity taxation can be an imperfect substitute for tariffs when markets are not perfectly competitive and that rates will depend on the taxation principle (see, for example, Haufler et al., 2005, and Keen and Lahiri, 1998). Thus, the VAT may not necessarily be neutral and/or non-discriminatory and could, consequently, serve implicitly or explicitly as a trade policy instrument. This is especially relevant since the global tariff level has steadily declined while VAT rates around the globe experienced a distinct increase.[1]

In this paper we analyze two research questions. First, is the VAT neutral? That is, we ask whether c.i.f. values of imports and the value of internal trade are affected by VAT rate changes. Second, is the VAT discriminatory, that is, are international and intra-national trade flows affected differently by VAT changes? To answer these questions, we employ a structural gravity model and recent innovations in modeling the effects of non-discriminatory trade policies as well as a novel data set containing VAT regime information for more than 150 countries from 2003-2020. Additionally, we analyze a panel of 28 EU countries from 1967 to 2020. We begin by extending the structural gravity model

[1]Loretz (2008) and Thunecke (2022) provide illustrative evidence for the development of the VAT.

to accommodate for the existence of a VAT to guide the empirical analysis of our research questions. In deriving this model we build on the seminal contribution of Anderson and van Wincoop (2003) who have set up the structural gravity model in a way that is consistent with general equilibrium constraints.[2] This model is very flexible (see Allen et al., 2020, and Carrère et al., 2020) and accommodates many trade models like Armington, Ricardo, Heckscher-Ohlin, monopolistic competition and models of heterogeneous firms.[3] To analyze the question of neutrality we employ a two stage approach following Yotov et al. (2016). In the first stage we estimate importer-time and exporter-time fixed effects (FEs) using the standard gravity model. In the second stage we regress the estimated importer-time FE on current VAT rates. We find that a VAT rate increase will lower both domestic production and aggregate imports of final goods. The size of this effect is economically significant and robust.

Since the VAT is applied to all trading partners equally, the question of non-discrimination is analyzed by using a border dummy to distinguish between internal and international trade flows as proposed by Beverelli et al. (2018) and Heid et al. (2021). The differential impact of the VAT on inter- and intra-national trade, respectively, is analyzed by interacting this border dummy with the VAT rate. We illustrate that the VAT is in fact discriminatory in the European Union. We find that an increase in the VAT rate leads to a larger decrease in aggregate imports compared to local production. This effect implies that relative demand for domestically produced goods increases. Consistent with our theoretical model, this result must be driven by differential price responses of domestic and importing firms. Following Arkolakis et al. (2012) and using our structural gravity model, we illustrate that the welfare implications of VAT changes are considerable: if the tax revenue increase is completely unproductive, a one percentage point increase in the VAT rate leads to a welfare decrease of between 1.94 and 4.92 % for an average country in the European Union. Allowing for productivity changes, we show that a welfare neutral VAT change requires substantial productivity gains from public good provision. When the VAT increase is used to compensate for another tax reform, the income effects of this reform must also be substantial.

[2]See also Anderson (1979) and Eaton and Kortum (2002).

[3]See Anderson and Yotov (2016), Arkolakis et al. (2012), Bergstrand (1985), Caliendo and Parro (2015), Chaney (2008), Chor (2010), Costinot et al. (2012), Deardorff (1998) and Helpman et al. (2008).

This paper contributes to several strands of the international trade and public finance literature. First, we add to the empirical trade literature analyzing VAT neutrality. This paper is not the first to evaluate the effect of VAT rates on trade, but the first to do so in a structural gravity model. Desai and Hines (2003) conduct a cross-sectional country-level analysis, finding a negative relation between VAT revenue and exports as well as imports. Keen and Syed (2006), also looking at the country-level but using panel data, find no VAT effect. In an industry-level panel analysis Nicholson (2010) finds negative effects on both exports and imports. Furthermore, the author reports moderate offsetting effects of consumption taxes on trade balances, with one-for-one responses of exchange rates to rate increases. Sharma (2020) analyzes an industry-level panel of more than 100 countries to investigate how the VAT affects exports. The author finds that industries with a high intermediate goods share of output decrease exports substantially. This effect is driven by developing countries and most likely attributable to imperfect refunding for exporters. Most recently, Benzarti and Tazhitdinova (2021) employ a generalized difference-in-difference following Fuest et al. (2018), regressing bilateral trade (exports and imports) on the reporting country's tax rate, a rich set of fixed effects, dynamic country-level controls and a full set of lags and leads of VAT rates to capture anticipatory or delayed responses.[4] Their analysis focuses on EU countries, and they find a VAT elasticity of trade close to zero, with no significant anticipatory or delayed effects.

Compared to this literature, our paper demonstrates clear-cut effects of the VAT on trade. On the one hand, our study goes beyond the EU context using a balanced panel of trade data for the first part of our analysis, and we do not focus exclusively on trade flows from and to EU members, but include both trade between non-EU members and internal trade. On the other hand, we use a structural gravity model and the Poisson Pseudo Maximum Likelihood (PPML) estimator following Santos Silva and Tenreyro (2006). Compared to papers that use a logarithmic transformation of trade flows, PPML allows us to properly account for zero trade flows and heteroskedasticity. Since the structural gravity model is a consistent general equilibrium model of trade, it has been extremely successful

[4]Benzarti and Tazhitdinova (2021) combine data on VAT rates at the commodity level with trade data on final consumption in the period 1988-2016. Furthermore, they combine three binary estimation choices for a total of eight regressions: using monthly or quarterly time intervals; aggregating over commodities or trading partners; and using value and volume of trade as dependent variable. In combination, these alternative estimates are taken to ensure that results are not driven by measurement error, price effects or by aggregation over units, commodities or time.

in trade policy analysis, and it has developed well-recognized best practice standards, see for example Anderson (2011), Head and Mayer (2014) and Yotov et al. (2016).

Second, we contribute to the empirical trade literature analyzing non-discriminatory trade policies. To the best of our knowledge, no paper has so far empirically investigated the question of trade discrimination in the context of the VAT. While the structural gravity model has allowed researchers to estimate the effect of bilateral trade policies – such as bilateral tariffs – with relative ease, estimating the effects of non-discriminatory policies such as behind-the-border measures or most-favored-nation (MFN) tariffs is more difficult. Heid et al. (2021) develop a methodological extension of the structural gravity model that allows for the quantification of the impact of unilateral policies and country-specific characteristics on trade. They exploit intra-national trade flows and a cross-border trade dummy to estimate the impact of MFNs and time to export on international trade flows relative to internal trade flows. Beverelli et al. (2018) employ a similar methodology to estimate the effect of institutional quality on trade. The authors find that stronger institutions foster more trade and that changes in institutional quality have a substantial impact on real GDP. Our paper utilizes these novel estimation techniques from the structural gravity literature to analyze the effects of the VAT rate changes on international trade. We focus on the relative response of imports vis-a-vis internal trade, i.e., non-discrimination of the VAT. Including internal trade data allows us to go beyond the analysis of recent papers, for example Benzarti and Tazhitdinova (2021), as they consider only international trade flows.

Third, we contribute to the public economics literature analyzing the effects of consumption tax reforms on demand. Doyle Jr. and Samphantharak (2008) illustrate that a substantial part of sales tax suspensions and reinstatements in Illinois and Indiana are passed on to consumers through price changes. Chetty et al. (2009) document that excise tax changes have considerable effects on the price and demand for alcoholic beverages. Similarly, Kosonen (2015) exploits a VAT reform for hairdressing services in Finland and demonstrates a significant pass-through due to reduced consumer prices, while demanded quantities do not change. Benzarti et al. (2020) exploit several European VAT reforms and illustrate that the pass-through of VAT increases is disproportionately larger compared to VAT reductions. Gaarder (2019) finds an almost full pass-through to consumer prices of a VAT change on food in Norway. Benzarti and Carloni (2020) exploit a temporary VAT reduction in France on restaurant visits and find that firm owners benefit most while

consumers benefit least due to an incomplete pass-through. Fuest et al. (2020) illustrate an almost full pass-through of a temporary VAT cut in Germany. Thus, the public finance literature illustrates that VAT rate changes should not be expected to be neutral as consumer prices change significantly. In contrast to most of this literature we are not exploiting a particular VAT reform in a distinct national setting but analyze the effect of VAT changes around the world. This allows for the generalization of our results in the context of international trade. Additionally, we are able to derive general equilibrium welfare effects of VAT reforms from our structural gravity model.

The remainder of this paper is organized as follows. Section 2 sets up the model that will guide our empirical analysis. Section 3 presents the data sets we use and some descriptive statistics, and section 4 shows our empirical results and develops theory consistent explanations for discriminatory effects. Section 5 presents the welfare results, and section 6 concludes.

