Latent Exports: Almost Ideal Gravity and Zeros

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December 2020

Abstract

Almost Ideal gravity associates zero trade flows with variable and fixed trade cost variation in a flexible demand system. Latent trade shares between non-partners are inferred from the Tobit estimator applied to trade among 75 countries and 25 sectors in 2006. Latent Trade Bias (LTB) is the difference between the latent trade share and the as-if-frictionless trade share. Explained LTB variance decomposition shows 52% due to variation of variable trade cost, 24% due to non-homothetic income effects, and 24% due to fixed trade cost effects. Counterfactual variable (fixed) cost reductions suggest cases of successful export promotion between non-partners.

Keywords: Zero flows; variable cost; fixed cost; latent trade.
JEL Codes: F10, F13, F14.

We thank Pol Antràs, Andrew Bernard, Arnaud Constinot, Thibault Fally, Ben G. Li, Yi Lu, Marc Muendler, Dennis Novy, Theodore Papageorgiou, Steve Redding, Anthony Venables and seminar participants at the Australasian Trade Workshop, Boston College, the Empirical Investigations in Trade and Investment Workshop, and the Tsinghua Workshop on International Trade for their helpful comments.

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1 Introduction

Action on the extensive margin (entry or exit) of bilateral trade accounts for a large portion of the variation of trade in cross-section or time series. [1] The standard Constant Elasticity of Substitution (CES) gravity model loads the explanation of zeros onto xed export costs because standard iceberg unit costs must rise without bound to drive trade to zero. In contrast, economic intuition suggests that choke price exceeded by high per-unit trade cost may be an important alternative explanation for zeros. Choke price variation is intuitively likely to be large – demand elasticities with respect to price vary across source countries and bilateral trade costs vary across destinations. Income effects may differ across destination countries, as variations in income per capita interact with income elasticities that differ from one. An Almost Ideal (Demand System) gravity model is developed in this paper to explain zeros by a combination of choke price variation and xed export costs. Choke price variation is further due to variable costs and their interaction with varying demand elasticities and variation of income elasticities interacting with variation of per capita incomes. Variance decomposition reveals that variable cost variation accounts in the estimated model for a much higher proportion of zeros than does xed cost variation or income elasticities variation.

The estimated model is applied to illustrate its potential for evaluating export promotion on the extensive margin. Export promotion motivates national policy, both unilatthis paper is flexible enough to allow heterogeneous price, fixed cost, and income elasticities to interact with a combination of fixed costs and iceberg costs in determining trade flows both positive and latent. We extend the Feenstra (2010) version of AIDS to allow exporter-specific substitution parameters, and exporter-specific non-homothetic income effects on the reservation prices associated with latent trade.

Latent trade is defined (in Section 5.1) as the hypothetical stock required to make the agent indifferent between consuming it and selling a marginal unit after absorbing the fixed trade cost. Trade Bias, in the literature, is the difference between predicted trade and as-if-frictionless trade. Latent Trade Bias (LTB), as used in this paper, is the difference between the latent trade share (the absolute value of a negative number for cross-border trade) and the as-if-frictionless trade share – a Trade Bias concept applicable to both latent and positive trade (see Figure 3 in Section 5.1 for details).

The Tobit estimator of AI gravity predicts the latent value of bilateral trade shares for non-partners, given the inferred bilateral iceberg costs and entry costs as well as the demand parameters. The estimated sectoral AI gravity model implies that, on average, variable cost explains 52% of the variation in LTBs, while fixed cost explains 24%. The remaining 24% is explained by income effects on demand due to the variations in per capita income interacting with variation in origin-specific income elasticities. Variable cost dominates fixed cost and income effects for almost all sectors. The variation in the causes of zeros implies differences in the efficacy of export promotion policies on the extensive margin.

lateral variable cost decreases the number of current sectoral zero flows much more than does the elimination of bilateral fixed cost. These are the upper bounds for what the hypothetical export promotion policy could do. More relevant to export promotion targeting, a 10% cut in variable cost induces trade in a much larger number of potential bilateral pairs than does a 10% cut in fixed cost. Here, the three-digit ISIC level of the data presumably hides a much larger number of potential targets in more disaggregated sectors.

