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The (Non-)Neutrality of Value Added Taxation

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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 conservative quantification of the welfare effects shows that a 1% increase in the VAT rate implies a welfare loss of at least 4.09 % for an average country in the European Union.

JEL-Classification: F10, F14, H22.

Keywords: Structural gravity, value-added taxation, neutrality, discrimination.

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, 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 to ac-

[1]Loretz (2008) and Thunecke (2021) provide illustrative evidence for the development of the VAT.

commodate for the existence of a VAT and deriving theoretical propositions regarding our research questions which we then proceed to test empirically. 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. This result on non-neutrality is robust to a number of different specifications and estimation strategies. 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. Following Arkolakis et al. (2012) and using our structural gravity model, we illustrate that the welfare implications of VAT changes are considerable: a one percent increase in the VAT rate leads to a welfare decrease of between 4.09 and 5.17 % in the European Union under the assumption that the domestic price adjustment absorbs the tax increase completely and local productivity remains unchanged. If we allow for productivity changes, we show that a welfare neutral VAT change requires substantial productivity gains from public good provision.

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. The most recent and most closely related paper estimating the effect of value-added taxation on trade flows comes from Benzarti and Tazhitdinova (2021). The authors 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.[2]

Their analysis focuses on EU countries, for which they combine data on VAT rates at the commodity level (HS 4-digit) with trade data in the period 1988-2016. The authors filter for final consumption goods according to the UN's Broad Economic Categories (BEC) classification of goods and disregard intermediate goods since the VAT can be fully recovered for intermediate inputs. In contrast to our results, they find a VAT elasticity of trade close to zero, with no significant anticipatory or delayed effects. These contradictory findings may be driven by differences in scope and methodology. While our study goes beyond the EU context using a balanced panel of trade data, Benzarti and Tazhitdinova (2021) focus exclusively on trade flows from and to EU members, thus disregarding trade flows between non-EU members. This potentially causes the results to be downwardly biased as the effects of VAT rate changes on non-EU members are only partially accounted for. Differences in the results may also stem from differing methodological approaches. Benzarti and Tazhitdinova (2021) estimate their model using a logarithmic transformation of trade flows, in combination with a reduced form OLS regression. In contrast, we use a structural gravity model and Poisson Pseudo Maximum Likelihood (PPML) estimator following Santos Silva and Tenreyro (2006). This allows us to properly account for zero trade flows and heteroskedasticity which may also drive differences in the results.

Second, we contribute to the theoretical literature on the effects of the VAT on trade by incorporating the VAT in the existing structural gravity framework. In contrast to the existing literature our structural gravity model relies on less restrictive assumptions

[2] Benzarti and Tazhitdinova (2021) 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.

and can fully rationalize our findings. Furthermore, we are able to calculate the welfare implications of VAT rate changes by using our empirical results in our theoretical model. The welfare analysis is conducted for a representative consumer effectively disregarding adverse effects on the distribution of income and subsequently different types of consumers. 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 (see also Anderson, 1979, and Eaton and Kortum, 2002). 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] In particular, Anderson and van Wincoop (2003) show that it is not only the direct effect of trade costs between two countries that explains trade flows, but also the ease of access to and for all other trading partners that is important. These general equilibrium effects are collected by the multilateral resistance terms that measure the ease of access for all exporters to a country and the ease of consumers to purchase goods from all other countries.[4] The structural gravity model has been extremely successful 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).

Third, 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 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

[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).

[4]For the importance of including multilateral resistance terms, see also Baldwin and Taglioni (2006).

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 Benzarti and Tazhitdinova (2021) as they consider only international trade flows which might also explain differences in the results.

The remainder of this paper is organized as follows. Section 2 sets up the model and develops three propositions 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. 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 country j and L_i^G is the labor input in public good provision. Intermediate imports 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 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] This is in

[6]The role of market power and markups has been emphasized recently in the literature, see for example

particular important as we will identify conditions under which price changes will occur. 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,

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

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

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 does the VAT affect expenditures, imports and internal trade? This will also depend on the response of the c.i.f. producer price p_{ij} to a change in τ_j. No change in p_{ij} would be the outcome of both perfect and monopolistic competition models. In case of perfect competition, t_{ij} reflects the pure trade friction as prices before VAT are equal to marginal costs of serving market j out of market i. In case of monopolistic competition, t_{ij} does not only reflect the pure trade friction but also the constant markup $\sigma/(\sigma - 1)$. 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

[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).