2 The model

We consider a general equilibrium model of trade with n countries. Our empirical analysis focuses on trade in final goods so we have to distinguish between trade in final and intermediate goods. In our model, each country is endowed with a (composite) factor of production (labor) that is internationally immobile and denoted by L_i for country i.[5] Each country produces two goods, an intermediate good m_i (materials) that is produced by a linear production technology using labor only such that $m_i = L_i^M$ where L_i^M denotes labor input in the intermediate goods sector, and a consumption (final) good. The intermediate goods and local labor are used in two production processes. First, the final good is produced with a linear-homogeneous production function $A_i F(m_{1i}^C, \cdots, m_{ni}^C, L_i^C)$ where m_{ji}^C denotes the inputs sourced from country j and L_i^C is the local labor input in final good production. Second, the government uses intermediate inputs to provide the public good A_i that improves the efficiency of production, and the production function is given by $A_i = \Phi(m_{1i}^G, \cdots, m_{ni}^G, L_i^C)$ where m_{ji}^G denotes the vector of inputs sourced from

[5]Our model extends easily to endogenous labor supply, multi-stage production and many factors of production but we prefer to keep it as simple as possible and thus follow the standard assumptions of the structural gravity literature.

country j and L_i^G is the labor input in public good provision. Intermediate imports from country j thus add up to $m_{ji}^C + m_{ji}^G$.

Within country i, total labor demand is given by $L_i^C + L_i^G + L_i^M$, and local labor markets are cleared by the wage w_i. Intermediate goods are sourced for a c.i.f. price r_{ji} from country j. Cost minimization of $\sum_n r_{ji} m_{ji}^C + w_i L_i^C$ s.t. $A_i F(m_{1i}^C, \cdots, m_{ni}^C, L_i^C) = 1$ yields the unit cost c_i of final good production. Furthermore, country i spends $G_i = \sum_n r_{ji} m_{ji}^G + w_i L_i^G$ for public good provision. Note that G_i and A_i are not set by the producers who take total efficiency as given, but by the government through tax policies. Production decisions imply trade flows of intermediate goods which are given by $M_{ji} = r_{ji}(m_{ji}^C + m_{ji}^G)$. An exporter of an intermediate good receives a full rebate of its home country's VAT and has to pay the importer's VAT upon entry. The producer acquiring the intermediate input is then allowed to deduct the VAT from its VAT liability of the final goods sale. Thus, intermediate goods trade is not affected by value added taxation and therefore not part of our analysis. We will thus focus on trade in (final) consumption goods which each country produces with a constant unit cost of c_i.

As for consumption of the final good, we follow the literature and Armington (1969) and assume that each country produces one consumption good such that goods are differentiated by country of origin. In particular, the utility function of the representative consumer in country j is given by

$$U_j\left(q_{ij}\right) = \left(\sum_{i=1}^{n} {\alpha_i}^{\frac{1-\sigma}{\sigma}} {q_{ij}}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \tag{1}$$

where q_{ij} denotes consumption of good i in country j, that is, country j's imports from country i, $\sigma, \sigma > 1$, denotes the elasticity of substitution, and α_i is a preference parameter for goods produced in country i. Note that q_{jj} is country j's internal trade.

Trade costs for consumption goods have the form of iceberg costs and are denoted by t_{ij} for trade from country i to country j. Note that we consider t_{ij} not only as a trade friction in the narrow sense, but this friction could also include markups which may differ across locations. Thus, while our paper is agnostic about market structures, it can also

accommodate oligopolistic market structures as in Heid and Stähler (2020).[6] Consumer good prices are given by $p_{ij}\tau_j = c_i t_{ij}\tau_j$, where p_{ij} is the c.i.f. producer price, and $\tau_j = 1+\psi_j$ denotes country j's VAT rate, defined as one plus the statutory commodity tax rate ψ_t.[7] Furthermore, as usual in the literature, we normalize the internal trade friction to $t_{ii} = 1$ such that all frictions are relative to the internal one.

The representative consumer maximizes (1) s.t. the budget constraint $E_j = \sum_{i=1}^{n} p_{ij}\tau_j q_{ij} = \sum_{i=1}^{n} c_i t_{ij}\tau_j q_{ij}$, where E_j denotes expenditures. Expenditures are equal to the after tax income of the representative consumer that is given by $E_j = w_j L_j + \phi_j T_j + \Pi_j - \mathcal{T}_j$ where $w_j L_j$ is the factor income of the local factor of production. T_j denotes the VAT revenues of which a share $\phi_j, 0 \leq \phi_j \leq 1$, is redistributed to consumers, and Π_j denotes the after-tax profits accruing to residents in country j. These could originate from all local production of intermediate and final goods if all local production has local ownership only. Alternatively, these could be due to a diversified ownership across local and foreign firms. Finally, $\mathcal{T}_j$ collects all other taxes such that $G_j = (1-\phi_j)T_j + \mathcal{T}_j$ gives the governmental budget constraint.

The representative consumer takes E_j as given, and utility maximization implies final good demands

$$q_{ij}^{*} = \frac{E_j \left(\alpha_i p_{ij}\right)^{-\sigma}}{\sum_{i=1}^{n} \left(\alpha_i p_{ij}\right)^{1-\sigma}} = \frac{E_j \left(\alpha_i c_i t_{ij}\tau_j\right)^{-\sigma}}{\sum_{i=1}^{n} \left(\alpha_i c_i t_{ij}\tau_j\right)^{1-\sigma}} = \frac{E_j \left(\alpha_i c_i t_{ij}\tau_j\right)^{-\sigma}}{P_j^{1-\sigma}}, \tag{2}$$

where

$$P_j = \left[\sum_{i=1}^{n} \left(\alpha_i c_i t_{ij}\tau_j\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$$

is the CES price index. Let X_{ij} denote the c.i.f. value of exports from country i to country j before VAT. Then,

[6]The role of market power and markups has been emphasized recently in the literature, see for example Amiti et al. (2019), Asprilla et al. (2019), Bernard et al. (2003), De Loecker et al. (2016), De Loecker and Eeckhout (2018), Feenstra and Weinstein (2017), Holmes et al. (2014) and Hsu et al. (2020).

[7]The VAT is applied on the sales price, and thus we do not have to distinguish between taxation of cost or revenue as Felbermayr et al. (2015) do for import tariffs.

$$X_{ij} = c_i t_{ij} q_{ij}^* = \left(\frac{\alpha_i c_i t_{ij}}{P_j}\right)^{1-\sigma} E_j \tau_j^{-\sigma}, \tag{3}$$

and the VAT revenues are given by

$$T_i = (\tau_i - 1) \sum_{j=1}^{n} X_{ji} = (\tau_i - 1) \sum_{j=1}^{n} c_j t_{ji} q_{ji}^*. \tag{4}$$

Aggregate sales in the final good sector of country i, denoted by Y_i^C, are equal to the sum of all final goods exports and domestic sales: $Y_i^C = \sum_{j=1}^{n} X_{ij}$. Thus,

$$Y_i^C = \sum_{j=1}^{n} X_{ij} = \sum_{j=1}^{n} \left(\frac{\alpha_i c_i t_{ij}}{P_j}\right)^{1-\sigma} E_j \tau_j^{-\sigma} = (\alpha_i c_i)^{1-\sigma} \sum_{j=1}^{n} \left(\frac{t_{ij}}{P_j}\right)^{1-\sigma} E_j \tau_j^{-\sigma},$$

which can be rewritten as

$$\begin{aligned}(\alpha_i c_i)^{1-\sigma} &= \frac{Y_i^C}{\sum_{j=1}^{n} \left(\frac{t_{ij}}{P_j}\right)^{1-\sigma} E_j \tau_j^{-\sigma}} = \frac{\frac{Y_i^C}{Y^C}}{\sum_{j=1}^{n} \left(\frac{t_{ij}}{P_j}\right)^{1-\sigma} \frac{E_j}{Y^C} \tau_j^{-\sigma}} \\ &= \frac{Y_i^C / Y^C}{Q_i^{1-\sigma}} \text{ where } Q_i = \left[\sum_{j=1}^{n} \left(\frac{t_{ij}}{P_j}\right)^{1-\sigma} \frac{E_j}{Y^C} \tau_j^{-\sigma}\right]^{\frac{1}{1-\sigma}}\end{aligned}$$

is the outward resistance term and $Y^C = \sum_{j=1}^{n} Y_j^C$ are the aggregate sales of the final goods industry in the world. Replacing $(\alpha_i c_i)^{1-\sigma}$ in (3) yields the gravity equation for final goods under commodity taxation as

$$X_{ij} = \frac{Y_i^C E_j}{Y^C} \left(\frac{t_{ij}}{Q_i P_j}\right)^{1-\sigma} \tau_j^{-\sigma}, \tag{5}$$

where P_j is the CES price index which can be rewritten as the inward resistance term because

$$P_j = \left[\sum_{i=1}^{n} \left(\alpha_i c_i t_{ij} \tau_j\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}} = \left[\sum_{i=1}^{n} \left(\frac{t_{ij}\tau_j}{Q_i}\right)^{1-\sigma} \frac{Y_i^C}{Y^C}\right]^{\frac{1}{1-\sigma}}$$

since $(\alpha_i p_i)^{1-\sigma} = (Y_i^C/Y^C)/Q_i^{1-\sigma}$. The derived gravity equation looks very similar to the one in the seminal paper by Anderson and van Wincoop (2003) and generalizes the structural gravity model to commodity taxation.[8]