An alternative clue to export promotion from our application is that reducing variable cost improves the probability of a new trading partner more if the source country is poorer. The results are consistent with the intuition that products from poorer couninformation can incorporate the intensive margin.

Our treatment of zero trade ows associated with exible demand systems is distinguished from the preceding literature in its application to export promotion policy issues, while in a technical sense it is an extension of that literature. One treatment in the literature assumes away an extensive margin by modeling trade as a Poisson arrival process with zeros accounted for as events with no observed shipments in the observation window. A multi-sector extension of the Ricardian model with random productivity draws (Eaton et al., 2012) generates zeros at the sector level with a CES demand system (Costinot et al., 2012) without either xed costs or choke prices. Allowing for an extensive margin associated with xed costs implies that standard CES gravity estimators that exclude zero ows are potentially biased due to selection effects. Helpman, Melitz, and Rubinstein (2008) adopt the Heckman two-stage estimation procedure that uses an equation for selection of trade partners in the rst stage and a trade ow equation in the second. [5] Baldwin and Harrigan (2011) add quality-selection to the Melitz (2003) model and, together with productivity-selection, show that only rms with the lowest quality-adjusted price export. Choke prices without xed costs can be generated in quadratic demand systems, e.g., in

In contrast to homothetic demand systems, choke prices can be due to the combined effect of high income-elasticity and low per capita income. The closest predecessor to our model is that of Fajgelbaum and Khandelwal (2016). They extend Feenstra's one-parameter translog to a non-homothetic AIDS gravity structure with income elasticities that can vary by source country. We extend their model to allow price (variable cost) elasticity heterogeneity across all N source countries.[8] Our version of AIDS allows variable cost to affect trade (including latent trade) flows differently across exporters. It is a reasonable compromise between parsimony and a realistic approximation of origin-specific variations in demand elasticity reflecting quality variations *inter alia*. Relative to Fajgelbaum and Khandelwal (2016), we find that allowing for price elasticity variation greatly reduces the significance of income effect variation. The more essential difference is that we focus on zeros with measures of latent trade.

Our paper is also related to a wider literature on zeros in international trade. Armenter and Koren (2014) propose a statistical model using balls and bins to account for the large number of zeros in firm- and product-level international shipments. Our economic structural model accounts for the same pattern in a setting from which policy implications are drawn. Eaton et al. (2012) show that the standard heterogeneous firm model can be modified to generate an integer number of firms that account for the zeros in bilateral trade data. Our model nests heterogeneous firms within a more general demand structure.

The remainder of the paper is organized as follows. The next section presents the zero flows in data. Section 3 derives the Almost Ideal gravity model. The model estimation is discussed in Section 4, and applied to quantify causes of the zero flows in Section 5. Section 6

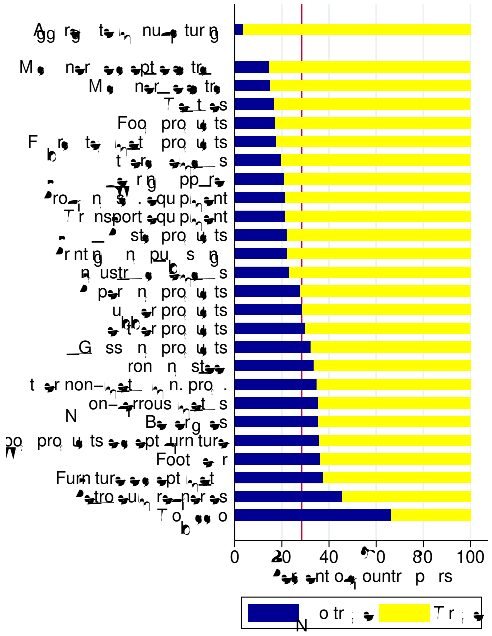

Figure 1: Zero Trade Frequency across Sectors

zero flow frequency in each sector. The zero flow frequency in the leather sector is closest to the average level. 15% of the country pairs do not trade machines. 65% of the trade flows in the tobacco sector among the country pairs are zero. Zero trade flows are more likely to occur in tobacco, petroleum, and furniture sectors, while less likely to occur in machinery, electric, and textile sectors.

