Destination Taxation and Evasion: Evidence from U.S. Inter-State Commodity Flows

By William F. Fox, LeAnn Luna and Georg Schaur*

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We develop a structural model where commodity shipments are differentiated by origin state and examine how commodity flows respond to destination taxes, allowing for tax evasion as a function of distance between trade partners. After accounting for transportation costs, we find that the effect of taxes decreases as distance increases. This is consistent with the notion that longer distances between trade partners hinder government oversight and increase the likelihood of successful tax evasion. This is important to policymakers because it evidences the difficulty of enforcing destination taxation in open economies such as U.S. states and the European Union.

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* Fox: The University of Tennessee, Department of Economics and CBER, 715 Stokely Management Center, Knoxville, TN 37996-0550, phone (865)974-6112, fax (865)974-3100, billfox@utk.edu. Luna:The University of Tennessee, Department of Accounting and CBER, 711 Stokely Management Center, Knoxville, TN 37996-0550, leann@utk.edu. Schaur: The University of Tennessee, Department of Economics, 505A Stokely Management Center, Knoxville, TN 37996-0550, gschaur@utk.edu. We thank Melissa Reynolds for excellent research assistance and data support. We thank Matt Murray, Bill Neilson, Luiz Lima, James Chyz and participants at the UT Brownbag seminar for helpful comments and suggestions.

Researchers have paid little attention to how taxes affect cross-border commodity flows across large geographic areas. On the other hand, a diverse literature has studied the effects of taxes on the location of capital and labor (Devereux and Griffith 2003). Tax rate differentials have been found to affect interstate business location decisions (Wasylenko 1997), flows of people and labor (Bruce et al. 2010), and international capital flows (Hines 2007). For example, foreign direct investment is significantly sensitive to tax factors (Gordon and Hines 2002, Desai et al. 2004) and multinational corporations use transfer pricing to allocate profits to low-tax jurisdictions (Altshuler and Grubert 2002, Bartelsman and Beetsma 2003). Limited streams of research have examined trade in specific commodities (Lovenheim 2008) and the effects of taxes along borders. The trade literature has extensively examined commodity flows in an international context, but we are not aware of any study that broadly examines commodity flows and taxation.

In this study, we use destination tax rates and data from the publicly available Commodity Flow Survey to examine trade flows between U.S. states with a special focus on how taxes and the potential for tax evasion affect those flows. Hilberry and Hummels (2008) also work with information from the Commodity Flow Survey, but they focus on border effects and changes in the quantity shipped and number of trading firms as the distance to the destination increases. To our knowledge, we are the first to take advantage of this rich dataset to provide evidence on tax evasion and effects of taxes on commodity flows.

Our paper makes several important contributions. We derive a structural gravity model (Anderson and van Wincoop 2003), where goods are differentiated by origin state, and commodity flows respond to transportation costs. The key novelty is that our model accounts for sales taxes and nests the possibility for tax evasion. By allowing for tax evasion, this approach recognizes the difficulty of enforcing destination taxation. The main hypothesis is that the probability of tax evasion increases with distance to the destination market because the probability of audit and detection decreases. This implies that the impact of destination commodity taxes on trade dissipates in the distance to the destination market. The problem is that we cannot directly observe evasion. Instead we apply the U.S. Census Commodity Flow Survey and test if the variation in U.S. commodity flows is consistent with evasion behavior. In our model, sales taxes interact with the distance to the destination market to predict commodity flows. Accounting for spatial effects and transportation costs, an increase in tax rates reduces sales to nearby destinations more than to remote destinations. This result is robust with respect to other types of taxes, outliers, strategic neighbor effects, selection, and various re-specifications. This is evidence that taxation and the possibility of tax evasion have important effects for the sourcing decisions of commodities beyond strategic border sales and can impact the location of production and the pattern of trade. This is important to policymakers because it evidences the difficulty of enforcing destination taxation in open economies such as U.S. states and the European Union.

The existing public literature examines evasion of transactions taxes in two common settings. First, shoppers physically cross state borders to take advantage of lower tax rates and either carry the item with them or have it shipped back to the home state for consumption. In this literature, the tax benefits from cross-border shopping are fixed and consumers realize the benefits if they are not offset by transportation costs (Mintz and Tulkens 1986, Kanbur and Keen 1993). Recent studies of cross-border shopping generally examine specific commodities, such as cigarettes, and focus on excise taxes (Devereux et al. 2007, Lovenheim 2008) that are also required to be paid at the destination but in practice are collected as origin taxes at the point of sale. The cross-border excise tax literature finds that an increase in the home state tax rate raises cross-state commodity flows to instate buyers that are closest to the border. Our results evidence that a home-state rate increase lowers cross-state commodity flows less from out of state vendors that are further away because of the greater ability to evade taxes. As expected, the coefficient for the tax-distance interaction is reversed in the evasion we measure relative to that previously analyzed in the literature.

Second, prior research examines the inability to collect sales tax on transactions ordered via mail order and the Internet (Goolsbee 2000, Bruce and Fox 2000). Sellers often collect sales taxes on items shipped to states in which the seller has physical presence. Concerns about this type of evasion receive considerable attention as states attempt a variety of means to force large remote sellers to collect the sales tax.

We focus on a third type of evasion, which has not been examined previously in the literature. This evasion includes businesses and individuals who purchase from remote vendors in part because they think they can successfully evade sales tax on the transaction. This evasion is broader than the two previously discussed and effectively subsumes evasion through e-commerce.

Our results are also important with respect to the international trade literature. Our empirics provide evidence that longer distances proxy for incentives related to tax evasion. This has three significant implications for standard gravity trade flow specifications. First, our empirics show that distances between trade partners not only proxy for transportation costs but also for transaction costs and incentives not related to physically moving goods. Second, the literature often captures information such as taxes with fixed effects. We show that even if we absorb taxes with fixed effects, the resulting incentives may still impact the coefficient estimates. Third, longer distances are usually associated with trade reducing frictions such as transportation costs and cultural differences. We show that some components of the distance proxy have the opposite effect. All else equal, longer distances reduce the transaction costs in the form of lower expected tax payments. These findings relate to a current literature in international trade that attempts to identify the various channels that impact coefficient estimates in standard trade flow specifications. Head et al. (2011) examine colonial linkages and the impact of independence on post colonial trade in a standard gravity trade specification. They attribute the gradual reduction in trade following independence to the depreciation of trading capital. Across countries, Helpman et al. (2008) decompose the impact of distance into changes in export quantities and changes in the number of exporting firms.

The remainder of the paper is divided into six sections. Section I provides background on how firms and consumers evade taxes. Section II describes the structural gravity model, with Section III deriving an empirical specification that incorporates tax evasion. We describe the data in Section IV and provide results and sensitivity tests in Section V. Section VI concludes.

I. Policy Background: How Firms and Consumers Evade Taxes

The sales tax is imposed on a destination basis, but compliance operates through two channels: sellers are responsible for remitting the tax to any destination state where they have physical presence,[1] and buyers are expected to remit the tax whenever the seller does not do so. Sales taxes are imposed on final consumption by individual consumers and on intermediate purchases by business. No legal planning mechanism shifts the location of or avoids the assessment of sales taxes short of the buyer moving from the state; only evasion by the buyer or seller reduces the tax burden on the transaction. Evasion is facilitated by selling from out of state, and particularly at greater distances from the state. Random audits conducted by the State of Washington confirm significant non-compliance (23 percent) on purchases from out of state sellers (State of Washington, 2010).

For several reasons, the probability of successful evasion may rise with distance from the destination state. The challenge for tax authorities is identifying taxpayers, whether buyers or sellers, and assigning auditors to ensure that taxpayers remit appropriate liabilities. States are better able to perform these identification and audit functions for in-state sellers, and the state of Washington's non-

[1] What constitutes physical presence (i.e., nexus) is a legal question but may be established by sending salesmen into the state and other relatively modest forms of presence.

compliance data confirm this with evidence that evasion most often occurs when the reporting and payment responsibilities are shifted to the buyer (which occurs when the seller is out-of-state). States may simply be more aware of businesses that are based nearby in part because flow of trade is greatest between nearby states. Also, states that are geographically close to each other are more likely to share tax and audit information, which enhances the home state audit function. As a result, evasion is easier as distances rise and particularly beyond neighboring states. Finally, all but the most simple audits require in-person examinations, the cost of which increases as distance increases. Only 28 states maintain any audit capacity outside the home state, and only 19 have an outside office.[2]

Buyers have the incentive to purchase from sellers that do not collect sales tax for their state if they want to evade taxes. Similarly, sellers have an incentive to act as though they are out-of-state to avoid a collection responsibility because states can enforce the tax more effectively on purchases from in-state vendors. Sellers can ensure that the tax payment responsibility is with the buyer (where it is much easier to evade) by not creating physical presence in a state. States cannot audit firms without taxable presence, facilitating evasion by buyers. Thus, sellers have an incentive to locate far enough away so that their activities are not readily visible to the home state's tax administration or those with whom the home state shares information, and this surely increases with distance.