Let $Y_j^D = \sum_{i=1}^{n} X_{ji}$ denote aggregate final good consumption in country j. How the VAT affect expenditures, imports and internal trade will also depend on the response of the c.i.f. producer price p_{ij} to a change in τ_j. The tax revenues change with the VAT rate according to

$$\frac{dT_j}{d\tau_j} = Y_j^D + (\tau_j - 1)\frac{dY_j^D}{d\tau_j} \geq 0, \tag{6}$$

for which we assume Laffer efficiency such that an increase in τ_j will increase T_j. We observe two effects: first, an increase in the VAT rate increases tax revenues for given aggregate final good consumption Y_j^D; second, it changes final goods consumption and thus the tax base. The representative consumer takes any expenditure change as given such that $dE_j/dT_j = \phi_j$. How do VAT rate changes affect final good imports? Let $\epsilon(z, \tau_j)$ denote the elasticity of the variable z w.r.t the VAT rate τ_j. We find that imports from country i change according to

$$\frac{dX_{ij}}{d\tau_j} = \frac{X_{ij}}{\tau_j}\left[(1-\sigma)\left(\epsilon(p_{ij}, \tau_j) - \epsilon(P_j, \tau_j)\right) + \frac{\tau_j}{E_j}\underbrace{\frac{dE_j}{dT_j}}_{=\phi_j}\frac{dT_j}{d\tau_j} - \sigma\right],$$

where

[8] For a similar derivation used to include import tariffs and tariff revenues, see Appendix B in Yotov et al. (2016) and Online Appendix A.1 of Heid and Larch (2016).

$$\epsilon(P_j, \tau_j) = \frac{\tau_j}{E_j} \sum_{i=1}^{n} X_{ij} \left[\epsilon(p_{ij}, \tau_j) + 1\right]$$

is the elasticity of the CES price index w.r.t to the VAT. We can now determine a benchmark for the neutrality of the VAT rate.

Lemma 1. *If all $\epsilon(p_{ij}, \tau_j) = 0$ and $\phi_j = 1$, the c.i.f. value of imports will not change with the VAT.*

Proof. If $\epsilon(p_{ij}, \tau_j) = 0$,

$$\epsilon(P_j, \tau_j) = \frac{\tau_j}{E_j} \sum_{i=1}^{n} X_{ij} = \frac{\tau_j}{E_j} Y_j^D = 1$$

and

$$\frac{dX_{ij}}{d\tau_j} = \frac{X_{ij}}{\tau_j} \left[(\sigma - 1) + \frac{\tau_j}{E_j} \phi_j \frac{dT_j}{d\tau_j} - \sigma\right].$$

If $dX_{ij}/d\tau_j = 0$ holds for all imports, it also follows for the aggregate change in consumption that

$$\frac{dY_j^D}{d\tau_j} = \sum_{i=1}^{n} \frac{dX_{ij}}{d\tau_j} = 0,$$

which implies that $dT_j/d\tau_j = Y_j^D$. In this case,

$$\frac{\tau_j}{E_j} \phi_j \frac{dT_j}{d\tau_j} = \phi_j \text{ because } \tau_j Y_j^D = E_j.$$

This is consistent if $\phi_j = 1$ as $\sigma - 1 + \phi_j - \sigma = 0$ for $\phi_j = 1$, implying $dX_{ij}/d\tau_j = 0$.

□

Lemma 1 shows that the c.i.f. value of imports does not change if the c.i.f. producer

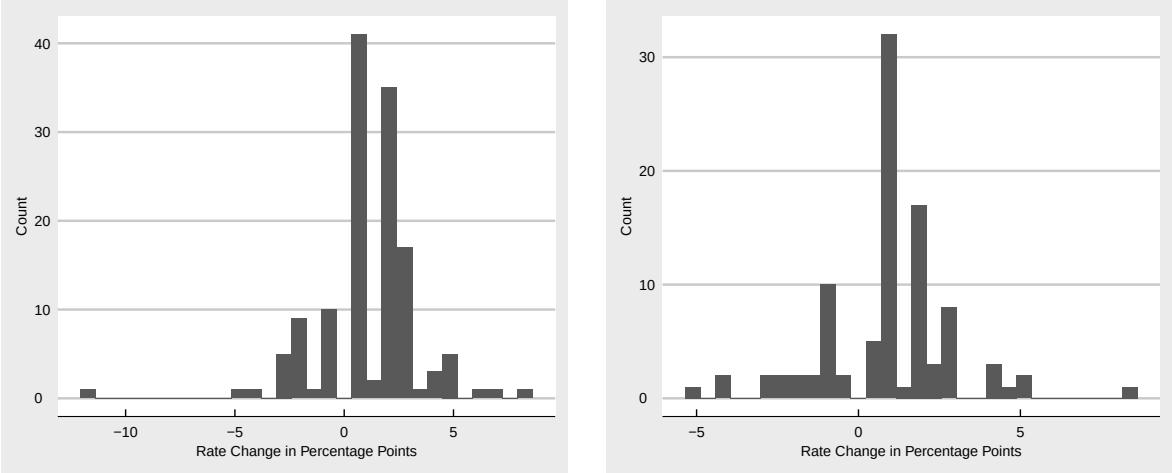
prices do not change and if the increased tax revenue is completely returned to the representative consumer as a lump-sum transfer, that is, if $\phi_j = 1$. The intuition is that – if c.i.f. producer prices do not change – relative prices do not change with the VAT, and since demand is homothetic, also relative demands do not change. Furthermore, a complete return of tax revenues to consumers compensates completely for the increase in consumer prices such that imports and internal trade do not change.

All in all, the structural gravity model developed above is very flexible in the sense that it relies on less restrictive assumptions than previous theoretical contributions on the relationship between VAT rates and international trade. The standard theoretical literature often relies on restrictive assumptions including constant prices over time and full pass-through of taxes to consumers (see e.g. Feldstein and Krugman (1990), Benzarti and Tazhitdinova (2021)). Subsequently for trade neutrality of the VAT, revenues must be returned to consumers via a lump sum transfer and countries are assumed to be small open economies. As Benzarti and Tazhitdinova (2021) outline, these assumptions are unlikely to hold, which would violate trade neutrality. In contrast, our structural gravity model accommodates a wide range of trade models as it is agnostic about the nature of firm competition, the formation of prices and the size of the economy. As outlined by Lemma 1 it can produce the result of trade neutrality of the VAT under similarly restrictive assumptions as the previous literature. However, by allowing for both relative price changes and an incomplete return of tax revenues to consumers we are able to fully rationalize potential non-neutrality and discrimination of the VAT. If firms change prices and their responses are not symmetric, and if tax revenues are not completely returned to the representative consumer, Lemma 1 will not hold and we have to find out empirically whether and how imports and internal trade will change. Ultimately the question of neutrality and non-discrimination is an empirical one.

3 Data

The empirical analysis of the research questions requires data on VAT regimes, trade flows and control variables. Regarding the information on VAT regimes, we employ two panel data sets which differ in their length and broadness. The first source for VAT rate data is a novel global panel of consumption tax regimes covering 228 countries from 2003 to 2020. The data is part of the RSIT International Tax Institutions Database and was

hand-collected from different sources including the EY *Worldwide VAT, GST and Sales Tax Guides* and reports by the International Bureau for Fiscal Documentation (IBFD). The data includes information on the standard and reduced consumption tax rates, the type of consumption tax regime, the year of introduction and the number of different rates applied. Though the data set also covers consumption taxes other than the VAT, such as sales taxes and goods and services taxes, all analyses below refer only to countries that apply a European style VAT. Out of the 228 countries, 159 levy such a VAT type consumption taxes in place. Though most countries only have a single standard rate for the VAT, some apply multiple different reduced rates to different goods, such as foodstuffs, books & magazines or pharmaceuticals. For countries applying multiple reduced rates, the rate applying to foodstuffs is chosen.[9] The second VAT data set, used in the analysis, covers a panel of the 28 (eventual) EU member countries from 1967 to 2020. Information on standard and reduced consumption tax rates was collected from a European Commission report also used in Benzarti and Tazhitdinova (2021). The report also gives current (2020) information on the rate applicable to foodstuffs, though no historical information on that matter. Since the period of study ends 2019 the United Kingdom is still included in the EU rates data set and will be considered an EU country in the analyses below.