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

where

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

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

Proposition 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 $dX_{ij}/d\tau_j = 0$.

□

Proposition 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.

While Proposition 1 offers an interesting benchmark, we can also conclude that neutrality is unlikely if firms change prices and their responses are not symmetric, and if tax revenues are not completely returned to the representative consumer, but we have to find out empirically whether and how imports and internal trade will change. How do relative imports change with the tax rate? We find that

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

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

$$\zeta_j = \frac{X_{jj}}{\sum_{i\neq j} X_{ij}} = \frac{\left(\alpha_j p_{jj}\right)^{1-\sigma}}{\sum_{i\neq j}\left(\alpha_i p_{ij}\right)^{1-\sigma}} \tag{7}$$

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 2. *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 (7) yields

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

□

Proposition 2 shows that value added taxation will be discriminatory if the price increase of the home variety is smaller than the market-share-weighted price increases of all foreign varieties. Suppose country j experiences an increase of the VAT rate and domestic and foreign firms alike bear part of the tax burden. Proposition 2 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.

What are the welfare effects of value added taxation? In general, these depend on the effects of VAT changes on a number of model components including relative consumption, redistribution of tax revenues, public good provision and productivity of final good production, final goods and factor price changes and profits. How can we accommodate these effects? Factor price changes and the redistribution of tax revenues will affect expenditures, and productivity changes will affect the pricing behavior of firms. We now follow Arkolakis et al. (2012) and develop how a change in expenditures on domestically produced final goods will affect any welfare change. 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 3. *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.1. □

The first part of Proposition 3 shows that – as in Arkolakis et al. (2012) – only the change in the expenditure share on domestically produced final goods matter. Note that an increase in λ_{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, only the change in the price charged by local firms for domestic consumers matters in addition to the change in the VAT rate. Additionally, the change in expenditures could come about due to a change in factor rewards, a larger income from the redistribution of tax revenues and a change in profits. We have also expressed the welfare changes in terms of the relative change in internal trade, as we are able to calculate this effect, but not the change in relative expenditures e_{jj}/E_j. In any case, Proposition 3 allows us to identify several channels of potential welfare changes. For example, if the effect of the VAT on aggregate imports is substantial, it will reduce welfare due to lower expenditures. At the same time, an increase (decrease) in internal trade will amplify (mitigate) this negative welfare effect. Furthermore, the welfare effects will also depend on the change in domestic pricing behavior.

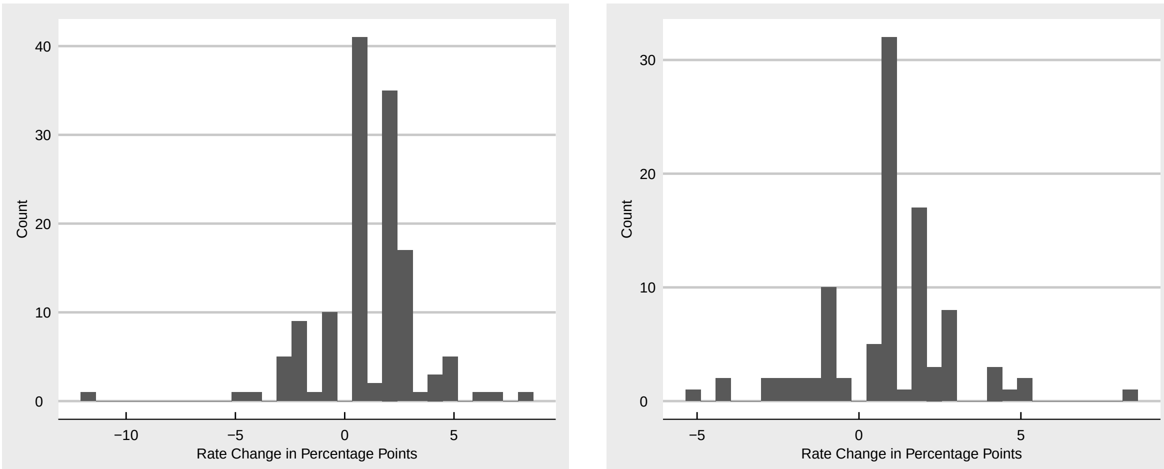
All in all, the structural gravity model developed above is very flexible in the sense that it relies on less restrictive assumptions than previous theoretical contributions on the relationship between VAT rates and international trade. The standard theoretical literature often relies on restrictive 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 in Proposition 1 it can produce the result of trade neutrality of the VAT under similarly restrictive assumptions as the previous literature. However, 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.