Zeros could be simply a result of a group of countries not trading with one another. To dismiss this possibility, we take the "average" sector, leather, as an example.[10] Figure 2 plots the trade matrix among all importers (rows) and exporters (columns) in descending order ranked by GDP. So the first row (column) displays the U.S. import from (export to) each country (including itself). The second row (column) follows Japan and succeeding rows (columns) follow Germany, China, etc. [11] Again, the blue dots represent zero flows, and the yellow dots represent positive observations. The diagonal elements are the domestic trade of each country and are all positive. This implies that every country produces and supplies leather products to its domestic market. The general sparseness of the trade matrix is evident – the fraction of zero observations is around 30%, and almost all countries are associated with zero flows. More specifically, there are zero flows in every row (column), meaning that no one imports (exports) leather products from (to) every-

[10] The zero frequency of international trade in the leather sector is 30%, close to the average zero frequency of 28%.

[11] Note that the year is 2006 in our sample.

Figure 2: Zero Trade Flows by Country Pairs: Leather Sector

To satisfy homogeneity of degree one, the parameters are constrained by $a(w) \in (0,1)$, $\int a(w)dw = 1$ and $\int g(w,w')dw = 0$ for any w'. Symmetry is imposed to satisfy Young's Theorem, $g(w,w') = g(w',w)$. Concavity is imposed by the requirement that $\{g(w',w)\}$ is negative semi-definite.

We let

$$g(w,w') = \begin{cases} gb(w)b(w'), & \text{if } w \neq w' \\ -gb(w)(1-b(w)), & \text{otherwise,} \end{cases} \tag{3}$$

where $b(w) \in (0,1)$ and $\int b(w)dw = 1$.[12] Specialization (3) satisfies the general restrictions of the AIDS but imposes a tight restriction on the cross-effects. In particular, complementarity is ruled out – all off-diagonal terms of the substitution effects matrix are non-negative.[13]

Applying Shephard's lemma and differentiating the expenditure function with respect to log price $p_j(w)$ generates the expenditure share in good w for consumers at country j equal to

$$s_j(w) = a(w) - gb(w)\ln\left(\frac{p_j(w)}{\bar{p}_j}\right) + f(w)\ln \ldots$$

Douglas preference.

AIDS allows for reservation (choke) prices above which demand is equal to zero. For a single consumer in isolation, this implies dif culties in identifying the demand system, since reservation prices are unobservable for the unavailable goods (Feenstra, 2010), yet have effects on positive demand.[15] In the many country gravity context, all goods are consumed somewhere. Thus the demand parameters can be identi ed. We also can identify the trade cost that it would take to serve any bilateral market. The full price vector, including the reservation prices, is implicitly solved in the gravity model. The resulting effect on positive shares is controlled for by the destination xed effects that control for the effect of variation in the full price vector via the theoretically founded price index (see Appendix A.1 for proof). This procedure essentially jumps over the unobserved reservation price problem.

For comparative static experiments of the sort we deploy in Section 6, the extensive margin changes and the response of the full price vector involves the shift from reservation prices to active market prices. Appendix A.1 analyzes this case with an extension of Feenstra (2010 segmented,[17] hence arbitrage forces markups (over full cost of production and trade) by firms of country i to be the same across destinations. Firm w from country i thus sets its markup based on the expected firm share in the world market which is denoted as $\bar{s}_i$. The common markup is denoted as m_i. Thus

$$m_i = 1 + (gb_i)^{-1}\bar{s}_i. \tag{6}$$

Then a firm receives a random productivity draw in log-level $\ln z$. Following the recent literature, denote $a = \ln z$ and assume a follows a special bounded Pareto distribution with accumulative density function as

$$G(a) = \frac{\ln a}{\ln H}, \; 1 < a < H, \tag{7}$$

where 1 and H are the lower and upper bounds of the distribution, respectively. [18] Parameter H also reflects the dispersion of the productivity. The equilibrium price in log for markets that are served is

$$\ln p_{ij}(z) = \ln m_i w_i t_{ij} - \ln z. \tag{8}$$

From equation (4), firm z's market share in country j is

$$s_{ij}(z) = a_i - gb_i \ln(m_i w_i t_{ij}/\bar{p}_j) + f_i \ln r_j + gb_i \ln z, \tag{9}$$