(a) Std. Rate Changes of Eventual EU Members

(b) Std. Rate Changes Global

Figure 1: Variation of VAT Rates

[9]Very few countries impose different reduced rates on various foodstuffs. In these cases the rate applying to basic foodstuffs was chosen.

Not including initial introductions, the EU records 135 VAT rate changes, 107 of which are positive and 28 of which are negative. The average rate change was an increase of 1.16 percentage points (pp), with a median value of 1 pp. The distribution is displayed in Figure 1 (a). Most changes were smaller than five pp. At the global level there is also considerable variation in rates. Even though we are looking at a shorter time period and regional averages appear relatively invariant over time, a closer look illustrates that there is sufficient variation for the purposes of our analysis. We observe 96 rate changes (23 negative, 73 positive) for the 77 countries in our main analysis and in the 17 years covered by the data set. The average rate change was an increase by 0.98 pp, with a median increase of 1 pp. the distribution is shown in Figure 1 (a).

For the analysis two sources of trade data are used; the UN's *Comtrade database* and CEPII's *TradeProd database*. As the VAT can be fully rebated for intermediate goods and our analysis focuses on final consumption, both data sets are filtered for trade in consumption goods based on the BEC classification system. The UN's Comtrade database used in our analysis covers the period from 1995-2019[10] and includes the 28 (eventual) EU countries and 49 non-EU countries.[11] The data used is aggregated to the one-digit BEC level and includes category 1 - food - and category 6 - consumption goods. CEPII's TradeProd database contains bilateral trade flows covers 75 countries for the period 1980-2006.[12] The key advantage of the TradeProd data is the inclusion of internal trade flows based on gross production figures. The data are only available at the three-digit ISIC level, which are converted to the two-digit BEC level to filter for food and consumption goods. For both data sets the ROW aggregation of trade flows was done by excluding the non-ROW partners and summing over individual partners. The panels were balanced

[10]Comtrade data in the BEC format are missing for many countries in the years 1996 and 1997. In the main analysis, these observations are not removed, but results remain unchanged if the panel is reduced to the period 1998-2019. The results are available upon request.

[11]The non-EU countries are Argentina, Australia, Bolivia, Brazil, Canada, Switzerland, Chile, China, Cameroon, Colombia, Costa Rica, Equador, Egypt, Hong Kong, Indonesia, India, Iran, Iceland, Israel, Jordan, Japan, Kenya, South Korea, Kuwait, Sri Lanka, Macao, Morocco, Mexico, Myanmar, Mauritius, Malawi, Malaysia, Niger, Nigeria, Nepal, Panama, Philippines, Qatar, Senegal, Singapore, Thailand, Tinidad & Tobago, Tunisia, Turkey, Tanzania, Uruguay, USA and South Africa. Other countries are aggregated to a Rest of World (ROW) observation. The countries were chosen according to the data provided in Yotov et al. (2016) with missing EU countries added.

[12]The countries are the same except for Belgium and Luxembourg which TradeProd aggregates to one country.

by adding zero trade flows for any missing dyadic observation. In both cases trade flows are reported net of VAT, just as they are reported net of tariffs. Unfortunately there is little overlap in the time periods covered by the two data sets. Therefore, the method of combining the two trade data sources, as discussed in Yotov et al. (2016), was not feasible.

For our empirical analysis we will combine the two trade data sets and two VAT rate data sets resulting in four pair-wise combinations. These combinations differ substantially in their temporal and geographical coverage. Generally, combining the EU VAT rates with either trade data sets allows for inference on a longer time period but less geographical coverage while the opposite is true for the global VAT panel. While both the TradeProd and Comtrade data cover time periods of similar length, the EU-TradeProd combination includes a smaller number of observations since fewer countries had introduced the VAT at that earlier time. The Global-Comtrade combination contains by far the most observations due to the broadness of the panel and the large temporal overlap. Unfortunately, we only have a limited overlap of four years between the global VAT data and the TradeProd database. This results in a small number of observations with little variation in the VAT rate (13 changes). Due to the limited inference that can be drawn from the Global-TradeProd combination we exclude the results for this combination from the main part of the analysis. [13] For the analysis we also use some control variables. Information on regional trade agreements are taken from Egger and Larch (2008). Bilateral geo-spatial information including distance and indicators for common language, colonial ties and border contiguity are taken from the CEPII GeoDist database.

4 Empirical results

We now use these data sets to investigate whether the VAT is neutral and/or non-discriminatory. In subsection 4.1, we focus on Lemma 1 and show that aggregate final goods imports, including internal trade, decline with the VAT. Furthermore, we show that the decline in aggregate trade cannot solely be attributed to a decline in internal trade. Thus the VAT is not neutral and reduces aggregate imports. In subsection 4.2, we explore how internal trade changes compared to aggregate imports, and we show that a

[13] Results based on the Global-TradeProd combination are, however, still consistent with our main findings and available upon request.

VAT increase leads to a substantial increase in internal trade compared to imports in the European Union. Thus, the VAT is discriminatory in the European context.

4.1 The effect of the VAT on overall trade flows

To estimate the effect of the VAT on overall trade flows, both internally and internationally, we proceed in two steps. First, we estimate the unobserved resistance terms P_j and Q_i. Following Santos Silva and Tenreyro (2006) we estimate the gravity model in the multiplicative form of equation (5) using the PPML estimator:

$$X_{ijt} = exp(\beta RTA_{ijt} + \eta_{it} + \nu_{jt} + \xi_{ij} + u_{ijt}), \tag{7}$$

where η_{it} is the exporter-time, ν_{jt} the importer-time and ξ_{ij} the (symmetric) pair fixed effect. The latter replaces the commonly added dyadic gravity variables of (the log of) distance, common languages, contiguous borders, and past colonial ties. Additionally, it captures unobserved time-invariant determinants of bilateral trade. Time-varying bilateral trade costs should be captured by the RTA indicator. In combination they allow us to estimate unbiased and consistent importer-time fixed effects Fally (2015). In what follows, we focus on imports and internal trade, since exports are exempt from the VAT. [14]

Second, the estimated importer-time fixed effects are regressed on the current VAT rate in place in the respective country:

$$\hat{\nu}_{jt} = \beta \cdot VAT_{jt} + \psi_j + \chi_t + \epsilon_{jt}. \tag{8}$$

VAT_{jt} represents the standard VAT rate in country j in year t. ψ_j and χ_t denote the country- and time-fixed effects respectively, to account for time-invariant components of multilateral resistance and for economic size.[15] They also control for common globalization

[14] Some research has hinted at imperfect rebating of the VAT for exports for Chinese exports; see Chandra and Long (2013), but since this effect is confined to China, we do not expect any variation of aggregate exports with the VAT for a representative country in our samples.

[15] Note carefully that these fixed effects also control for productivity changes. This is due to the modularity of structural gravity models that allows us to consider final goods trade only, see Anderson (2011).

effects. By controlling for the effects of size (E_j, Y_i^C) and the resistances ($\sum_{i=1}^{n}(\frac{t_{ij}}{Q_i})^{1-\sigma}$ and $\sum_{j=1}^{n}(\frac{t_{ij}}{P_j})^{1-\sigma}$) it is possible to estimate the effect of the VAT from variation in countries over time. If the VAT is in fact neutral, the coefficient of interest β should not be statistically significant.

Table 1: Gravity Import-FE and VAT

VAT Data	EU		Global
Trade Data	Cmtrd ('95-'19)	TrdPrd ('80-'06)	Cmtrd ('03-'19)
	(1)	(2)	(3)
VAT %	-0.052**	-0.039**	-0.081***
	(0.020)	(0.016)	(0.016)
Num.Obs.	631	490	1103

Note: Standard errors are clustered at the country level and are reported in parentheses. All models were estimated with country and year fixed effects.
Significance levels: *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1 depicts the results for the baseline specification of model (8). Only second stage results are presented, since we are only interested in the effects of VAT rate changes in the importer fixed effect. Columns (1)-(3) indicate a statistically significant negative coefficient of β implying that the VAT is not neutral. Note that with the country and year fixed effects in the second stage these effects are identified from within-country variation over time and not driven by large shocks affecting countries similarly.