3 Data

The empirical analysis of Propositions 1, 2 and 3 derived in section 2 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 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

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

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

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)

[10]Comtrade data in the BEC format are missing for many countries in the years 1996 and 1997. In

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 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-

the main analysis, these observations are not removed, but as shown in Appendix A.2, results remain unchanged if the panel is reduced to the period 1998-2019.

[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.

TradeProd combination we exclude the results for this combination from the main part of the analysis. [13]

For the analysis we also use several control variables. Information on regional trade agreements are taken from Egger and Larch (2008). As controls for country size we use GDP data at constant prices in millions of national currency from from Eurostat (EU panel) and the OECD (Global panel). Information on trade cost includes average tariff data which were retrieved from the World Bank and cost of insurance and freight data from CEPII's Trade Unit Values (TUV) data set. The TUV denotes the ratio of cost of insurance and freight per tonne of trade. We calculate average importer TUV by first averaging over products and then averaging over partners. 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 Proposition 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 investigate Proposition 2 and explore how internal trade changes compared to aggregate imports, and we show that a 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

[13]Results based on the Global-TradeProd combination do not contradict our main findings and are reported in the appendix A.3.

multiplicative form of equation (5) using the PPML estimator:

$$X_{ijt} = exp(\beta RTA_{ijt} + \eta_{it} + \nu_{jt} + \xi_{ij} + u_{ijt}), \tag{8}$$

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 importer-time fixed effects. In what follows, we focus on imports and internal trade, since exports are exempt from the VAT. We do not expect any variation of aggregate exports with the VAT.[14]

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

$$\hat{\nu}_{jt} = \beta \cdot VAT_{jt} + \psi_j + \chi_t + \epsilon_{jt}. \tag{9}$$

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 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 depicts the results for the baseline specification of model (9). Only second stage results are presented, since we are only interested in the effects of VAT rate changes

[14]Some research has hinted at imperfect rebating of the VAT for exports, in particular for Chinese exports Chandra and Long (2013). Therefore, we replicate all our estimations with exports as dependent variables. The results do not contradict our results and indicate that imperfect rebating is not a common pattern. These results are available from the authors upon request.

[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).

Table 1: Gravity Import-FE and VAT

VAT Data	EU		Global
Trade Data	Cmtrd ('95-'19) (1)	TrdPrd ('80-'06) (2)	Cmtrd ('03-'19) (3)
VAT %	-0.052** (0.020)	-0.039** (0.016)	-0.081*** (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: *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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). In order to control for size, we include GDP as a covariate.[17] Controlling for changes in the multilateral resistance terms proves more difficult as they are unobservable theoretical constructs. Theoretically, the multilateral resistance terms capture the ease of market access for importers and exporters. Consequently, we proxy for changes in the multilateral resistance term using country-level unweighted average trade costs and tariffs.[18] Trade cost are measured by the average

[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 $1 - \exp[\beta]$.

[17] The country fixed effects in the second stage control for the use of different currencies between countries.

[18] For trade costs and for tariffs there may be concerns with the method of aggregation. A weighted average rate where the weights are trade volume at that rate would understate the relevance of prohibitively high rates, where the volume would necessarily be zero. An unweighted mean, as chosen in our case,

importer trade unit values. The intuitive logic for using this proxy is that if average costs of insurance and freight change over time, it changes ease of market access. Results are shown in Table 2. Even with the reduced sample size, due to missing data on control variables, we find significant effects of the VAT on import fixed effects. Moreover, the coefficients are of similar magnitude as before.