II. Theory

This section introduces the possibility of tax evasion into the set up of Anderson and van Wincoop (2003). We derive a state level export specification as a function of trade costs, spatial effects and the probability of tax evasion.

Let all goods be differentiated by origin i, such that each source state is specialized in the production of only one good. Consumers[3] in state j choose the

[2] Unpublished survey conducted by the Federation of Tax Administrators (2010).
[3] Consumers may be individuals or businesses purchasing intermediates.

level of consumption in period t, c_{ijt}, for each good i at prices p_{ijt} to maximize the Constant Elasticity of Substitution (CES) utility function[4]

$$\left(\sum_{i=1}^{N} c_{ijt}^{(\sigma-1)/\sigma}\right)^{\sigma/(\sigma-1)}$$

subject to the budget constraint $\sum_{i=1}^{N} p_{ijt}c_{ijt} = y_{jt}$. y_{jt} denotes nominal income and $\sigma > 1$ characterizes the substitution between any two goods. At a transaction price of p_{ijt} consumers purchase the quantity $c_{ijt} = p_{ijt}^{-\sigma} y_{jt}/P_{jt}^{1-\sigma}$ given the CES price index $P_{jt} = \left[\sum_{i=1} (p_{ijt})^{1-\sigma}\right]^{1/(1-\sigma)}$.

The exporter in state i supplies the demand in j subject to a bilateral trade cost, μ_{ij}, a destination specific sales tax,τ_{jt}, and an origin specific constant marginal cost of production, w_{it}.[5] The possibility of tax evasion introduces uncertainty in the firm's transaction cost.[6] An exporter learns whether it successfully evades the taxes after the transaction. If the firm evades the tax, the firm realizes revenue net of transportation costs $\frac{p_{ijt}}{t_{ij}} \frac{p_{ijt}^{-\sigma}}{P_{jt}^{1-\sigma}} y_{jt}$. If the firm does not evade the tax, then net of transportation costs and taxes, the firm realizes the revenue $\frac{p_{ijt}}{\mu_{ij}\tau_{jt}} \frac{p_{ijt}^{-\sigma}}{P_{jt}^{1-\sigma}} y_{jt}$. If the firm successfully evades[7] the tax with probability $1-\gamma_j$, then the expected

[4]As in Feenstra (2006) we simplify the distribution parameters in Anderson and van Wincoop (2003) to $\beta_i = 1$. This simplification is benign as the distribution parameters are solved out from their main specification anyway.

[5]We assume that transportation costs do not change over time, because we proxy for transportation costs in the empirical section with bilateral distances as is common in the international trade literature. We check for robustness with respect to this assumption by letting the impact of the distance vary across time periods in the robustness exercises.

[6]The background section discusses that evasion can occur on the firm or consumer side. The tax incidence literature (Fullerton and Metcalf 2002) shows that modeling taxes on the firm or consumer side is equivalent. Our model is consistent with this result because in our set-up firms pass taxes and transportation costs to the consumer. It follows that modeling evasion behavior on the consumer or firm side results in the same estimation specification. This means that our estimation specification captures both channels of evasion but cannot distinguish between the two alternatives. Derivation of the estimation specification where consumers drive the evasion decision is available from the authors upon request.

[7]Successful evasion depends on the attempt to evade the tax and the auditors inability to detect evasion. Taxpayers cannot know with certainty whether an attempt to evade taxes is successful until well after the transaction is complete and the statute of limitations expires, but traders can estimate the probability of detection, and the probability can be taken into account in pricing decisions. The expected effective tax rate and total cost of the transaction will therefore vary depending on the chance taxing authorities will discover the transaction during audit and impose back taxes, penalties, and interest. We

profits from selling in state j are

$$\Pi_{jt} = \gamma_j \left[\frac{p_{ijt}}{\mu_{ij}\tau_{jt}} \frac{p_{ijt}^{-\sigma}}{P_{jt}^{1-\sigma}} y_{jt} \right] + (1-\gamma_j) \left[\frac{p_{ijt}}{\mu_{ij}} \frac{p_{ijt}^{-\sigma}}{P_{jt}^{1-\sigma}} y_{jt} \right] - \frac{p_{ijt}^{-\sigma}}{P_{jt}^{1-\sigma}} y_{jt} w_{it}.$$

The exporter sets a transaction price to maximize expected profits. Take first order conditions and solve for the maximizing price: $p_{ijt} = \frac{\sigma w_{it} \mu_{ij} \tau_{jt}}{(\sigma-1)(\gamma+\tau_{jt}-\tau_{jt}\gamma)}$.[8] In optimum, the firm charges the mill price $p_{it} = \frac{\sigma w_{it}}{(\sigma-1)}$ times an expected trade cost factor

$$t_{ijt}^{*} = \frac{\mu_{ij}\tau_{jt}}{(\gamma_j + \tau_{jt} - \tau_{jt}\gamma_j)}. \tag{1}$$

If the probability of tax evasion increases, firms lower their prices to increase the quantity they sell on the destination market and raise their expected profit due to constant markups over marginal costs, $\frac{\sigma}{\sigma-1}$.

The value of exports of state i goods in state j is then

$$x_{ijt} = \left(\frac{p_{it} t_{ijt}^{*}}{P_{jt}} \right)^{1-\sigma} y_{jt} \tag{2}$$

with CES price index $P_{jt} = \left[\sum_{i=1} \left(p_{it} t_{ijt}^{*} \right)^{1-\sigma} \right]^{1/(1-\sigma)}$. Anderson and van Wincoop (2003) refer to this price index as multilateral resistance. As trade barriers with all trading partners increase, P_{jt} increases and lowers state $j's$ import demand with respect to all other source states.

capture both of these channels in the evasion probability $1 - \gamma_j$.

[8] In this model firms operate under monopolistic competition and firms price across markets. This departs from the perfect competition assumption often applied in the literature on cross-border shopping where prices follow the law of one price (Mintz and Tulkens 1986). Engel and Rogers (1996) provide state level evidence for the failure of the law of one price across US States and Canadian provinces.

Income in state i equals the sales across all states less the sales tax payments,

(3)
$$y_{it} = \sum_j x_{ijt} = \left(\frac{p_{it}t^*_{iit}}{P_{it}}\right)^{1-\sigma} y_{it} + \sum_{j\neq i}\left(\frac{\gamma_j}{\tau_{jt}} + (1-\gamma_j)\right)\left(\frac{p_{it}t^*_{ijt}}{P_{jt}}\right)^{1-\sigma} y_{jt} \quad \forall i.$$

The idea is that we can think of our total sales as the aggregation of many underlying transactions. Then, because each transaction to a given destination is subject to the same probability of paying taxes, γ_j, by the law of large numbers the income net of taxes becomes deterministic.

To derive an export specification solve (3) for the prices

$$(4) \qquad p_{it}^{1-\sigma} = \frac{y_{it}}{\left(\frac{p_{it}t^*_{iit}}{P_{it}}\right)^{1-\sigma} y_{it} + \sum_{j\neq i}\left(\frac{\gamma_j}{\tau_{jt}} + (1-\gamma_j)\right)\left(\frac{p_{it}t^*_{ijt}}{P_{jt}}\right)^{1-\sigma} y_{jt}}$$

Let y^{US} equal United States aggregate income and define $\theta_j = y_j/y^{US}$ to obtain

$$(5) \qquad p_{it}^{1-\sigma} = \frac{y_{it}/y_t^{US}}{\left(\frac{p_{it}t^*_{iit}}{P_{it}}\right)^{1-\sigma} \theta_{it} + \sum_{j\neq i}\left(\frac{\gamma_j}{\tau_{jt}} + (1-\gamma_j)\right)\left(\frac{p_{it}t^*_{ijt}}{P_{jt}}\right)^{1-\sigma} \theta_{jt}} = \frac{y_{it}/y_t^{US}}{\Pi_{it}}$$

Substitute (5) into (2) to obtain the export value state i realizes in state j, $x_{ijt} = \frac{y_{it}y_{jt}}{y_t^{US}}\left(\frac{t^*_{ijt}}{\Pi_{it}P_{jt}}\right)^{1-\sigma}$ and substitute equation (1) for t^* to obtain the sales value as a function of transportation costs, taxes and the possibility of tax evasion.

$$(6) \qquad x_{ijt} = \frac{y_{it}y_{jt}}{y_t^{US}}\left(\frac{\mu_{ij}\tau_{jt}}{(\gamma_j + \tau_{jt} - \tau_{jt}\gamma_j)} \Big/ \Pi_{it}P_{jt}\right)^{1-\sigma}.$$

Anderson and van Wincoop (2003) do not include taxes in their transaction costs and assume symmetry to derive (6) as a function of the multilateral resistance in the destination, P_{it}, and origin regions, P_{jt}. Because the multilateral resistance terms are not observable, they develop a careful estimation routine that identifies those terms. Sales taxes are often different in the destination and source locations, so assuming tax symmetry in our case is not consistent with the data. This implies that even if the transportation costs are symmetric, the cost of exporting from state i to state j is different than exporting from state j to state i because of sales tax differentials.