While Table 1 shows significant (and sizable) effects,[16] its fixed effect structure implicitly assumes that economic size and average trade costs vary uniformly over all countries. Countries may, however, be hit by idiosyncratic productivity shocks or may change non-discriminatory trade policies (such as MFN tariffs). Furthermore, the dependent variable in equation (8) may also be driven by (un-)observable country-time specific confounders

[16]Note that the coefficients of the gravity model are additive on the log scale, thus, the marginal effect of a one percentage point increase of the VAT rate is given by $1 - \exp[\beta]$. Furthermore, the country fixed effects in the second stage control for the use of different currencies between countries.

for which we cannot control in a one-sector model. To obtain a dependent variable that varies at the country-year level, we estimate a two-sector model by exploiting the fact that reduced VAT rates apply to foodstuffs in most countries, in particular in the EU. Reduced rates to identify changes in trade due to between-type variation in VAT rates, and data on trade filtered for food(-stuffs) and the applicable reduced rates are available at the country-year level. Therefore we extend the two-stage procedure to include two sectors: a consumption good and a food sector. The gravity model is estimated with importer-sector-time, exporter-sector-time and sector-pair fixed effects. In the second stage, the importer-sector-time fixed effects are regressed on the sector's applicable rate, as well as on sector-year, sector-country and country-year fixed effects.[17] This model is only estimated for EU countries, since the applicable rates for food can be clearly identified from the EC report.[18] Results are shown in Table 2. Because of the rich fixed-effect structure, the model for importer fixed effects are reported with one-way (country-sector) and three-way (at all fixed effect levels) clustering.

We find a negative effect of VAT rates on import FE, even when using only between-type variations in VAT rates while controlling for any factor impacting the inward multilateral resistance terms at the country-year level. When clustering at the country-sector level, the coefficient is significant at the 5 percent level, with three-way clustering even at the 1 percent level. The coefficient is smaller than the previous estimates for importer-fixed effects, yet still in the same order of magnitude and still economically significant. Even at this smaller coefficient, the increase in imports (including from domestic producers) for a one percentage reduction in VAT rates would be 3.05 %.

Finally, the non-neutrality of the VAT could be driven by internal trade rather than international trade flows. It is possible that only internal trade responds strongly to VAT changes while external trade is neutral in the sense that it stays constant and unaffected by VAT changes. To ensure that our results generalize to international trade flows we re-estimate the two-sector model of Table 2, columns (1) and (2), on the TradeProd data that includes only international trade flows and report the result in Table 2, columns

[17] We have also run regression (8) using additional control variables, and results hardly change; these results are available upon request. In any case, the use of country-year fixed effects is more consistent than including a selective number of control variables.

[18] Some countries apply the standard rate or a zero rate to food, reducing available variation over time.

Table 2: Two-Sector Model

	TrdPrd & EU VAT, '80-'06		TrdPrd & EU VAT, '80-'06 w/o internal trade	
	Import FE (1)	Import FE (2)	Import FE (3)	Import FE (4)
appl. VAT %	-0.031**	-0.031***	-0.016*	-0.016**
	(0.014)	(0.009)	(0.008)	(0.006)
Num.Obs.	888	888	866	866

Note: Shown are results from a linear fixed effects model. Standard errors are clustered at the country-sector level for model (1) and (3). For model (2) and (4) standard errors are calculated using three-way clustering at the country-sector, sector-year and country-year levels. Standard errors are reported in parentheses. All models were estimated with country-sector, sector-year and country-year fixed effects. The dependent variable are importer-sector-time and exporter-sector-time fixed effects from a two-sector gravity model estimated with PPML.
Significance levels: *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

(3) and (4). Again, we find that the effect of the VAT on import-time fixed effect does not disappear. The coefficient is halved and now only significant at the 10 and 5 percent level respectively. While the results appear less robust, removing internal trade flows decreases importer-time and importer-sector-time fixed effects. Therefore, the second-stage dependent variable has a smaller range with internal trade flows removed, as long as internal trade flows were a significant share of a country's total trade (which they are in the TradeProd data).

All in all, these results lead to the conclusion that the VAT is not neutral. In our structural gravity framework Lemma 1 implies that either some $\epsilon_{ij,\tau_j} \neq 0$ and that $\phi_j < 1$; c.i.f. producer prices change and/or revenues are not completely returned to consumers. If producer prices were to change not only in absolute but also in relative terms, consumers would substitute between goods and the VAT would potentially be discriminatory. If the lump-sum transfer of the revenues would be smaller than revenues but relative prices were unchanged, the VAT would be non-neutral due to income effects but non-discriminatory

in the sense that relative trade flows would not change. The analysis so far provides no direct evidence that relative prices change. Nevertheless, the results from excluding internal trade flows indicate that the VAT may also be discriminatory, a question which will be more thoroughly analyzed in the following section.

4.2 The effect of the VAT on internal trade

So far we have illustrated that both international and internal trade decline with an increase in the (importing) country's VAT rate. While this result implies non-neutrality of the VAT it speaks little to the question of non-discrimination. To answer the question of non-discrimination, we are interested in the effects on imports relative to internal trade: do imports react more, less or proportionately to VAT rate changes compared to internal trade? First we must distinguish between internal and international trade flows in the data and examine the relative changes between the two types of flows. Empirically, this is done within an estimated gravity model using the methodology of Beverelli et al. (2018) and Heid et al. (2021). It includes a border indicator distinguishing between international and internal trade flows and an interaction with the VAT rate of the importing country. Though the method was originally devised to analyze non-discriminatory trade policies which do not affect internal trade, it is applicable to policy instruments that affect both internal and international trade. In particular, it is necessary to directly include τ_j in the gravity estimation. Additionally, to ensure unbiased estimates in the presence of globalization effects, a border-year fixed effect ζ_{ijt} should be added. The latter captures the reduced costs of international trade relative to domestic trade due to changed economic interdependence and integration. We thus estimate the following model with border-year fixed effects using a PPML estimator:

$$X_{ijt} = exp\left(\beta_1 RTA_{ijt} + \beta_2 BORDER_{ij} * VAT_{jt} + \eta_{it} + \nu_{jt} + \xi_{ij} + \zeta_{ijt} + u_{ijt}\right), \quad (9)$$

where the coefficient β_2 measures the *additional* impact of the VAT on imports from a foreign country compared to internal trade. That is, a positive (negative) coefficient will indicate that international trade responds less (more) to VAT changes than internal trade, while a null results would indicate non-discrimination. The absolute trade costs – i.e. how much internal consumption and international imports combined are reduced for a given

increase in the VAT rate – are still captured by the importer-time fixed effect. Since the coverage of internal trade in our data is crucial for this estimation strategy we use only the TradeProd data set. We combine it with the the VAT data set of the EU only as we have only an overlap of three years for the world date set and the TradeProd data set, so that we introduce a $BORDER * VAT_{EU}$ interaction term.[19] Furthermore, we also estimate the followings model using the traditional approach, that is,

$$X_{ijt} = exp\left(\beta_1 RTA_{ijt} + \beta_2 BORDER_{ij} * VAT_{jt} + \beta_3 dist + \beta_4 border + \beta_5 lang + \beta_6 col + \eta_{it} + \nu_{jt} + u_{ijt}\right), \quad (10)$$

that includes observable gravity variables such as the log of distance (*dist*), contiguous border (*border*), common language (*lang*) and former colonial ties (*col*). Using the EU data comes at the cost of dropping all trade flows where the importer is not an eventual EU country applying a VAT in that year, but the resulting coefficient estimate can still be usefully interpreted as a local treatment effect for EU countries.

The results are shown in Table 3. We see sizable negative coefficients for the interaction with EU rates that are statistically significant at the 5 and 1 percent level, respectively. This indicates that, as EU countries increased their VAT rates, imports decreased relative to internal trade. A one percentage point increase in the standard VAT rate of the importing country leads to a decrease in imports from a foreign country relative to internal trade between 5.4 % to 7.9 %. Although this estimate is EU-specific, it suggests that the VAT discriminates against international trade even though it is applied uniformly to all final goods sales.[20]

Given the empirical result of discrimination of the VAT, the question remains which factors drive this result. In line with the theoretical model derived in section 2 we find that the relative trade flow from countries i and k to country j, that is,

[19] The border dummy is one for each national border, irrespective of whether countries are both members of the same RTA.

[20] We have also estimated models (9) and (10) using global VAT rates in the interaction term, and unsurprisingly results are less clear. While we do see negative coefficients in the same order of magnitude as those for the EU rate models, they are smaller and not statistically significant at conventional levels due to the much smaller sample size and observational period. Details are available upon request.