and its profit

$$p_{ij}(z) = (1 - m_i^{-1}) s_{ij}(z) E_j - F_{ij}, \tag{10}$$

where E_j is the total expenditure of country j, F_{ij} denotes the fixed cost for firms from country i export to country j. Then from zero profit condition $p_{ij}(z_{ij}) = 0$, we can get the cutoff productivity in log is

$$\ln z_{ij} = (gb_i)^{-1}\left[\frac{m_i}{m_i - 1} f_{ij} - a_i + gb_i \ln(m_i w_i t_{ij}/\bar{p}_j) - f_i \ln r_j\right], \tag{11}$$

where

$$f_{ij} = F_{ij}/E_j \tag{12}$$

[17]The assumption avoids having to deal with a complex endogeneity problem in firm-destination markups, but is also plausible for many sectors. Segmented markets require firm-destination-specific barriers that prevent spatial arbitrage. For many products, these seem unlikely. Nevertheless, the no segmentation assumption rules out pricing-to-market behavior observable in some well-known sectors.

[18]We normalize the lower bound as 1. Alternatively, we assume $G(a) = \frac{\ln a - \ln L}{\ln H - \ln L} = \frac{\ln(a/L)}{\ln(H/L)}$, $L < a < H$, which is equivalent to our setup.

denotes the adjusted fixed cost by the total market expenditure.

3.3 Aggregates

Let S_{ij} denote the total market share of country j imports from all firms of country i. By definition, the bilateral import share is

$$S_{ij} = N_i \int_{\ln z_{ij}}^{H} s_{ij}(a) dG(a), \tag{13}$$

where N_i is the measure of firms in country i. Here the total number of firms N_i are exogenous while the proportion that export is endogenous. Using the demand system structure and rearranging yields

$$S_{ij} / N_i$$

Note that a_i^0, gb_i^0, and f_i^0 are productivity-adjusted tastes, productivity-adjusted price elasticities, and productivity-adjusted income elasticities. Thus, $a_i^0 > 0$, $gb_i^0 > 0$. f_i^0 and f_i have the same sign. Relative to a_i, gb_i, and f_i, they include dependence on the supply side productivity distribution parameter H. Finally l_i^0 is the marginal effect of xed cost on trade shares. The coef cients satisfy $\sum_i N_i a_i^0 = (1/\ln H) + (H/\ln H)g$, $\sum_i N_i b_i^0 = (1/\ln H)$, and $\sum_i N_i f_i^0 = 0$. And thus $b_i = b_i^0 / \sum_i N_i b_i^0$. Note that the total number of rms N_i is exogeneously given, but the fraction of rms that export is endogenously determined.[21] The main parametric action in our model is on the demand side. The supply side productivity dispersion parameter plays a role in the implied trade elasticities.[22] Aggregate share per rm in (14) is decomposed into four parts. The rst term a_i^0 includes all origin-speci c factors, and the last term $f_i^0 \ln r_j$ includes all destination-speci c factors multiplied by an origin-speci c coef cient. The two terms in the middle are the effects of bilateral variable costs and xed costs.

3.4 Gravity

Market clearance for each origin i is given by

$$Y_i = \sum_j S_{ij} E_j, \tag{19}$$

where Y_i is the total income of country i. Using market clearance in the AIDS share equation yields the AI gravity equation.[23] Thus:

$$S_{ij}/N_i \quad \frac{Y_i}{Y}/N_i = \quad gb_i^0 \ln\left(\frac{t_{ij}}{\mathrm{P}_i P_j}\right) \quad l_i^0 (f_{ij} \quad \mathrm{Y}_i) + f_i^0 \ln(r_j/R), \tag{20}$$

where Y is world total income, and

$$\ln \mathrm{P}_i \quad \sum_j (E_j/Y) \ln t_{ij}, \tag{21}$$

$$\ln P_j \quad \sum_i N_i b_i \ln(t_{ij}/\mathrm{P}_i), \tag{22}$$

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$$\Upsilon_i = \sum_j (E_j/Y)\, \phi_{ij}, \tag{23}$$

$$\ln R = \sum_j (E_j/Y) \ln \rho_j. \tag{24}$$

On the left hand side, $S_{ij}/N_i - \frac{Y_i}{Y}/N_i$ is the deviation of bilateral trade per firm from its frictionless level $\frac{Y_i}{Y}/N_i$. There are three terms on the right hand side, which capture the *variable cost effect*, *fixed cost effect*, and *income effect*, respectively. The first term, $-\gamma b_i \ln \frac{t_{ij}}{\Pi_i P_j}$

4 Estimation

The estimation of AI gravity derived in Section 3 is described in this section. Section 4.1 describes the data and speci cations. Estimation results using aggregate trade data are presented in Section 4.2 and results using sectoral trade data are presented in Section 4.3.