If there is zero probability for tax evasion, then $1-\gamma_j = 0$ which implies that $\frac{\mu_{ij}\tau_{jt}}{(\gamma_j+\tau_{jt}-\tau_{jt}\gamma_j)}$ simplifies to $\mu_{ij}\tau_{jt}$. This means that if there is no possibility for tax evasion, then the destination specific sales given by (6) are a function of bilateral transportation costs and the direct impact of destination specific sales taxes. If tax evasion is perfect, then $1-\gamma_j = 1$ and sales taxes do not impact the sales at all. If $1 > 1-\gamma_j > 0$, then the sales values are a function of the direct impact of sales taxes as well as the expected sales tax determined by the destination specific sales tax and the probability for tax evasion. The following section explains how we implement (6) directly using fixed effects and proxy variables to test which case of tax evasion is consistent with the variation in the US commodity flow data.

III. Empirical Model

This section derives an empirical specification based on the structural export relationship of equation (6). The empirical model relates commodity flows to transportation costs, sales taxes and nests the possibility for tax evasion.

To derive the stochastic version of (6), remember that $t^*_{ij} = \frac{\mu_{ij}\tau_i}{\gamma+(1-\gamma)\tau_j}$. Approximate the transportation costs as a function of the distance, $\mu_{ij} = d^{\rho}_{ij}$ and substitute this expression into (6). In natural logs we obtain

$$\begin{aligned} ln(x_{ijt}) &= \beta_0 + ln(y_{jt}) + ln(y_{it}) + (1-\sigma)\rho ln(d_{ij}) + (1-\sigma)ln(\tau_{jt}) \\ &+ (1-\sigma)ln\left(\frac{1}{\gamma_j+(1-\gamma_j)\tau_{jt}}\right) - (1-\sigma)ln(\Pi_{it}) - (1-\sigma)ln(P_{jt}). \end{aligned} \tag{7}$$

Note that $f(\tau) = ln\left(\frac{1}{\gamma+(1-\gamma)\tau}\right)$ is non linear in the tax rate and the probability of evasion. We can either approach the empirical relationship with an estimator such as non linear least squares, or, linearize the term to estimate the coefficients with OLS. We focus on the linear approximation. To log linearize, define $g(x) = ln\left(\frac{1}{\gamma+(1-\gamma)e^{\tau}}\right)$. Then linearizing around $\tau = 1$,

$$f(\tau) = g(ln(\tau)) \approx f(1) + f'(1)ln(\tau) = -(1-\gamma)ln(\tau). \tag{8}$$

Figure 1 illustrates the quality of the linearization. The solid line plots $f(\tau)$ and the dotted line plots the log linearization $-(1-\gamma)ln(\tau)$ as a function of τ over the range we observe in our sample assuming $\gamma = 0.5$.[9] There are two important points from this figure. First, the linearization does a good job of approximating $f(\tau)$. Second, over the relevant parameter range for τ, $f(\tau)$ is fairly linear in τ which would make it hard to identify any non-linearities using non-linear least squares.[10]

Let the $I_j = 1$ if the firm evades the tax in state j and zero otherwise. Specify the probability of tax evasion as a function of distance such that

$$P(I_j = 1) = (1-\gamma_j) = \delta_0 + \delta_1 ln(d_{ij}). \tag{9}$$

Based on the policy background in section I, our expectation is that the further away the destination, the more likely it is that firms evade taxes because the probability of detection falls. Substitute (9) into (7) to obtain

$$\begin{aligned} ln(x_{ijt}) = \beta_0 &+ ln(y_{jt}) + ln(y_{it}) + (1-\sigma)\rho ln(d_{ij}) + (1-\sigma)ln(\tau_{jt}) \\ &- (1-\sigma)\delta_0 ln(\tau_{jt}) - (1-\sigma)\delta_1 ln(d_{ij})ln(\tau_{jt}) - (1-\sigma)ln(\Pi_{it}) \\ &- (1-\sigma)ln(P_{jt}). \end{aligned} \tag{10}$$

[9] Other values of γ result in similar plots. For small γ the two lines are closer together, while for large γ the two lines move more apart.

[10] Nevertheless, we revisit this issue in the robustness exercises as we also potentially introduce non-linearity through the probability of tax evasion.

Note that Π_{it} varies across origin states and years. Let v_{it} be a source-state-by-year fixed effect and rewrite (10) to obtain the base specification

$$\begin{aligned} ln\left(\frac{x_{ijt}}{y_{it}y_{jt}}\right) &= \beta_0 + \beta_1 ln(d_{ij}) + \beta_2 ln(\tau_{jt}) \\ &+ \beta_3 ln(d_{ij}) ln(\tau_{jt}) + \beta_4 ln(P_{jt}) + v_{it} + u_{ijt}. \end{aligned} \tag{11}$$

We predict $\beta_1 < 0$. As the distance increases the transportation costs increase, $\rho > 0$. If the transportation costs increase, exporters mark up over a higher transactions cost. The resulting price increase and drop in the transaction quantity lowers export flows.[11]

Given the structure of the model, we must discuss the predictions for β_2 together with β_3 to distinguish three cases. First, if the probability of tax evasion equals zero, across all destination states, then $P(I_j = 1) = 0 \Rightarrow \delta_0 = 0$ and $\delta_1 = 0$. In that case, $\beta_2 = (1 - \sigma)$ and $\beta_3 = 0$. Second, if tax evasion is perfect, then $P(I_j = 1) = 1 \Rightarrow \delta_0 = 1$ and $\delta_1 = 0$. In that case, $\beta_3 = 0$ and $\beta_2 = (1-\sigma) - (1-\sigma)\delta_0 = 0$. This implies that if tax evasion is perfect then sales taxes do not impact sales values. Third, if the probability of tax evasion increases in distance, then $\delta_1 > 0$ and $\delta_0 < 1$. In this case, $\beta_2 < 0$ and $\beta_3 > 0$.[12] This implies that if we find $\beta_2 < 0$ and $\beta_3 > 0$, then that is evidence for tax evasion with a level of evasion that changes in the distance to the destination market.

IV. Data

We collect state level export flows (in millions) for 1997, 2002, and 2007 from the U.S. Census Bureau's Commodity Flow Survey, which reports data on the

[11] Throughout we make the monopolistic competition assumption that implies that an individual firm's actions do not impact multilateral resistance terms.

[12] Note that if tax evasion is constant across all states such that $P(I_j = 1) = \delta_0$ and $1 > \delta_0 > 0$. In this case $\beta_2 < 0$ and $\beta_3 = 0$. This suggests that unless we know the true elasticity σ we cannot distinguish "no evasion" from "constant evasion" across all states. All our results suggest $\beta_3 > 0$, which implies that $P(I_j = 1)$ changes cross destination states, and the constant evasion case is empirically irrelevant.

movement of goods in the U.S. [13] We drop Alaska and Hawaii from the sample because they are not contiguous with the Continental United States. Eliminating these destinations and origins (including Washington D.C.) drops about 0.5 percent of the total trade value from the dataset.

After dropping Alaska, Hawaii and Washington DC we obtain bilateral trade relationships across 48 states, resulting in a maximum of 2,304 possible observations per year for a total of 6,912 possible observations across all three survey years. We actually observe 6,117 positive trade flows. This accounts for about 89 percent of the possible observations. This alleviates concerns of sample selection as we observe most of the possible trade relationships.[14] Nevertheless, in the robustness exercises we apply an estimator developed to include zero trade flows to check robustness with respect to zero trade flows.

We collect state gross domestic product (GDP) from the Bureau of Economic Analysis. Consistent with the theory, the dependent variable $ln\left(\frac{x_{ijt}}{y_i y_j}\right)$ equals $ln\left(\frac{\text{Export Value}_{ijt}}{GDP_{it}GDP_{jt}}\right)$, where i and j reflect the origin and destination states, respectively.