Table 3: Discriminatory VAT

	(1)	(2)
RTA	0.882***	0.578***
	(0.209)	(0.127)
Border X VAT (EU)	-0.054**	-0.079***
	(0.026)	(0.028)
Log Distance		-0.361***
		(0.084)
Contiguous Border		0.232*
		(0.122)
Common Language		0.762***
		(0.091)
Colony		0.222**
		(0.102)
Num.Obs.	37550	37295

Note: Shown are results from a gravity model estimated using PPML. Standard errors are clustered at the country-pair level and shown in parantheses. Both models are estimated with importer-time and exporter-time fixed effects. Model (1) also includes symmetric pair fixed effects. Both models also include border-year fixed effects.
Significance levels: *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

$$\frac{X_{kj}}{X_{ij}} = \left(\frac{\alpha_k c_k t_{kj}}{\alpha_i c_i t_{ij}} \right)^{1-\sigma}$$

does not depend on the VAT rate. Hence, if c.i.f. prices do not respond to VAT rate changes, or respond proportionately, also internal trade does not change relative to external trade which would imply that the VAT rate is neither discriminatory nor import-promoting. As we do not find this result in our empirical analysis, we now scrutinize the effect of price changes in more detail. For this purpose, we define

$$\zeta_j = \frac{X_{jj}}{\sum_{i \neq j} X_{ij}} = \frac{(\alpha_j p_{jj})^{1-\sigma}}{\sum_{i \neq j} (\alpha_i p_{ij})^{1-\sigma}} \tag{11}$$

as the ratio of internal trade in final goods to the aggregate imports of final goods. Let $s_{ij} = X_{ij} / \sum_{i \neq j} X_{ij}$ denote the share of country i's final goods exports to country j to all imports of country j. We find:

Proposition 1. *Internal trade in final goods increases relative to aggregate imports of final goods if the relative price change of p_{jj} is smaller than the sum of relative prices changes of $p_{ij}, i \neq j$, weighted by the import shares s_{ij}.*

Proof. Total differentiation of (11) yields

$$\frac{d\zeta_j}{\zeta_j} = (\sigma - 1) \left[\sum_{i \neq j} s_{ij} \frac{dp_{ij}}{p_{ij}} - \frac{dp_{jj}}{p_{jj}} \right].$$

□

Suppose country j experiences an increase of the VAT rate and domestic and foreign firms bear part of the tax burden. Proposition 1 reads such that internal trade relative to imports increases if and only if the producer price of the home final good decreases stronger than the weighted average producer price of all imported final goods ($0 > \sum_{i \neq j} s_{ij} \frac{dp_{ij}}{p_{ij}} > \frac{dp_{jj}}{p_{jj}}$). This implies that the pass-through of the VAT to consumers needs to be smaller for home firms than for foreign firms. The result of the non-neutrality of the VAT as illustrated in subsection 4.1 is also driven by changes in relative prices and might be further intensified by an incomplete return of the tax revenue to consumers.

In line with our model we can identify three potential channels that may explain our results. First, changes in the VAT may also result in changes in absolute trade cost, i.e., increased customs scrutiny and/or higher administrative cost. These changes in absolute trade cost affect only international trade and result in a price increase of all foreign varieties compared to the home variety. While theoretically feasible, potential changes in trade cost are to a large extent captured in the rich fixed effects structure of eq. (9). The border-year fixed effect captures potential changes in border enforcement, while the

importer-year fixed effect controls average changes in the administrative workload for all trading partners.

Second, different price responses could be the result of a productivity increase from public goods provision. This would imply that both domestic and importing firms as well as consumers share the economic burden of the VAT and that part of the revenues will be invested into (local) public good provision. While importing firms share some of the burden of the tax, public good provision and the subsequent productivity increases benefit only domestic firms. Passing a share of these productivity gains on to consumers in the form of price reductions leads to a differential price response and effectively a lower pass-through of the VAT for domestic firms.[21] While we empirically control for average annual productivity changes across importers and exporters, importer-year and exporter-year fixed effects do not capture productivity changes between importers and domestic producers. Consequently, the coefficient of interest may reflect differential productivity responses and thus price changes. However, this would imply that tax increases and subsequent revenues are only raised when the public good is provided leading to an immediate increase in productivity and falling producer prices of domestic firms.

Third, relative prices may adjust due to changes at the extensive margin because some importers leave the market. Bearing some of the burden of a potential VAT change, importers may no longer find it profitable to serve the market in country i and exit while domestic firms stay active. When some importers exit, the overall market composition changes such that the share of domestic firms increases. Domestic firms charge lower markups causing relative prices to decrease.[22] Empirically, the average change in market composition is again absorbed by the importer-year fixed effect. However, the market exit of importers and the subsequent changes in market shares and average productivity of importers affect domestic and firms differently. This deviation from the mean is captured by the coefficient of interest and can rationalize our empirical finding of discrimination.

[21] Note that this channel could also be an explanation for the distinct global increase in the VAT. Governments have an incentive to increase the VAT as non-residents bear some of the tax burden, but revenues benefit only residents. This incentive structure is theoretically and empirically well-documented in the public finance literature.

[22] Appendix A.1 offers a simple model of firm entry and exit to illustrate the extensive margin effect.

5 Welfare effects of the VAT

What are the welfare effects of changes in value added taxation? In general, a number of model components are affected by the VAT including relative consumption, public spending, the efficiency of final good production, final goods and factor prices as well as firm profits. Factor price changes and the redistribution of tax revenues will affect expenditures, and productivity changes will affect the pricing behavior of firms. We follow Arkolakis et al. (2012) to accommodate these effects in the theoretical model developed in section 2. For this purpose, we have to distinguish between the value of imports which is given before VAT in c.i.f. terms and expenditures which include the VAT.

Let $e_{ij} = \tau_j X_{ij}$ denote the expenditures of consumers in country j on goods produced in country i, and let $\lambda_{ij} = e_{ij}/E_j$ denote the respective expenditure share. The change of any variable z from its level z^0 before to the level z^1 after the VAT change is denoted by $\widehat{z} \equiv z^1/z^0$. Furthermore, welfare is determined by the representative consumer and given by $W_j = U(q^*_{ij})$. We find:

Proposition 2. *The welfare change due to a change in the VAT rate is given by*

$$\widehat{W}_j = \widehat{E}_j \frac{\widehat{\lambda}_{jj}^{\frac{1}{1-\sigma}}}{\widehat{p}_{jj}\widehat{\tau}_j} = \left(\frac{\widehat{E}_j}{\widehat{\tau}_j}\right)^{\frac{\sigma}{\sigma-1}} \frac{\widehat{X}_{jj}^{\frac{1}{1-\sigma}}}{\widehat{p}_{jj}}.$$

Proof. See Appendix A.2. □

The first part of Proposition 2 shows that – as in Arkolakis et al. (2012) – only changes in domestic variables affect overall welfare in country j. An increase in the expenditure share on domestically produced final goods ($\widehat{\lambda}_{jj}$) will decrease welfare as it is the outcome of protection: consumers consume more final goods from the home firms at the expense of final goods from other countries. Furthermore, welfare decreases as local firms charge higher prices for domestic consumers and/or the VAT rate increases. Additionally, overall welfare will be affected by changes in expenditures stemming from changed factor rewards, a larger income from the redistribution of tax revenues and a change in profits. As we do not observe the change in relative expenditure e_{jj}/E_j, Proposition 2 has also developed the welfare effects in terms of the relative change in internal trade which we are able to calculate. In the following we quantify the welfare effects of VAT rate changes by

combining the empirical results from subsections 4.1 and 4.2 with Proposition 2. Given the geographical scope of our empirical results, the welfare analysis is confined to the EU context.

To calculate the welfare effects from a VAT rate change we need to make several assumptions. For the elasticity of substitution, we use $\sigma_1 = 3.8$, the median value result of the meta-study by Bajzik et al. (2020), and $\sigma_2 = 5.03$, the preferred estimate of the literature survey of Head and Mayer (2014).[23] Furthermore, we normalize the consumer price to unity prior to the VAT change. All welfare changes are calculated for an increase in the VAT rate by one percent for an average country in the EU. In our data set, the average VAT rate is given by $\bar{\tau} = 1.1962683$, so a one percentage point increase implies $\widehat{\tau} = 1.2062683/1.1962683 = 1.00836$. Table 2 in subsection 4.1 indicates that a conservative estimate implies a decrease in aggregate trade of at least 3.05 % due to an increase in the VAT rate by 1 percentage point. Given this result and Proposition 2, a one percentage point VAT increase implies $\widehat{E}_j = 1.0084 \times 0.9695 = 0.9776$. We do not observe $\widehat{X}_{jj}$ directly, but we know that aggregate trade declines by 3.05 % while external trade with a foreign country declines by an *additional* 5.4 % or 7.9 % on average according to Table 3.