Table 2: Gravity Import-FE and VAT with Controls

VAT Data	EU			Global
Trade Data	Cmtrd ('95-'19)	TrdPrd ('80-'06)	TrdPrd ('80-'06) w/o internal trade	Cmtrd ('03-'19)
	(1)	(2)	(3)	(4)
VAT %	-0.041*	-0.056**	-0.057***	-0.054***
	(0.022)	(0.020)	(0.016)	(0.018)
GDP	0.000	0.000	0.000*	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Trade Costs (import)	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Tariffs				-0.005
				(0.031)
Num.Obs.	499	154	154	644

Note: Shown are results from a linear fixed effects model. Standard errors are clustered at the country level and are reported in parentheses. All models were estimated with country and year fixed effects. The dependent variable are importer-time fixed effects from a gravity model estimated with PPML.
Significance levels: *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Furthermore, the dependent variable in equation (9) may be driven by (un-)observable country-time specific confounders 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,

on the other hand loses much information that would be present if the gravity model was estimated at a highly dis-aggregated level. As the gravity model aggregates over all consumption goods we must aggregate tariffs and trade costs as well and, thus, choose the simpler, unweighted, method. Note that for European countries tariffs are irrelevant, since the same tariffs are applied to all imports of the customs union since 1968.

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. This model is only estimated for EU countries, since the applicable rates for food can be clearly identified from the EC report.[19] Results are shown in Table 3. 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.

Table 3: 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: *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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

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

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 import 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 results for the TradeProd data in Table 2 column (2) without intra-national trade flows.[20] If our results were driven by the internal trade only, these empirical estimates should differ substantially from the ones including internal trade. The results of re-estimating Table 2 without intra-national trade flows are reported in Table 2 column (3). The coefficient estimate remains virtually unchanged – if anything, we note that the standard errors of model estimated on TradeProd data decrease.

We also re-estimate model 3 column (1) and (2) on the TradeProd data that includes only international trade flows and report the result in Table 3 column (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 Proposition 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

[20]Note that the Comtrade data does not contain internal trade flows.

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 equally applies to 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 followings model with border-year fixed effects using a PPML estimator:

$$X_{ijt} = exp\left(\beta_1 RTA_{ijt} + \beta_2 BORDER_{ij} * VAT_{jt} + \eta_{it} + \nu_{jt} + \xi_{ij} + \zeta_{ijt} + u_{ijt}\right), \qquad (10)$$

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.[21] Furthermore, we also estimate the followings model using the traditional approach, that is,

$$X_{ijt} = exp\left(\beta_1 RTA_{ijt} + \beta_2 BORDER_{ij} * VAT_{jt} + \beta_3 dist + \beta_4 border + \beta_5 lang + \beta_6 col + \eta_{it} + \nu_{jt} + u_{ijt}\right), \tag{11}$$

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 4. 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 consumption of the same consumption goods. 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. In line with Proposition 2, these results imply that the relative change of domestic producer prices p_{jj} is smaller than the change of the sum of all weighted importer prices p_{ij}; domestically produced goods become relatively cheaper. This change in relative prices implies different pass-through rates with domestic firms having a lower pass-through compared to importers. As both domestic producers and importers serve the same market, differences in the pass-through can be driven by variable markups due to oligopolistic competition. Given discrimination of the

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

VAT, non-neutrality as illustrated in 4.1 is also driven by changes in relative prices which might be further intensified by an incomplete return of the tax revenue to consumers.[22]

Table 4: 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: *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5 Welfare effects of the VAT

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 the theoretical model derived in section 2. Given the empirical results, the welfare analysis is confined to the EU context. For

[22]We have also estimated models (10) and (11) 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 level due to the much smaller sample size and observational period. Details are available upon request.

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. We conduct the counterfactual analyses under two different sets of assumptions to shed light on different policy relevant aspects of a VAT reform.

Table 3 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 %, and we will use this estimate in what follows. In a first exercise, we predict the welfare changes of an increase in the VAT rate by one percent in the EU.[24] We now use Proposition 3, and given that aggregate trade declines by 3.05 %, a one percent increase implies $\widehat{E}_j = 1.01 \times 0.9695 = 0.979195$. Furthermore, we make the (welfare-optimistic) assumption that $\widehat{p}_{jj}\widehat{\tau}_j = 1$ holds which implies that the VAT increase is completely absorbed by the domestic price adjustment. Domestic producers bear the entire burden of the VAT, and the reduction in expenditures is driven by income effects only. Assumption $\widehat{p}_{jj}\widehat{\tau}_j = 1$ implies:

$$\widehat{p}_{jj}\widehat{\tau}^{\frac{\sigma}{\sigma-1}}\widehat{\tau}^{\frac{-1}{\sigma-1}} = 1 \Leftrightarrow \widehat{p}_{jj}\widehat{\tau}^{\frac{\sigma}{\sigma-1}} = \widehat{\tau}^{\frac{1}{\sigma-1}},$$

which we can use to rewrite the welfare change of Proposition 3. Under these assumptions a one percent increase of the VAT rate implies a welfare change of:

$$\widehat{W}_j = \widehat{E}_j^{\frac{\sigma}{1-\sigma}}\left(\widehat{X}_{jj}\widehat{\tau}_j\right)^{\frac{1}{1-\sigma}} = (0.979195)^{\frac{\sigma}{1-\sigma}}\left(1.01\widehat{X}_{jj}\right)^{\frac{1}{1-\sigma}}. \tag{12}$$

We do not know $\widehat{X}_{jj}$, 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 4. Let γ denote the ratio of external trade to aggregate trade; if $\gamma = 0$, the

[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.

[24] Note that the 1 % increase of the VAT rate τ_j is not equivalent to a 1 % increase of the statutory commodity tax rate ψ_j. For example, if $\psi_j = 0.2$ to begin with, $\psi_j = 0.32$ after the increase of τ_j by 1 %.

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 $\beta_2 = -7.9\%$. The average ratio is given by $\bar{\gamma} = 0.6734958$ in our data set. We now calculate relative welfare losses $1 - \widehat{W}_j$ for $\bar{\gamma}$ and for the different β_2-estimates for this average country. Table 5 summarizes the results.

Table 5: $1 - \widehat{W}_j$ in % for $\widehat{p}_{jj}\widehat{\tau}_j = 1$

	β_2	
	-0.054	-0.079
$\sigma_1 = 3.8$	4.57	5.17
$\sigma_2 = 5.03$	4.09	4.51

Table 5 illustrates that, given the above assumptions, welfare declines by 4.09 to 5.17 % for the average country. It is easy to show that welfare decreases with γ as an increase in γ implies a larger $\widehat{X}_{jj}$, so we have also done sensitivity checks for $\gamma = 0.1241292$, the smallest realization in our data set, and $\gamma = 1$, the largest realization in our data set. The smallest welfare loss (for $\gamma = 00.1241292$) is equal to 3.36 % and the largest welfare loss (for $\gamma = 1$) is equal to 6.1 % which shows that the assumptions on γ and σ do not imply substantive differences in the welfare effects; these effects stay in a close range. Furthermore, the results suggest that non-neutrality and discrimination of the VAT translate into substantial welfare losses. 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. While this effect is relatively small as $\widehat{X}_{jj} = 1.01(1.02)$ for $\beta_2 = -0.054(-0.079)$, it is complemented by a substantial decline in expenditures. Relaxing the assumption that the producers do not pass on any VAT increase and allowing for some of the tax burden to be borne by consumers would lead to even more pronounced welfare losses. Benzarti and Tazhitdinova (2021), for example, conclude that consumers are likely to bear a substantial part of the VAT burden.

In a second exercise, we assume that the revenue raised from a one percent VAT increase is entirely used for public good provision G_j, and thus increases total factor productivity A_j. Thus, the efficiency of local production is increased which translates into a lower unit cost and potentially lower prices. Note 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 $\bar{\gamma}$. 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 $\widehat{W}_j = 1$ and $\widehat{\tau}_j = 1.01$

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

Both 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. These welfare implications are 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

This paper makes several contributions to the international trade and public finance literature analyzing the non-neutrality and discrimination of the VAT. First, 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 a conditional equilibrium welfare analysis. Second, we provide robust estimation results for the non-neutrality and discrimination of the VAT using a novel global VAT regime dataset and recent advancements in the estimation of non-discriminatory trade policies in the structural gravity framework. Third, we quantify welfare effects of a 1 percent VAT increase for different sets of assumptions. We demonstrate that the VAT is neither neutral nor non-discriminatory using a structural gravity model and novel global VAT regime information. VAT rate changes not only imply a reduction in aggregate imports, but also an increase of internal trade relative to aggregate imports. We have also illustrated that the welfare effects of a one percent increase in the VAT rate are substantial and lie between 4.09 and 5.17 % 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.

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 imply 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.