We obtain sales tax rates, tax_{jt}, by year and state from a series of annual reports provided by the Federation of Tax Administrators. Consistent with the theory, we construct the sales tax factor $\tau_{jt} = 1 + \frac{tax_{jt}}{100}$. Our theory requires us to identify the impact of the direct effect of an increase in the tax factor as well as the impact of an interaction of the log distance with the log of the tax factor. The challenge is that interaction terms tend to be highly correlated with the direct effects. In our raw sample we find a 0.96 correlation between the log tax factor and the distance-tax interaction. This high level of correlation inflates the standard errors, thereby making it difficult to reject any hypothesis. Zero tax rates in some states are one reason for this high level of correlation because

[13] This survey is conducted every five years and provides the value, weight, mode of transportation, and the origin and destination of shipments of commodities from manufacturing, mining, wholesale, and selected retail and service establishments.

[14] Helpman et al. (2008) document that in cross country trade flows from 1970 to 1997 often more than 50 percent of bilateral trade relationships report zero trade, raising concerns of sample selection.

the interaction and the tax variable are exactly identical when the tax rate equals zero. In addition, when tax rates equal zero, there is no variation in the interaction term which splits our sample into two structurally different clusters, as shown in Figure 2. We choose to drop all destination states with zero tax rates to mitigate both of these challenges. From an econometric theory point of view, exogenous selection based on a regressor applying a deterministic selection rule does not impact the consistency of our estimates.[15] From a data point of view, the states with zero tax rates represent only 2 percent of the total trade value in the sample. For several robustness checks we also collect corporate income tax rates from the annual reports provided by the Federation of Tax Administrators.

To proxy for transportation costs we experiment with two distance measures. Our first measure is the distance between state capitals, which we obtain using googlemaps.com. Our second measure is reported in the Commodity Flow Survey and is the value weighted average distance of the reported commodity flows. An advantage of the distance between capitals is that we observe it for all survey years 1997, 2002 and 2007. The value-weighted average is only observed for 2002 and 2007. However, we are only able to observe within state distances for the value-weighted measure. The robustness section estimates several specifications with both measures of distance. The results are not sensitive to this distinction.

According to the theory the multilateral resistance in the destination state is

$$P_j = \left[\sum_{i=1} \left(p_i \mu_{ij}^* \right)^{1-\sigma} \right]^{1/(1-\sigma)} . \tag{12}$$

It is common in the literature to absorb this multilateral resistance with a time period by destination state fixed effect. This approach is not practical in our case because state fixed effects would eliminate the sales tax and sacrifice important identifying variation. Instead we compute a proxy for $P_j^{1-\sigma}$. The challenge is

[15]Theorem 19.1 on page 794 of Wooldridge (2010) demonstrates that exogenous selection based on an independent variable preserves the consistency of the OLS estimates under the Gauss Markov assumptions (sans random sampling).

that P_j is a function of the unobserved elasticity σ. According to the theory, $1-\sigma<1$ and $p_i\mu_{ij}^*=p_{ij}$ is the transaction price in the destination state. This suggests that $P_j^{1-\sigma}$ sums the fractions $\frac{1}{p_{ij}}$ over all source regions weighted by the elasticity of substitution. Let $Weight_{ijt}$ be the aggregate export weight and compute $\hat{p}_{ijt}=\frac{\text{Export Value}_{ijt}}{\text{Weight}_{ijt}}$. Then, $\hat{P}_{jt}^{1-\sigma}=\sum_i \frac{1}{\hat{p}_{ijt}^s}$.[16] In our main specifications we set $s=1$, but we experiment with different values of $s\geq 1$ in the robustness section. In addition, we compute proxies for the price index based on state level average wages collected from The Bureau of Economic Analysis.

Eighteen states change their sales tax rates over the time period we observe the trade flows. However, these within destination state tax changes are fairly small. The maximum within destination state standard deviation is .75 and reaches as low as 0.003. The average of the within standard deviations for the states that change their sales tax rates is about .37. This suggests that the average state changed its tax rate by about .37 percentage points around its mean. Of course, factoring in all states this average is even lower as the remaining states did not change their rates. Table 1 reports the summary statistics.

To account for potential historical linkages between states we generate and indicator that equals 1 for each state pair that is linked by a major navigable river. The idea is that states that are linked by a river may historically have a close proximity in terms of trade. The source for this information is the Water Fact Sheet of the US Geological Survey by the Department of the Interior in May 1990.

V. Estimation

Specification (11) provides the baseline relationship we estimate in this section. Accounting for origin-by-year fixed effects, an OLS estimator exploits variation across destination states. The estimates are consistent as long as the disturbance is not correlated with the regressors. We allow for dependence of export flows to

[16]Unfortunately state level price indexes are not available.

a given destination and report robust standard errors clustered by destination for all of the OLS estimates.

A. *Main Specification*

Column 1 of Table 2 reports the estimation results for the baseline specification. An increase in distance lowers trade flows. Distance proxies for transportation costs. This result is consistent with the existing literature of gravity estimation.

The direct impact of the sales tax is negative, but the interaction between the sales tax and distance is positive. Long distances mitigate the impact of a sales tax. These estimates are consistent with a probability of tax evasion that increases in the distance to the destination market. The intuition is that the farther away the sales destination, the less is the opportunity for oversight and auditing. Therefore, longer distances raise the likelihood of successful tax evasion.

Consistent with the theory, an increase in the proxy for the CES price index raises the export values. However, Wooldridge (2009) shows that a proxy does not identify the true coefficient on the price index. The more important issue is that the proxy for the price index allows us to correctly identify the parameters on all other independent variables.[17] To this end, a key assumption is that the proxy is not correlated with the disturbance. We will do several robustness exercises applying instrumental variables and varying how we compute the proxy to examine the impact of this assumption.

Figure 3 helps to interpret the magnitudes. We plot the elasticity $\epsilon_\tau = \frac{dln(x/y_i y_j)}{dln\tau}$ with a $+/-$ two standard error confidence interval. The figure shows that for small distances an increase in the tax rate lowers trade relative to trade partner size. The effect turns around at the log distance of about 6.45 or about 630 miles.

[17] To consistently identify the parameters on the distance requires that the disturbance of our estimation specification is not correlated with any of the regressors including the true price index. In addition, identification requires that after accounting for the true price index, the disturbance is not correlated with the proxy for the price index.Wooldridge (2009) classifies these assumptions as not very controversial. Let P_{jt} be the true CES price index and let $\hat{P}_{jt}$ be the proxy such that $P_{jt} = \phi_o + \phi_1 \hat{P}_{jt} + v_{jt}$. We also require that $\hat{P}_{jt}$ is a "good" proxy, meaning that v_{jt} is not correlated with the regressors of the main estimation specification and is not correlated with $\hat{P}_{jt}$ (Wooldridge (2009), p. 307).

Further, a one percent increase in the distance lowers trade by about 1.3 percent evaluated at the mean of τ.

To evaluate the probability of tax evasion requires an estimate for δ_0 and δ_1. Our estimation specification does not separately identify σ from these parameters. To obtain the estimates for the probability model we assume $\sigma = 20$.[18] The estimates of specification 1 of Table 2 then give $\hat{\delta_0} = 1 - 142.334/19$ and $\hat{\delta_1} = 22.202/19$.

A standard problem with linear probability models is that they tend to predict probabilities that are out of range.[19] The same is true here and we set $\hat{P} = \hat{\delta_0} + \hat{\delta_1} ln(d_{ij})$ equal to 1 when we predict a probability greater than 1 and we set $\hat{P} = 0$ when we predict a probability less than 0.

Figure 4 plots the predicted probabilities of evasion against the log distance. The bars show the value share of trade flows that are realized within discrete ranges of the distance. For example, about 20 percent of the total trade value occurs at a log distance of 5.5 (245 miles) to 6.1 (446 miles).

For distances less than about 5.5 the evasion probability is zero and commodity flows respond to taxes according to the elasticity of substitution. For log distances between 5.5 and about 6.3 (545 miles), the evasion probability is between 0 and 1 increasing at a steep rate. The evasion probability turns over a short distance of only about 200 miles from no evasion to perfect evasion.[20] From the trade-value bars we observe that a lot of the transaction value is realized over this range. For distances greater than 6.3 the evasion probability equals one and commodity flows do not respond to sales taxes.

Next we evaluate the predicted impact of the sales tax on prices. The transaction price is $p_{ijt} = \frac{\sigma}{\sigma-1} w_{it} \mu_{ij} \frac{\tau_{jt}}{\gamma_j + (1-\gamma_j)\tau_{jt}}$. Substitute $\mu_{ij} = d_{ij}^{\rho}$, take logs and

[18] Anderson and van Wincoop work with values of 5, 10, 15 and 20.

[19] We also tried to estimate a normal and logit probability model. Non linear least squares estimates of these models are not stable and difficult to interpret without further restrictions.