Let γ denote the ratio of external trade to aggregate trade; if $\gamma = 0$, the respective country is in autarky; if $\gamma = 1$, the respective country has no own final good production for its own market. In any case, $\gamma\widehat{X}_{ij} + (1-\gamma)\widehat{X}_{jj} = \gamma(1+\beta_2)\widehat{X}_{jj} + (1-\gamma)\widehat{X}_{jj} = \widehat{X}_{ij}\left[1+\gamma\beta_2\right] = 1 - 0.0305 = 0.9695$ must hold for the average European country which implies $\widehat{X}_{jj} = 0.9695/(1+\gamma\beta_2)$ where $\beta_2 = -5.4\%$ or $\beta_2 = -7.9\%$. For the welfare analysis we employ the average ratio of external trade to aggregate trade in our data set which is given by $\bar{\gamma} = 0.6735$. Welfare effects are calculated for price responses which range from the complete absorption ($\widehat{p}_{jj}\widehat{\tau}_j = 1$) to complete pass-through ($\widehat{p}_{jj} = 1$) of domestic prices. In the first case, domestic producers reduce producer prices by the VAT increase, in the second case, producer prices remain unchanged. Given these prerequisites, we conduct the counterfactual analysis for three different sets of assumptions to shed light on different-policy relevant aspects of a VAT reform.

[23] $\sigma_2 = 5.03$ is also close to the value of 4.927 estimated by Gaubert and Itskhoki (2021) and the value of 5.39 estimated by Breinlich et al. (2020); both papers estimate σ using a structural, oligopolistic trade model.

First, we compute the welfare losses under the assumption that the tax revenue increase is completely unproductive, that is, that it is neither returned to consumers in any way nor used to increase productivity nor used to compensate for any other potentially income-increasing tax reform. Table 4 summarizes the results. Given the above assumptions, welfare declines by 3.13 to 4.92 % for the average country if the additional tax revenue is completely wasted. The results suggest that non-neutrality and discrimination of the VAT translate into substantial welfare losses if the tax revenue increase has no significant effect. How does this welfare loss come about? It can be shown that $\widehat{X}_{jj} > 1$ which translates into a partial welfare loss as internal trade increases and is complemented by a decline in expenditures.

Table 4: $1 - \widehat{W}_j$ in % for complete absorption ($\widehat{p}_{jj}\widehat{\tau}_j = 1$) to complete pass-through ($\widehat{p}_{jj} = 1$)

	β_2	
	-0.054	-0.079
$\sigma_1 = 3.8$	3.52 - 3.31	4.13 - 4.92
$\sigma_2 = 5.03$	3.13 - 3.94	3.56 - 4.36

To distinguish how much of these welfare losses are driven by the change in aggregate imports, we run the same welfare analysis also under the assumption that expenditures do not not change.[24] $\widehat{E}_j = 1$ implies a substantially lower decrease of 0.82 % in aggregate trade. Since expenditures cannot be expected to increase with the VAT, this number gives us a lower bound for our counterfactual welfare analysis. In this case, however, welfare effects do not vanish as the coefficient estimates of subsection 4.2 can still be used and show that internal trade decreases compared to external trade. Table 5 shows that the welfare changes are smaller, but still substantial. Tables 4 and 5 establish a benchmark of what the increase in tax revenue has to achieve in order to make the VAT increase at least welfare neutral.

Second, we assume that the revenue raised from a one percentage point VAT increase is entirely used for public good provision G_j to raise total factor productivity A_j. Thus, the efficiency of local production is increased which translates into a lower unit cost and

[24]This approach is applicable if only the sign and significance level but not the size of the coefficients presented in Table 2 were to be taken at face value. Following Fally (2015) and Yotov et al. (2016) the two step procedure outlined in section 4.1 yields unbiased estimates.

Table 5: $1 - \widehat{W}_j$ in % for complete absorption ($\widehat{p}_{jj}\widehat{\tau}_j = 1$) to complete pass-through ($\widehat{p}_{jj} = 1$) and for $\widehat{E}_j = 1$

	β_2	
	-0.054	-0.079
$\sigma_1 = 3.8$	2.42 - 3.23	3.04 - 3.84
$\sigma_2 = 5.03$	1.94 - 2.75	2.37 - 3.18

potentially lower prices. Remember that the domestic welfare effect depends only on the price change of domestically produced final goods for domestic consumers. Given these assumptions, we can compute by how much the domestic price must decrease in order to keep welfare constant. We do a similar exercise as above and report the results for $\widehat{E}_j < 1$ as in Table 4 (the results for $\widehat{E}_j = 1$ are available upon request). Table 6 illustrates that these price reductions have to be substantial and should not fall short of 5.27 % in the average country if the increase in tax revenues is completely used for increasing the provision of the public good. Consequently, productivity gains from the additional public good need to be large and at least partially passed on to consumers through substantial domestic price reductions.

Table 6: $1 - \widehat{p}_{jj}$ in % for $\widehat{W}_j = 1$

	β_2	
	-0.054	-0.079
$\sigma_1 = 3.8$	5.85	6.44
$\sigma_2 = 5.03$	5.27	5.69

Third, we consider the case where the VAT increase is employed to compensate for a potentially income-increasing income or cooperate tax reform. The question is how much income a reduction in the personal or corporate income tax must generate to make up the welfare losses from a VAT increase. Table 7 illustrates that income should at least increase by 2.58% for the tax reforms to be welfare neutral.

All exercises show that the (negative) welfare effects of the VAT are substantial. For a VAT change to be welfare neutral, productivity gains from additional public good provision need to be disproportionately larger than the VAT rate change. At the same time, if the VAT increase is a substitute for another tax reform, the additional income that must generated by this reform must be substantial, too. These welfare implications are

Table 7: $\widehat{Y}_{jj}$ in % for complete absorption ($\widehat{p}_{jj}\widehat{\tau}_j = 1$) to complete pass-through ($\widehat{p}_{jj} = 1$) and for $\widehat{W}_j = 1$

	β_2	
	-0.054	-0.079
$\sigma_1 = 3.8$	2.68 - 3.31	3.16 - 3.79
$\sigma_2 = 5.03$	2.58 - 3.27	2.94 - 3.63

calculated for a representative consumer and are thus not driven by the effects of changes in the distribution of income on heterogeneous consumer types. It is thus noteworthy that the VAT has substantial welfare effects even in this environment that is completely agnostic on distributional effects.

6 Concluding remarks

In this paper we analyze whether the VAT is neutral and or non-discriminatory. Using a structural gravity model and novel global VAT regime information, we demonstrate that VAT rate increases not only imply a reduction in aggregate imports, but also an increase of internal trade relative to aggregate imports. Thus the VAT is neither neutral nor non-discriminatory. For the analysis we develop a comprehensive theoretical structural gravity model that relies on less restrictive assumptions than the previous literature while fully rationalizing our empirical results and also allowing us to conduct an equilibrium welfare analysis. We illustrate that the welfare effects of a one percentage point increase in the VAT rate are substantial and lie between 1.94 and 4.92 % for an average EU country. These results challenge the conventional perception that the VAT is a policy instrument with little to no economic distortions. If the VAT increase improves public good provision, a welfare neutral VAT change requires substantial productivity gains; if it is part of a larger tax reform, it has to imply substantial income increases. The empirical results are derived using recent advancements in the estimation of non-discriminatory trade policies in the structural gravity framework. To the best of our knowledge, this paper is the first to empirically investigate the question of trade discrimination in the context of the VAT.

Given our results, policy-makers should be aware that VAT rate changes have substantial effects on trade patterns and welfare implications even when distributional effects are disregarded. While the VAT is legally a non-discriminatory policy instrument, its effect

is discriminatory and non-neutral and thus distortionary. Our paper has shown that the reason for this welfare loss must originate from different price responses of importers and local producers. In particular, local producers seem to respond to a VAT increase with larger c.i.f. producer price reductions than importers, and this changes the relative consumer prices in favor of local producers. Thus, our results point at substantial differences in the pass-through of the VAT between local and international final good producers. Consequently, increasing the VAT as a compensation for other tax reductions should be conducted more carefully. Our model also gives some guidance on tax reforms as it is able to demonstrate how large the welfare effects of reducing distortions must be when tax revenue effects should be compensated by VAT increases.

The result that internal trade increases relative to aggregate imports indicates that governments could (un-)intentionally use the VAT not only as a tax but also a trade policy tool. Given the substantial global rise in VAT rates, governments may have already engaged in this new type of discriminatory trade policy by compensating falling tariff levels through VAT increases. Exploring the details of these responses requires a model of which can explain the differential markup behavior of firms and/or different market entry behavior of domestic and foreign firms. Future research could also focus on the question whether these developments are particularly relevant in common markets like the EU or if they also generalize to RTAs as well. We leave such an analysis to future research.

Appendix

A.1 A simple model of firm entry

We consider a perfect competition model of trade with n countries. Each country i hosts N_i firms, and each firm is able to sell one unit (or none) in each country. Each firm draws its unit cost realization from a distribution $F(\cdot)$ that has positive support between 0 and $\bar{c}$. We focus on sales in country j, and each foreign firm located in country i has to carry an iceberg trade cost of size t_{ij} when serving country j; we normalize internal trade costs such that $t_{jj} = 1$. Consequently, a firm located in country i sells a unit in country j if its cost realization is less or equal to $p_{ij}/(\tau_j t_{ij})$.