4.1 Data and Speci cations

Trade and production data for 75 countries in the year 2006 comprise the sample.[25] We follow Novy (2013) to measure the number of goods that originate from each country, N_i, with the extensive margin data constructed by Hummels and Klenow (2005). The extensive margin is measured by weighting categories of goods by their overall importance in exports.[26]

xed cost components.

Recall that real expenditure per capita is de ned as $\ln r_j = \ln(e_j/\bar{Q}_j)$ where e_j, nominal expenditures per capita, are observable. Aggregate price index $\ln \bar{Q}_j$ can be proxied by a Stone index following the literature, [29] that is

$$\ln \bar{Q}_j = \sum_{i=1}^{N} S_{ij} \ln(p_{ii} dist_{ij}^{r_0}), \tag{26}$$

where p_{ii} are the quality-adjusted prices estimated by Feenstra and Romalis (2014). We pick $r_0 = 0.177$ following Fajgelbaum and Khandelwal (2016).

The AI gravity equation derived above is

$$S_{ij}/N_i \quad \frac{Y_i}{Y}/N_i = \quad gb_i^0 \ln\left(\frac{t_{ij}}{P_i P_j}\right) \quad l_i^0(f_{ij} \quad Y_i) + f_i^0 \ln(r_j/R),$$

where there are a large number of parameters to be estimated. There is a set of productivity-adjusted variable cost (price) elasticities $f gb_i^0 g$, a set of xed cost elasticity parameters $f l_i^0 g$, and a set of productivity-adjusted income elasticities $f f_i^0 g$. In order to reduce the number of estimated parameters, we impose some restrictions. First, we impose the constraint $f_i^0 = c_0 + c \ln r_i$ where $c > 0$ and r_i is the exporter income, similar to Fajgelbaum and Khandelwal (2016). This is because rich countries are more likely to export high-quality goods. The theoretical restriction $\sum_{i=1}^{N} N_i f_i = 0$ implies $c_0 = \quad c \sum_{i=1}^{N} N_i \ln r_i$, transforming this linear relationship to

$$f_i^0 = c(\ln r_i \quad \ln \bar{r}), \tag{27}$$

where $\ln \bar{r} = \sum_{k=1}^{N} N_k \ln r_k$, and reducingi*and Khan]TJ/F38 12.4598 11.9598 11b* the markup in equation (17), and thus a function of the price elasticity parameters implied in equation (6). Then we have

$$I_i^0 = (1/\ln \ H)(1 + gb_i / \bar{s_i}). \tag{29}$$

Since the xed cost coef cient is linear in the price elasticity, we can estimate I_i^0 in a similar way to distance elasticities. Speci cally, similar to (28), we assume

$$I_i^0 = b_0^f \quad b_1^f \ln r_i, \tag{30}$$

where r_i is the exporter income of exporter i and $b_1^f > 0$. The rich country's goods are

0 for import and 1 for internal trade, to capture all the other unobserved trade cost across border, similar to Ramondo et al. (2016) and Anderson and Yotov (2017). Unfortunately r cannot be identified from b_0 and b_1. So we pick $r = 0.117$ directly following the literature, and then b_0 and b_1 are identified. We expect the coefficients of $\ln dist_{ij}$ and $entrycost_{ij}$ are both negative, while those of the interaction terms $\ln r_i \quad \ln dist_{ij}$, $\ln r_i \quad entrycost_{ij}$, and $\ln r_i \quad \ln r_j$ are all positive. In other word, all parameter estimates $\{b_0, b_1, b_0^f, b_1^f, l, c\}$ should be positive. The productivity-adjusted elasticity parameters are identified by

$$\widetilde{b}_i^0 = b_0 \quad b_1 \ln r_i ,$$

distance reduces the bilateral trade share. AIDS gravity fits the smaller shares better than CES. Novy (2013) finds that the translog model generates a reasonably good fit for intermediate import shares in the range from 0.05 to 0.15. He points out that for large import shares both CES and translog models produce larger residuals, and the translog model in particular underpredicts the actual import shares. Since 99.7% of the import shares in our sample are below 0.15, the AI gravity estimates are consistent with Novy (2013).