[20] The slope of the probability is even steeper for smaller values of σ.

apply the same linearization as above to simplify the interpretation and obtain

$$ln(p_{ijt}) = ln\left(\frac{\sigma}{\sigma - 1} w_{it}\right) + \rho ln(d_{ij}) + \gamma_j ln(\tau_{jt}). \tag{13}$$

Assuming a value of $\sigma = 20$ gives $\hat{\rho} = .14$ from the estimate on the distance of specification 1 in Table 2. A one percent increase in the distance raises the prices by about .14 percent. A one percent increase in the sales tax raises the price according to the probability of tax evasion by $\hat{\gamma_j}$, which is the probability that taxes have to be paid in full. This probability varies with the distance to the destination market. Based on Figure 4, the probability of not evading the tax at a log distance of 6 equals about 0.55. This implies that a one percent increase in the sales tax raises the price by about 0.55 percent. A tax increase passes perfectly into the price for small distances where firms cannot evade the tax. A tax increase does not impact the price at long distances because tax evasion is perfect.

B. Alternative Specifications

A concern with specification (11) is that omitted corporate income taxes bias the coefficients. Corporate income taxes are apportioned in part at least, based on the firm's sales in the destination states.[21] If sales decrease in the distance, the direct effect of the corporate income tax rate and the interaction of the corporate income tax with the distance may be omitted from specification (11). Column 2 of Table (2) augments the base specification with the corporate income tax in the destination state and its interaction with distance.[22] Neither of these terms have a significant impact.

Column 3 of Table (2) augments the baseline specification with two indicator variables. First, River Link equals one if the origin and destination states of a

[21] The origin component of corporate income taxes is accounted for with the origin-by-year fixed effects.
[22] We also interacted the corporate income tax rate with the sales apportionment factor and the results were unchanged.

particular commodity flow are linked by a major river. The intuition is that these states historically have stronger trade relationships due to existing waterways. The second indicator is a neighbor effect. This effect accounts for the strategic location of industry along state borders to be close to customers and to take advantage of policy differences such as tax differentials. As we would expect, both indicators have a positive and significant impact on cross-state sales but do not change our conclusions about the impact of sales taxes and tax evasion.

Columns 1 to 3 proxy for the destination specific multilateral resistance terms with the average prices across all source locations.[23] Column 4 accounts for these terms with a destination-by-year effect.[24] This eliminates the identifying variation of the sales tax factor, but we can still identify the impact of the sales-tax-distance interaction. The coefficient on the distance-tax interaction drops in magnitude, but remains positive and significant at the 10 percent level. The loss in precision of the estimate is not surprising as the destination-by-year effect eliminates a main source of identifying variation.[25]

C. Robustness Checks

Alternative Measure of Distance and Within State Trade Flows. — Table (3) repeats the specifications of Table (2), but replaces the distance between state capitals with the value weighted average distance reported by the Commodity Flow Survey. Two main advantages result. First, this distance measure includes average miles traveled within states and therefore can proxy transportation costs both within states and across state lines, allowing trades within states to be

[23]Note that the multilateral resistance terms are akin to spatial effects. They account for the average pricing in the origin and destination across all trade partners taking into account the distance and the possibility for tax evasion. In general spatial terms are weighted averages that vary by destination or origin state. Given that we have bilateral trade data among many states we absorb the origin specific terms with origin-by-year fixed effects.

[24]This means all possible spatial information that varies by orign and year as well as by destination and year.

[25]For comparison, a Wald test does not reject the null hypothesis that the coefficient on the tax-distance interaction of this specification is equal to the mean of the coefficient estimate of that interaction of the previous specification ($H_o : \beta_3 = 18$).

included in the sample. This distance measure, however, is not reported for 1997, and we lose a large fraction of the data. Table (3) shows that the results are robust to this alternative distance measure. The coefficients are of the same order of magnitude and show a similar pattern of significance as seen in Table (2). The results are not surprising as the correlation coefficient between the distance measure of Table (2) and the distance measure of Table (3) is fairly high at 0.82. We conclude that including within state trade flows does not significantly change our estimation results.

Estimation by Commodity. — In the previous estimations we aggregated over all available commodities by origin-destination pair for each year reported by the Commodity Flow Survey. Table 4 provides estimates of the distance, sales tax, and distance-sales-tax interaction coefficients obtained from the base specification (11) estimated by commodity. For most commodities we obtain the expected sign and many are significantly different from zero. For the 42 commodities, we estimate 34 negative coefficients on the distance variable, of which 29 are significant at least at the 10 percent level. Only one coefficient (i.e. fuel oils) is positive and significant. For the tax variable we estimate 28 negative coefficients of which 17 are significant at the 10 percent level. Four of the coefficients for the tax factor are positive and significant and are predominately goods produced in a limited number of locations but distributed nationwide (e.g., fuel oil). Twenty-eight coefficients are positive on the interaction, of which 18 are significant at the 10 percent level. Four of the estimates are negative and significant at 10 percent level.

For several product categories the results are very intuitive based on the assumption of product differentiation and the possibility for tax evasion. For example, "Electronics," "Paper Products" and "Textiles" confirm the same sign pattern as the estimates for aggregate trade flows. On the other hand, there are several reasons for why some commodities may have coefficients that are not consistent with our predictions. For example, a wide literature examines the cross-border shopping of cigarettes. According to that theory, a high sales tax in the destination state could lead to strategic cross-border activity where sellers locate across state borders to possibly evade taxes, which would result in a high inflow of cigarettes. Also, our theory relies on product differentiation. This may not be a good assumption for commodities such as “Sand,” “Gravel and Crushed Stone” or “Fuel Oils.” In general, “Transportation Equipment” and “Motorized Vehicles” have to be licensed, which requires a proof of tax payment and makes it difficult to evade the taxes. For these products the existing predictions of the literature based on perfect competition may be more appropriate. However, for most of the products, our conclusions about the impact of sales taxes and tax evasion hold.

Robustness with Respect to the CES Price Index Proxy. — This section assumes that the constructed proxy for the CES price index is correlated with the regression disturbance and applies instrumental variables to break this endogeneity. We apply a two-stage least squares (2sls) estimator to examine whether endogeneity of the price index proxy impacts the coefficients.

To construct the instrument we collect wage data by state and compute the average wage by destination state across all origin states from which we observe positive commodity flows. According to our theory, after the CES price index is accounted for, average wages do not predict commodity flows. This implies that this destination specific average wage is a valid instrument if it is correlated with the price index proxy.

Table 5 reports the results from the 2sls estimation. The estimates on the distance, sales tax and distance-tax interactions are similar as above. The coefficient on the price index increases. We conclude that a possible endogeneity of the price index proxy does not impact the estimates on the main variables of interest.[26]

[26] Across the four specifications, the variation explained by the instrument in the first stage regression

We also performed robustness exercises varying the assumed elasticity of substitution we assume to generate the proxy for the price index. Equation (12) defines the CES price index. For $\sigma > 1$, we can write (12) as $P_j^{1-\sigma} = \sum_{i=1} \frac{1}{p_{ij}^{\alpha}}$, where $\alpha = 1 - \sigma$. Since we do not know σ we do not observe α. In the specifications above we assumed $\alpha = 2$. To examine robustness with respect to this assumption we let $\alpha = 1, 2, 3, ...$[27] Varying the elasticity of substitution did not change the main coefficients of interest. The results are available upon request.

Strategic Border Sales. — Next we examine how taxes impact trade flows at state borders. To do so, we generate two interaction terms. First, we develop the interaction of the log-destination-tax factor with a neighbor indicator where the neighbor indicator is defined as $N_i = 1$ if the origin state is a contiguous neighbor and zero otherwise. The second interaction is the log-origin-sales tax factor with the neighbor indicator. The base specification is augmented with these two interaction terms to obtain

$$\begin{aligned} ln\left(\frac{x_{ijt}}{y_{it}y_{jt}}\right) &= \beta_0 + \beta_1 ln(d_{ij}) + \beta_2 ln(\tau_{jt}) + \beta_3 ln(d_{ij}) ln(\tau_{jt}) + \beta_4 ln(P_{jt}) \\ &+ \beta_5 N_i + \beta_6 N_i ln(tau_j) + \beta_7 N_i ln(tau_i) + \delta_{it} + \epsilon_{ijt}. \end{aligned} \tag{14}$$

Table 6 reports the estimation results. Column 1 exploits variation across all origin states in the sample and column 2 drops all the origin states with zero sales tax rates (as we did with zero tax states above). Across both specifications the direct impact of sales taxes and the interaction of the tax factor with distance are

after partialling out all other variables is between 0.07 and 0.09. Cameron and Trivedi (2005) provide and example with a partial R^2 of 0.08, which they consider not low enough to raise weak instrument concerns. They also discuss a rule of thumb critical value on the F-Statistic testing for significance of the instruments in the first stage regression. In the first two specification the F-statistic comes in at about 15, clearly rejecting weak instrument concerns. In the third and fourth specification the F-Statistic comes in between 8 and 9, suggesting that the instrument has less explanatory power in the first stage regressions when we use the weighted distances. This may explain why the level of significance drops on the distance and distance-tax interaction in the fourth specification.