In equilibrium, each firm correctly anticipates demand and supply for each variety i sold in country j to clear such that

$$q_{ij} = \frac{E_j p_{ij}^{-\sigma}}{\sum_{k=1}^{n} p_{kj}^{1-\sigma}} = \min\left[F\left(\frac{p_{ij}}{\tau_j t_{ij}}\right), 1\right] N_i \tag{A.1}$$

holds where we have set $\alpha_i = 1$ w.l.o.g. The LHS is the demand for variety i in country j, and the RHS is the supply that is the fraction of firms serving country j times the number of firms located in country i. We find for $k \neq i$ that

$$\begin{aligned}
\frac{\partial q_{ij}}{\partial p_{ij}} &= -\frac{q_{ij}}{p_{ij}}\left(\sigma - (\sigma-1)\frac{p_{ij}q_{ij}}{E_j}\right) = -\frac{q_{ij}}{p_{ij}}\left(\sigma - (\sigma-1)s_{ij}\right) < 0 \text{ and} \\
\frac{\partial q_{ij}}{\partial p_{ik}} &= \frac{q_{ij}}{p_{ij}}(\sigma-1)\frac{p_{kj}q_{kj}}{E_j} = \frac{q_{ij}}{p_{ij}}(\sigma-1)s_{kj} > 0,
\end{aligned}$$

where s_{ij} denotes the market share of country i in country j. Let

$$z_{ij} = F\left(\frac{p_{ij}}{\tau_j t_{ij}}\right) N_i$$

denote supply in case that $\min[F\left(p_{ij}/(\tau_j t_{ij})\right), 1] < 1$. We find that

$$\begin{aligned}
\frac{\partial z_{ij}}{\partial p_{ij}} &= \frac{f\left(p_{ij}/(\tau_j t_{ij})\right)}{\tau_j t_{ij}} N_i > 0, \frac{\partial z_{ij}}{\partial p_{ik}} = 0 \text{ and} \\
\frac{\partial z_{ij}}{\partial \tau_j} &= -\frac{f\left(p_{ij}/(\tau_j t_{ij})\right) p_{ij}}{\tau_j^2 t_{ij}} N_i < 0.
\end{aligned}$$

We now consider the case that all producers in the domestic country j serve their own country because $p_{jj}/\tau_j < \bar{c}$, that is, $F\left(p_{jj}/\tau_j\right) = 1$ holds before and after the VAT change. All foreign producers, however, select themselves into exporters and non-exporters because $F\left(p_{ij}/(\tau_j t_{ij})\right) < 1$. In order to keep the model analytically tractable, we assume that all foreign countries are symmetric, and we use p_j, q_j, s_j now to denote the equilibrium price, demand and market share, respectively, of domestic producers, and p_i, q_i, s_i to denote the symmetric foreign prices, demands and market shares, respectively. We now scrutinize how the relative c.i.f. price p_j/p_i is affected by a marginal increase in the VAT rate τ_j. Total differentiation yields

$$\overbrace{\frac{\partial q_j}{\partial p_j}}^{a_{jj}}\frac{dp_j}{d\tau_j}+\overbrace{(n-1)\frac{\partial q_j}{\partial p_i}}^{a_{ji}}\frac{dp_i}{d\tau_j}=0,$$
$$\underbrace{\frac{\partial q_i}{\partial p_j}}_{a_{ij}}\frac{dp_j}{d\tau_j}+\underbrace{\left((n-1)\frac{\partial q_i}{\partial p_i}-\frac{\partial z_i}{\partial p_i}\right)}_{a_{ii}}\frac{dp_i}{d\tau_j}=-\underbrace{\frac{\partial z_i}{\partial \tau_j}}_{a_\tau},$$

where $a_\tau < 0$ and

$$\begin{aligned}
a_{jj} &= -\frac{q_j}{p_j}\left(\sigma-(\sigma-1)s_j\right)<0,\\
a_{ji} &= (n-1)\left(\frac{q_j}{p_j}(\sigma-1)s_i\right)>0,\\
a_{ij} &= \frac{q_i}{p_i}(\sigma-1)s_j>0,\\
a_{ii} &= (n-1)\left(-\frac{q_i}{p_i}\left(\sigma-(\sigma-1)s_i-\frac{f\left(p_i/(\tau_j t_i)\right)}{\tau_j t_i}N_i\right)\right)\\
&< -(n-1)\left(\frac{q_i}{p_i}\left(\sigma-(\sigma-1)s_i\right)\right)<0.
\end{aligned}$$

The changes are given by $dp_j/d\tau_j = a_{ji}a_\tau/\det(A)$ and $dp_i/d\tau_j = -a_{jj}a_\tau/\det(A)$ where

$$\det(A)=a_{jj}a_{ii}-a_{ji}a_{ij}>\frac{(n-1)\sigma q_i q_j\left(\sigma-(\sigma-1)s_i-(\sigma-1)s_j\right)}{p_i p_j}>0$$

because $g(\sigma)\equiv\sigma-(\sigma-1)s_i-(\sigma-1)s_j$ implies $g(1)=1$ and $g'(\sigma)1-s_i-s_j\geq 0$ as $s_i+s_j\leq 1$. The relative c.i.f. price change is given by

$$\frac{dp_j}{dp_i}=-\frac{a_{ji}}{a_{jj}}=\frac{(n-1)(\sigma-1)s_i}{\sigma-(\sigma-1)s_j}=\frac{(\sigma-1)\left(1-s_j\right)}{\sigma-(\sigma-1)s_j}=1-\frac{1}{\sigma-(\sigma-1)s_j}<1 \qquad \text{(A.2)}$$

because $(n-1)s_i = 1-s_j$. Eq. (A.2) shows that the c.i.f. price change is smaller for domestic producers than for foreign producers, implying an increase in relative demand for the domestically produced good.

A.2 Proof of Proposition 2

Totally differentiating the price index yields

$$d\ln P_j = \sum_{i=1}^{n} \lambda_{ij} d\ln p_{ij} + d\ln \tau_j.$$

Since $\lambda_{ij} = (p_{ij}\tau_j/P_j)^{1-\sigma}$, $\lambda_{kj}/\lambda_{ij} = (p_{kj}/p_{ij})^{1-\sigma}$. Taking logs and differentiating allow us to write any price change as a function of the change in the domestic price and the respective expenditure changes as

$$d\ln p_{ij} = d\ln p_{jj} + \frac{d\ln \lambda_{ij} - d\ln \lambda_{jj}}{1-\sigma},$$

which also allows us to rewrite the change in the price index as

$$\begin{aligned} d\ln P_j &= \sum_{i=1}^{n} \lambda_{ij} \left[d\ln p_{jj} + \frac{d\ln \lambda_{ij} - d\ln \lambda_{jj}}{1-\sigma} \right] + d\ln \tau_j \\ &= \frac{d\ln \lambda_{jj}}{\sigma - 1} + d\ln p_{jj} + d\ln \tau_j. \end{aligned} \tag{A.3}$$

The last line follows from $\sum_{i=1}^{n} \lambda_{ij} d\ln \lambda_{ij} = \sum_{i=1}^{n} d\lambda_{ij} = 0$ and $\sum_{i=1}^{n} \lambda_{ij} = 1$. Define $d\ln \Lambda_j = d\ln \lambda_{jj} + (\sigma - 1)[d\ln p_{jj} + d\ln \tau_j]$ such that we can write (A.3) as a differential equation

$$\frac{dP_j}{P_j} = \frac{d\Lambda_j}{(\sigma-1)\Lambda_j} \Leftrightarrow \frac{dP_j}{d\Lambda_j} = \frac{P_j}{(\sigma-1)\Lambda_j}$$

which has the solution $P_j = C\Lambda^{\frac{1}{\sigma-1}}$ with $C > 0$ as a constant. Let us denote the change in welfare as a transition from period 0 to period 1, denoted by superscripts, such that

$$\widehat{W}_j = \frac{W_j^1}{W_j^0} = \frac{E_j^1}{E_j^0}\frac{P_j^0}{P_j^1} = \widehat{E}_j \widehat{\Lambda}_j^{\frac{1}{1-\sigma}}. \tag{A.4}$$

where $\Lambda_j = \lambda_{jj}(p_{jj}\tau_j)^{\sigma-1}$ which – together with (A.4) – implies the first part of Proposition 2. Since $\lambda_{jj} = \tau_j X_{jj}/E_j$, we can also write the relative change in Λ_j as

$$d \ln \Lambda_j = d \ln X_{jj} - d \ln E_j + (\sigma - 1) d \ln p_{jj} + \sigma d \ln \tau_j$$

which implies

$$\Lambda_j = \frac{X_{jj}}{E_j} p_{jj}^{\sigma-1} \tau_j^{\sigma}$$

which – together with (A.4) – implies the second part of Proposition 2.

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