A more novel result is that the coefficient of the interaction term of distance and exporter income is significantly positive, implying that the distance reduces trade by less for rich exporters than for poor exporters. This suggests that there is a significant distance (price) elasticity heterogeneity across exporters, and the magnitude of the coefficient reflects the size of the distance elasticity dispersion. Since we assume that $r = 0.177$, the estimates imply that $\hat{b}_0 = 1.158/0.177 = 6.542$ and $\hat{b}_1 = 0.128/0.177 = 0.723$. Thus the productivity-adjusted variable cost (price) elasticity is $\widehat{gb}'_i = \hat{b}_0 - \hat{b}_1 \ln r_i$, where r_i is exporter GDP per capita. And $\{\hat{b}_i\}_{i=1}^{N}$ can be calculated from equation (33). As discussed earlier, g and H cannot be identified from their estimated product.

The coefficient of entry cost is significantly negative, which implies that the entry cost also reduces the bilateral trade share. The estimates imply that $\hat{b}^f_0 = 5.805$ and $\hat{b}^f_1 = 0.550$. Thus the productivity-adjusted fixed cost elasticity is $þ' = \hat{b}^f_0 - \hat{b}^f_1 \ln r_i$. The coefficient of the income interaction term is not significantly different from zero. This suggests that there is little income elasticity heterogeneity across exporters – non-homotheticity is not statistically significant in aggregate trade. The income elasticity parameter $\hat{c} = 0.017$. This positive coefficient implies that richer importers (higher $\ln r_j$) are more likely to spend larger shares on products from richer exporters (higher $\ln r_i$), conditional on trade costs. The productivity-adjusted income elasticity is $\hat{f}'_i = \hat{c} \ln(r_i / \bar{r})$.[32] The coefficient of the internal trade dummy is also significant, implying that the internal trade share is larger given all else equal. This home-bias term picks up all the relevant forces that discriminate between internal and international trade.

The interpretation of the Tobit estimates for latent trade is not straightforward. The

Table 1: AI Gravity Estimation: Baseline

Import share per rm	(1) Tobit	(2) OLS	(3) Heckit
Distance	-1.158	-1.131	-1.115
	(0.026)	(0.025)	(0.026)
Distance Income_ex	0.128	0.126	0.124
	(0.003)	(0.003)	(0.003)
Entry cost	-5.805	-4.195	-6.012
	(0.893)	(0.798)	(0.947)
Entry cost Income_ex	0.550	0.397	0.573
	(0.088)	(0.079)	(0.093)
Income_im Income_ex	0.017	0.025	0.058
	(0.021)	(0.021)	(0.023)
Internal	2.829	2.896	2.870
	(0.080)	(0.080)	(0.080)
$\hat{s}$	0.121		
	(0.002)		
Mills			-0.117
			(0.047)
Observations	5625	5625	5625
R-squared	0.576	0.642	
Log-likelihood value	-2078.929	-1938.263	

Notes: Table reports the estimates of the AI gravity in equation (32) using aggregated manufacturing trade data. Estimated exporter- and importer-speci c xed effects are dropped. Robust standard errors in parentheses. Signi cance * .10, ** .05, *** .01.