[27] As an alternative, specification 4 of Table 2 absorbs the destination specific price index with fixed effects for any value of α. The downside of this approach is that we cannot identify the direct impact of the sales tax.

similar to the results above. In both specifications the coefficient on the neighbor indicator is positive suggesting that a structural difference between trade flows with neighbors compared to other origin states. However, in both specifications this effect is only marginally or not significant. In column 1 the interaction of the neighbor indicator with the log sales tax factor does not significantly impact trade flows. Dropping origin states with zero tax rates changes this conclusion. In that case we find that the higher the tax rate in the destination states, the higher the amount of trade with neighbors. While only estimated with large standard errors, we also find that trade flows are higher with neighbor states that have low taxes. This evidence is consistent with the intuition that firms may strategically locate on the low tax side of state borders to either evade the taxes on cross-border sales or charge the lower origin sales tax rate for commodities that are transacted in the origin state and moved across state borders after the transaction. A key issue that prevents a more precise identification of these effects is that we only observe a state's aggregate trade flows and we cannot distinguish flows that are right across the border from those that come from longer distances.

We also repeated the specification using the value weighted distances from the Commodity Flow Survey instead of the distance between state capitals. The results are similar to those in specification 1 in Table 6.

D. Zero Trade Flows

Silva and Tenreyro (2006) show that in the light of heteroskedasticity log linearization of the stochastic gravity model may result in a violation of Jensen's inequality and bias the estimates. They suggest a poisson estimator that solves this identification problem. An additional advantage is that this estimator can also handle zero trade flows. Let EV_{ijt} be the exports in a given trade relationship at time t. In our sample we have a total of 44 destination and 48 origin states. This results in a total of 6,204 bilateral trade relationships. To implement the

Poisson estimator with zero trade flows we specify

$$EV_{ijt} = exp(\beta X_{ijt} + \delta_{it}) + \epsilon_{ijt} \quad (15)$$

where the matrix X_{ijt} contains the log of the aggregate GDP in the destination state in addition to the same regressors as in the specification above. We pull GDP into the specification, because we observe it, even if we do not observe a trade flow. Table 7 reports the results. The coefficients are estimated with a larger number of observations, because we include the zero trade flows. The sign and significance patterns stay comparable to the previous estimation results. However, the coefficients drop in magnitude.

Additional Robustness Checks. — We may be missing some of the unit values when we compute the CES price index because some trade weights are not reported when we observe the export values. We estimate the baseline specifications including only the trade pairs where we observe all the information and the results were similar in magnitude and significance.

The CES price index reveals some potential outlier observations. Deleting those observations from the sample and re-estimating leaves the results unchanged. We also estimated a median regression (Koenker and Bassett 1978), which is more robust with respect to outliers than OLS regressions. The conclusions remain the same.

We also specified the probability for tax evasion as a normal and logisitc probability distribution functions. Obtaining stable estimates from these specifications is difficult because we have to estimate a large number of fixed effects. In addition, the data do not seem to have enough non linearity to identify these models. Not even a simple squared log distance or squared log tax variable have a significant impact on commodity flows.

Table 4 reports the results by commodity and show that the category “Commodity Unknown" has coefficients that are large in magnitude compared to the other commodities. To examine whether this category is driving our results, we drop it from our sample before aggregating the trade flows. Re-estimating Table 2 we find that dropping this category from the sample has no almost no impact on the estimates.

We allowed for two-way clustering (Cameron et al. 2010) by destination and origin in our main specifications of Table 2. The patterns of significance (and of course the estimates) remain the same. All results from the this additional robustness exercises are available upon request.

VI. Conclusion

Traders involved in interstate commerce are subject to a variety of taxes, two of which are levied at destination - sales taxes and corporate income taxes. Applicable sales taxes are collected by the seller based on the consumer's location if the seller has nexus in the destination state, or if not collected by the seller, are reportable and payable by the buyer. No planning mechanism avoids the legal imposition of sales taxes; only evasion by the buyer or seller reduces the tax burden on the transaction. Income taxes are not owed on a transaction basis but apply to taxable income apportioned to the destination with sales being one of the factors (often the predominant or sole factor) used to apportion business taxable income. The question is whether the potential for evasion affects interstate trade flows by altering the relative price of domestic and imported goods.

Our results show that sales taxes have a negative impact on commodity flows but that the interaction between the sales tax and distance is positive. Thus, these results are consistent with the theory that evasion rises with increases in distance because destination taxes are less enforceable. One important implication from these results is that destination-based tax regimes are undermined as distances between traders increase. This suggests that in addition to origin taxation, destination taxation and the possibility for evasion influence the location of production. With origin taxation the potential tax benefits from remote purchases are a negative function of distance but with destination taxation the potential tax benefits of remote purchases rise with distance because of evasion.

A value added tax (VAT) and a retail sales tax are both intended as consumption taxes imposed at destination rates, and, assuming similar tax bases and perfect compliance, the taxes have equivalent economic effects. However, the taxes have different enforcement mechanisms, and these differences affect where tax evasion is most likely to occur. In a VAT regime, border controls often act as a powerful oversight tool, virtually assuring high tax compliance on cross border sales. Because there are no interstate border controls, tax evasion is likely easier on domestic transactions, meaning the VAT operates to some extent as a tariff on exports (see Desai and Hines (2002)). On the other hand, state sales taxes lead to relatively higher taxes on domestic sales than on import sales (effectively a tariff on domestic sales) because sales tax compliance decreases with the ability to enforce destination taxation. Accordingly, the sales tax burdens domestic vendors with higher effective tax rates providing perverse incentives for businesses with a national scope, or those that can use alternative organizational forms, to exploit markets with the least effective oversight of remote sales. Interestingly, the VAT in Europe may offer similar incentives to sales taxes because the reverse charging mechanism used to enforce cross- country VAT payments within Europe has similarities to buyer compliance at the destination under the sales tax.