Models of perfect and monopolistic competition cannot explain these findings unless the pure trade frictions themselves change with the VAT. Alternatively, they might be driven by changes in the markups such that international final good producers respond differently than local final good producers. 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 markup behavior of firms due to imperfect competition. 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 Proof of Proposition 3

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

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

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.1) 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

$$\widehat{W}_j = \frac{W_j^1}{W_j^0} = \frac{E_j^1}{E_j^0}\frac{P_j^0}{P_j^1} = \widehat{E}_j \widehat{\Lambda}_j^{\frac{1}{1-\sigma}}. \tag{A.2}$$

where $\Lambda_j = \lambda_{jj}(p_{jj}\tau_j)^{\sigma-1}$ which – together with (A.2) – implies the first part of Proposition 3. 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.2) – implies the second part of Proposition 3.

A.2 Reduced Comtrade Panel

In this section we re-estimate the first and second stage regressions from Tables 1 and 2 on a reduced Comtrade data set which only includes the years 1998-2019. The reason is that for the years 1996 and 1997 there are no reports from a number of countries. Still, results are in line with those obtained on the period 1995-2019.

Table 7: Gravity FE and VAT, Reduced Panel (1998)

Dep. Var.	Import FE		Export FE	
VAT Data	EU '67-'20	World '03-'20	EU '67-'20	World '03-'20
	(1)	(2)	(3)	(4)
VAT %	-0.051**	-0.045*	-0.036	0.002
	(0.020)	(0.027)	(0.021)	(0.016)
Num.Obs.	605	1250	613	1296

Note: Shown are results from a linear fixed effects model. Standard errors are clustered at the country level and are reported in parentheses. All models were estimated with country and year fixed effects. The dependent variable are importer-time and exporter-time fixed effects from a gravity model estimated with PPML for the period 1998-2019.
Significance levels: $^*p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 8: Gravity FE and VAT controls, Reduced Panel

	World VAT 2003-2020	
	Imp.FE Cmtrd	Exp.FE Cmtrd
VAT %	-0.049***	0.003
	(0.017)	(0.015)
GDP	0.000***	0.000**
	(0.000)	(0.000)
Trade Costs (import)	0.000	0.000
	(0.000)	(0.000)
tariffs	-0.003	0.012
	(0.028)	(0.018)
Num.Obs.	714	720

Note: Shown are results from a linear fixed effects model. Standard errors are clustered at the country level and are reported in parentheses. All models were estimated with country and year fixed effects. The dependent variable are importer-time and exporter-time fixed effects from a gravity model estimated with PPML for the period 1998-2019.
Significance levels: *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A.3 Estimations with Global VAT and TradeProd Data

In this section we present all the estimation results using the global panel of VAT rates and the TradeProd database. As mentioned in section 3 the overlap between the two datasets is limited to four years and in this period we only observe 13 changes in the VAT rate. While this allows for limited interpretability the results do not contradict our main findings and if anything support them. The results are reported in Table **??**. Column (1) contains the results for the baseline specification. Column (2) depicts the results for the baseline specification with additional control variables and internal trade, while column (3) excludes internal trade flows. Column (1) shows a negative, but insignificant coefficient, potentially due to the smaller sample size and insufficient variation in the tax rates. However, when including additional control variables the effect becomes statistically significant at the 10 percent level, even for the smaller sample due to missing control data. When excluding internal trade the coefficient remains virtually unchanged but is now significant at the 5% level. While the results are initially statistically insignificant for the baseline specification, significance increase the more restrictive the estimation becomes. Taken together with the results for the ComTrade database we can conclude that non-neutrality of the VAT is not limited to the EU context.

Table 9: Results for VAT and TradeProd ('03-'06)

	(1)	(2) w/o	(3) internal trade
VAT %	-0.010	-0.038*	-0.038**
	(0.032)	(0.021)	(0.015)
GDP		0.000***	0.000**
		(0.000)	(0.000)
Trade Costs (import)		0.000	0.000
		(0.000)	(0.000)
Tariffs		-0.009	-0.016
		(0.009)	(0.012)
Num.Obs.	294	175	175

Note: Standard errors are clustered at the country level and are reported in parentheses. All models were estimated with country and year fixed effects. The dependent variable are importer-time fixed effects from a gravity model estimated with PPML.
Significance levels: *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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