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VII. Figures

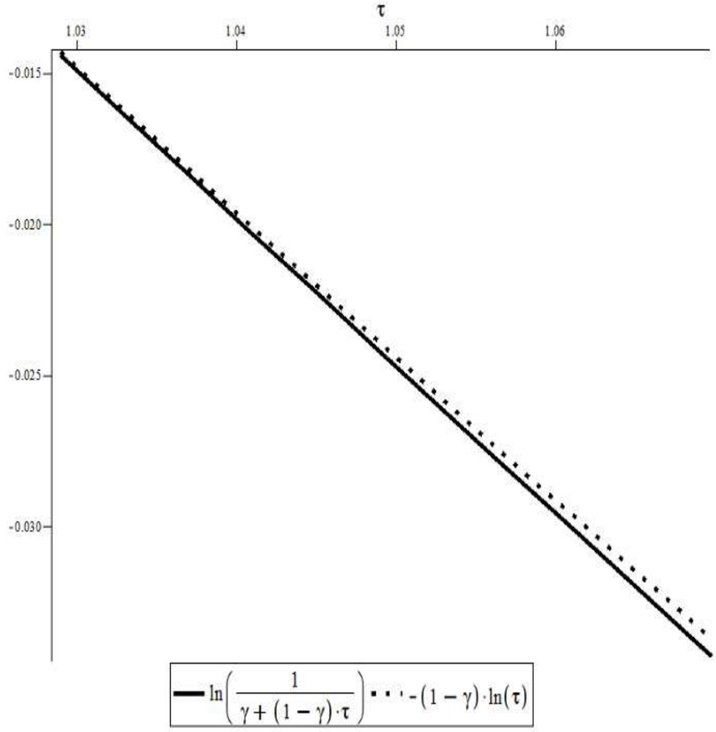

Figure 1. Quality of Linear Approximation

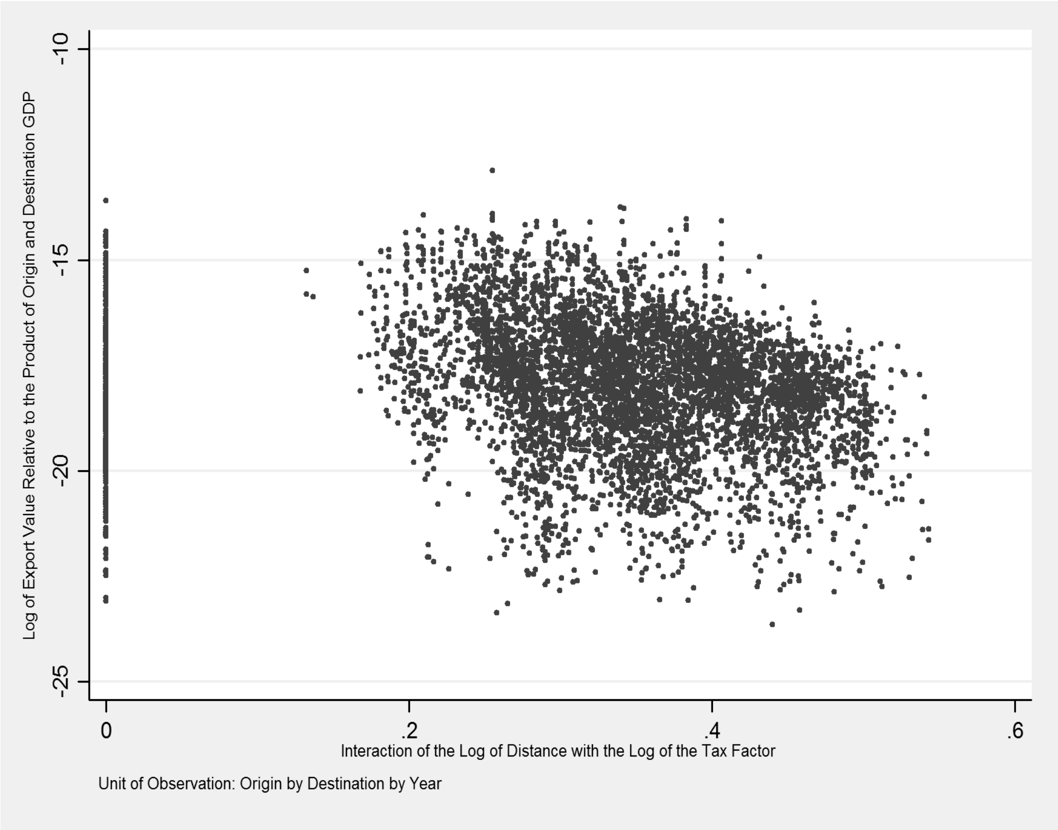

FIGURE 2. IMPACT OF ZERO SALES TAX RATES

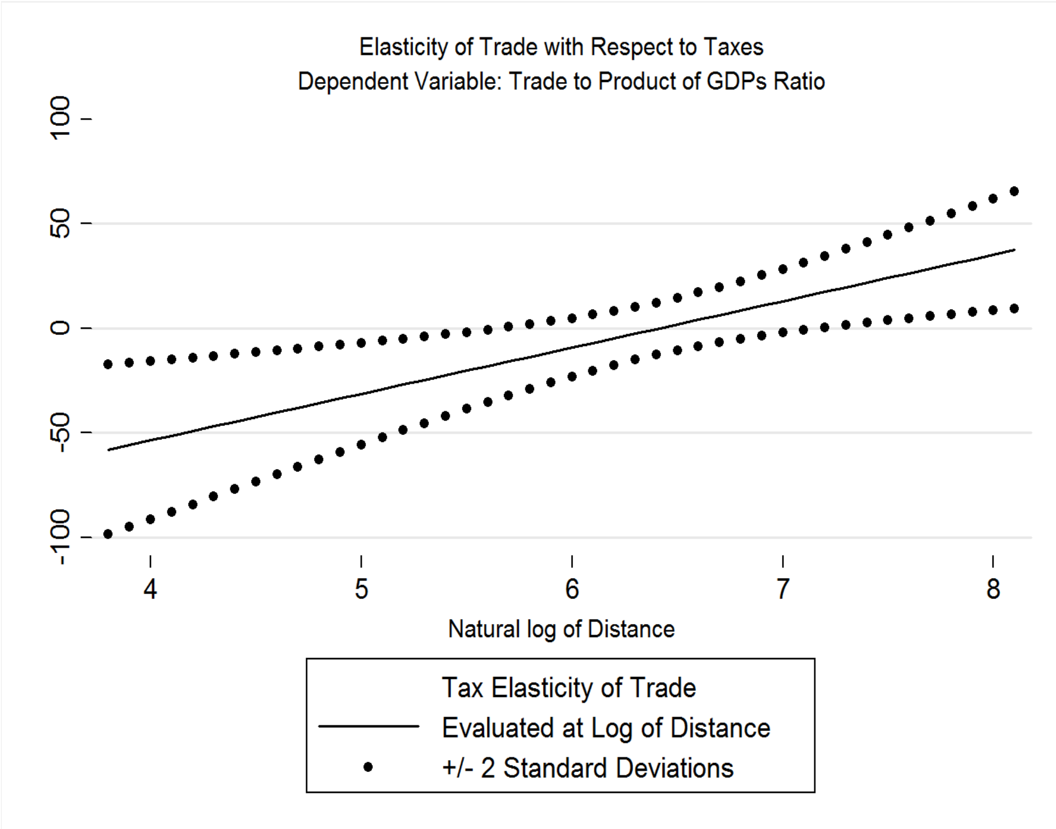

Figure 3. Tax Elasticity of Export Flows

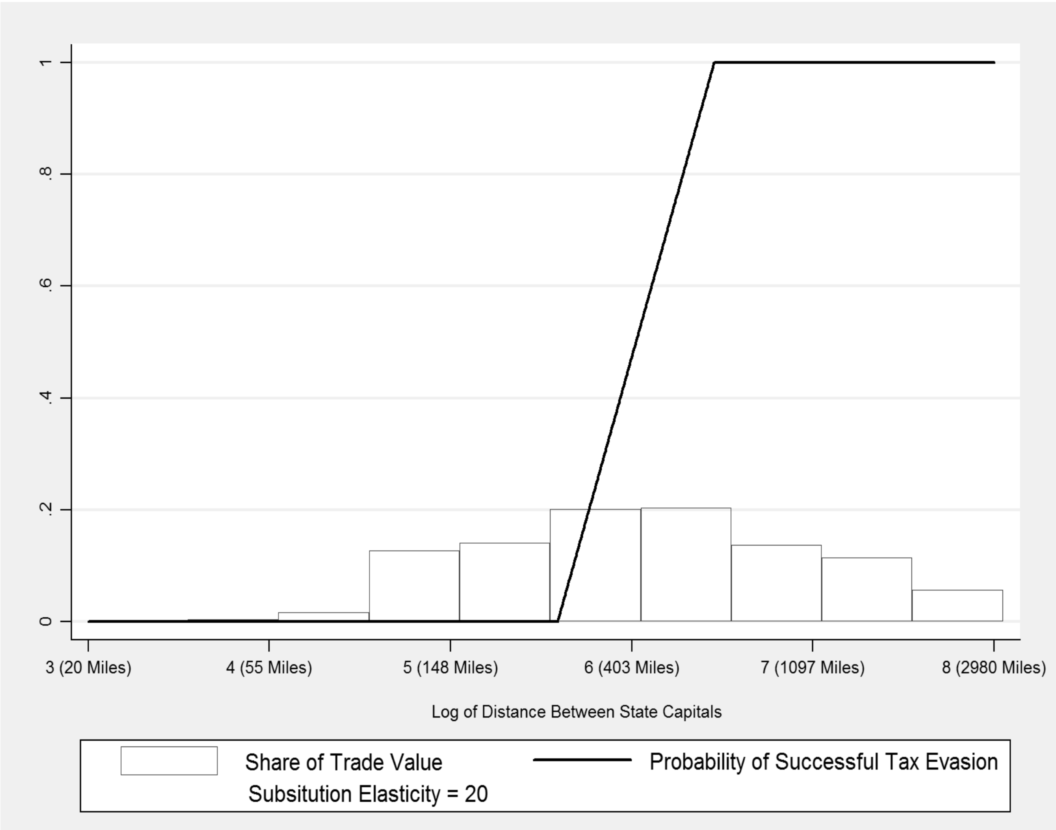

Figure 4. Probability of Tax Evasion

VIII. Tables

Table 1—Summary statistics

Variable	Mean	Std. Dev.	N
Destination Sales Tax Factor	1.05	0.01	5543
Distance between Capitals	1152.08	705.68	5543
Value Weighted Distance	808.34	513.5	3668
Export Value in Mil.	1832.71	3907.41	5543
Export Weight in Tons	1218.97	3673.65	5543
Nominal GDP in Bil.	237.9	252.7	5543
Indicator=1 if Linked by Major River	0.12	0.33	5543
Inidcator=1 if Neighbor	0.11	0.31	5543
Multilateral Resistance at alpha=1	156.88	840.55	5543

Table 2—Impact of Sales Taxes on Export Flows

	Spc1	Spc2	Spc3	Spc4
	(1)	(2)	(3)	(4)
Distance	-2.582	-2.659	-2.121	-1.820
	(.378)***	(.473)***	(.305)***	(.296)***
Sales Tax	-142.334	-131.530	-119.686	
	(47.914)***	(49.084)***	(38.402)***	
Distance× Sales Tax	22.202	20.735	18.874	9.816
	(7.409)***	(7.688)***	(6.064)***	(5.694)*
Corp. Inc. Tax		-17.332		
		(18.595)		
Distance× Inc. Tax		2.079		
		(2.907)		
CES Index	.037	.036	.034	
	(.022)*	(.021)*	(.020)*	
Indicator=1 if Linked by River			.350	.282
			(.092)***	(.098)***
Inidcator=1 if Neighbor			.779	.679
			(.126)***	(.123)***
Obs.	5543	5543	5543	5543
R^2	.581	.584	.606	.698

Note: The dependent variable in all specifications is the log of the export value divided by the product of the origin and destination GDP. The standard errors are robust and clustered by destination state. All specifications include origin-by-year fixed effects (Not reported to save space). Estimator: Ordinary Least Squares.

Table 3—Robustness Exercise: Alternative Measure of Distance

	Spc1	Spc2	Spc3	Spc4
	(1)	(2)	(3)	(4)
Weighted Average Miles	-2.821	-2.882	-2.544	-2.478
	(.358)***	(.427)***	(.324)***	(.428)***
Sales Tax	-146.000	-136.415	-133.389	
	(41.700)***	(41.141)***	(37.646)***	
AvgMiles × Sales Tax	24.268	22.891	22.313	15.071
	(7.158)***	(7.164)***	(6.537)***	(8.030)*
Corp. Inc. Tax		-15.098		
		(15.212)		
AvgMiles × Inc. Tax.		1.904		
		(2.701)		
CES Index	.042	.042	.038	
	(.026)	(.026)	(.025)	
Indicator=1 if Linked by River			.268	.209
			(.094)***	(.089)**
Inidcator=1 if Neighbor			.684	.466
			(.104)***	(.087)***
Obs.	3756	3756	3756	3756
R^2	.576	.578	.593	.707

Note: The dependent variable in all specifications is the log of the export value divided by the product of the origin and destination GDP. The standard errors are robust and clustered by destination state. All specifications include origin-by-year fixed effects (Not reported to save space). Estimator: Ordinary Least Squares.

Table 4—Robustness Exercise: Results by Commodity

Commodity	Distance	Tax	DistanceXTax
Live Animals and Fish	-0.44	9.06	-1.79
Cereal and Grains	-0.71	-25.8	-4.81
Other Agricultural Products	-1.75***	-92.44***	12.45**
Animal Feeds and Products of Animal Origin	-1.8***	-82.85	12.63
Meat, Fish and Seafood	-2.11***	-111.2***	17.83***
Grains, Alcohol and Tobacco	-1.56***	-49.73	8.76*
Other Prepared Foodstuffs and Fats and Oils	-1.68***	-53.18*	8.48*
Alcoholic Beverages	-1.02***	-8.77	2.45
Tobacco Products	-0.74	40.26	-2.38
Calcareous Monumental or Building Stone	-0.56	43.74	-5.98
Natural Sands	0.48	135.11	-24.72
Gravel and Crushed Stone	0.75	124.83	-23.92
Nonmetallic Minerals	0.04	106.51**	-15.85**
Metallic Ores and Concentrates	0.23	139.44	-20.58
Nonagglomerated Bituminous Coal	1.1	201.42**	-32.84**
Gasoline and Aviation Turbine Fuel	-0.96	123.48	-19.6
Fuel Oils	2.63***	446.6***	-73.59***
Coal and Petroleum Products	-2.21***	-98.76*	16.74*
Basic Chemicals	-1.66***	-67.66*	12.05**
Pharmaceutical Products	-1.93***	-92.63**	15.04***
Fertilizers	0.62	183.12**	-31.02**
Chemical Productsand Preparations	-1.5***	-63.78*	10.43**
Plastic and Rubber	-1.59***	-56.03*	9.34**
Logs and Other Wood in the Rough	0.2	124.89	-18.27
Wood Products	-1.83***	-52.4	7.2
Pulp, Newsprint, Paper and Paperboard	-1.31***	-33.97	5.67
Paper or Paperboard Articles	-1.81***	-73.45**	11.52**
Printed Products	-1.39***	-53.36*	9.01*
Textiles, Leather and Articles Thereof	-1.39***	-81.79**	12.57***
Nonmetallic Mioneral Products	-1.85***	-64.88**	10.3**
Base Metal	-1.4***	-4.5	2.19
Articles of Base Metal	-1.66***	-66.21**	10.6**
Machinery	-1.26***	-39.86	6.73
Electronics	-1.23***	-64.12***	10.81***
Motorized and Other Vehicles	-1.42***	-41.54	7.11
Transportation Equipment	-.98**	-44.92	8.97
Precsision Instruments and Aparatus	-.65***	2.04	1.52
Furniture, Mattressess, Lamps and Lighting	-1.13***	-26.92	3.84
Miscellaneous Manufactured Products	-1.44***	-73**	11.14**
Waste and Scrap	-1.39*	2.47	-0.31
Mixed Freight	-3.18***	-130.34**	20.09**
Commodity Unknown	-4.39**	-376.13**	57.62**

Note: All estimates are from the same specification as Specification 1 in Table 2, but estimated by commodity.

Table 5—Robustness Exercise: Using Average Wages as Instrument for the Price Index

	Spc1	Spc2	Spc3	Spc4
	(1)	(2)	(3)	(4)
Distance	-2.514	-1.951		
	(.423)***	(.350)***		
Sales Tax	-136.307	-99.550	-125.368	-105.852
	(55.130)**	(47.594)**	(60.888)**	(57.888)*
Distance× Sales Tax	22.796	17.497		
	(8.996)**	(7.684)**		
Weighted Average Miles			-2.659	-2.350
			(.515)***	(.487)***
AvgMiles × Sales Tax			22.311	19.386
			(10.662)**	(10.054)*
AvgMiles × Inc. Tax.				
CES Index	.354	.351	.412	.406
	(.095)***	(.097)***	(.132)***	(.136)***
Indicator=1 if Linked by River		-.216		-.432
		(.170)		(.275)
Inidcator=1 if Neighbor		1.139		1.022
		(.214)***		(.222)***
Obs.	5543	5543	3756	3756
R^2	.255	.29	.158	.192

Note: The dependent variable in all specifications is the log of the export value divided by the product of the origin and destination GDP. The standard errors are robust and clustered by destination state. All specifications include origin-by-year fixed effects. (Not reported to save space). Estimator: 2 Stage Least Squares. Instrument: Average wage across states.

Table 6—Robustness Exercise: Strategic Border Sales

	Spc1	Spc2
	(1)	(2)
Distance	-2.318	-2.389
	(.306)***	(.353)***
Sales Tax	-144.622	-151.412
	(42.389)***	(47.186)***
Distance× Sales Tax	22.311	23.306
	(6.308)***	(7.078)***
CES Index	.040	.039
	(.020)**	(.021)*
Inidcator=1 if Neighbor	7.172	1.999
	(4.247)*	(4.044)
Neighbor × Dest. Sales Tax	16.663	22.213
	(12.084)	(10.938)**
Neighbor × Orig. Sales Tax	-6.761	-2.139
	(3.810)*	(3.870)
Obs.	5543	5119
R^2	.604	.608

Note: The dependent variable in all specifications is the log of the export value divided by the product of the origin and destination GDP. The standard errors are robust and clustered by destination state. All specifications include origin-by-year fixed effects (Not reported to save space). Estimator: Ordinary Least Squares.

Table 7—Robustness Exercise: Poisson Estimates

	Spc1	Spc2
	(1)	(2)
Dest. GDP	1.077	1.077
	(.047)***	(.045)***
Distance	-1.130	-1.128
	(.118)***	(.113)***
Sales Tax	-42.699	-32.030
	(16.481)***	(16.665)*
Distance × Sales Tax	7.954	6.484
	(2.426)***	(2.532)**
Corp. Inc. Taxe		-14.669
		(14.831)
Distance × Inc. Tax		1.607
		(2.190)
CES Index	.029	.024
	(.012)**	(.010)**
Indicator= 1 if Neighbor	.687	.667
	(.059)***	(.059)***
Indicator= 1 if linked by River	.120	.186
	(.077)	(.059)***
Obs.	6204	5640

Note: The dependent variable in all specifications is the level of the export value. The standard errors are clustered by destination state. All specifications include origin-by-year fixed effects (Not reported to save space). Estimator: Poisson MML (Silva and Tenreyro 2006).