coefficient of entry cost, -(5.805-0.550 lnr_i), is the marginal effect of the entry cost on the latent share S_{ij}/N_i, as well as its the marginal effect on the observed trade share $\tilde{S}_{ij}/N_i$ above zeros. The slope for zero observations is different from this number. The Tobit model suggests that the average marginal effect of the predictor on the response for all observations is equal to its marginal effect on the latent variable multiplied by an adjustment factor. With the estimated standard deviation of the error term, $\hat{s}$, we can compute the adjustment factor. Its value is about 0.504, evaluated at the estimates and the mean values of independent variables.[34] Thus the average marginal effect of entry cost on the observed trade share $\tilde{S}_{ij}/N_i$ is -0.504 (5.805-0.550 lnr_i). Similarly, taking the interaction term into account, a one percent increase in distance leads to a decrease of (1.158-0.128 ln r_i) in the latent trade share S_{ij}/N_i, in contrast to a decrease of 0.504 (1.158-0.128 lnr_i) in observed trade share $\tilde{S}_{ij}/N_i$. For example, China's GDP per capita in log is 7.62 and thus the average marginal effect of log distance on the observed import share from China is -0.092. The Tobit estimates are related to but differ from the OLS results reported in column (2). The Tobit coefficient estimates have the same sign as the corresponding OLS estimates, and the statistical significance of the estimates is similar. The similarity arises because the aggregated manufacturing sample has a very low proportion of zero trade flows. But directly comparing the coefficients with the Tobit estimates is not informative.

As a robustness check, we compare the Tobit estimates with the Heckman two-stage method (Heckit) which regards the zero flows as missing values. Similar to Helpman, Melitz, and Rubinstein (2008), the first stage estimates the inverse Mills ratio using a probit model. The second stage runs an OLS estimation by adding the inverse Mills ratio into the regressors. The results are reported in column (3).[35] All coefficients have the intuitive signs. The coefficient of the inverse Mills ratio is significant, which implies there is a sample selection bias when dropping the zero flows in the gravity estimation. This result confirms the systematic nature of the extensive margin, and suggests applying the richer structure of AI gravity using the Tobit estimator. Although there are very few zeros in the aggregate trade flows, there are sizable differences in results between OLS, Heckit and Tobit estimators. The differences are even more significant in the sectoral estimation, where zero frequencies are higher.

We also report the estimates of AI gravity with different elasticity specifications in Table 2 to compare our baseline specification estimates with the results under the specifications of Fajgelbaum and Khandelwal (2016) and Novy (2013) along with other variations. The results under their specifications run on our data are similar to their results,

[34] In the Tobit model, the adjustment factor of the coefficient is $F(xb/s)$.
[35] See Heckman (1979) for detailed explanations of the inverse Mills ratio.

Table 2: AI Gravity Estimation: Speci cations

	(1)	(2)	(3)	(4)	(5)	(6)
Import share per rm						
Distance	-1.158	-0.038	-1.158	-0.041	-0.037	-0.043
	(0.026)	(0.010)	(0.026)	(0.009)	(0.010)	(0.009)
Distance Income_ex	0.128		0.128			
	(0.003)		(0.003)			
Entry cost	-5.805	-0.316	-5.805	-0.353		
	(0.893)	(0.098)	(0.893)	(0.096)		
Entry cost Income_ex	0.550		0.550			
	(0.088)		(0.088)			
Income_im Income_ex	0.017	0.004			0.006	
	(0.021)	(0.002)			(0.002)	
Internal	2.829	3.024	2.829	3.000	3.038	3.003
	(0.080)	(0.095)	(0.080)	(0.094)	(0.095)	(0.094)
Observations	5625	5625	5625	5625	5625	5625
R-squared	0.576	0.352	0.576	0.352	0.351	0.350

Notes: Table reports the estimates of the AI gravity in equation (32) with different speci cations. Estimated exporter- and importer-speci c xed effects are dropped. Robust standard errors in parentheses. Signi cance * .10, ** .05, *** .01.

assuring that our differences are due to speci cation rather than data. Column (1) is our baseline result for equation (32). In column (2), we drop the elasticity heterogeneity term measured by the interaction with exporter income, yielding a distance elasticity equal to -0.038.[36] The coef cients on distance and its interaction with exporter income are robust for the translog model in which the non-homothetic term is dropped as shown in column (3). When we further shut down the elasticity heterogeneity, as shown in column (4), all coef cients remain signi cant with intuitive signs.

We check our results with Fajgelbaum and Khandelwal (2016) by keeping the distance and non-homothetic terms as shown in column (5), and with Novy (2013) by keeping only distance as shown in the last column. The coef cients of distance are robust compared with column (2). The coef cient of the income interaction term in column (5) is 0.006 and signi cant, very close to the 0.0057 in Fajgelbaum and Khandelwal (2016), despite the different sample used in our paper. The biggest difference between our paper and Fajgelbaum and Khandelwal (2016) is the interaction term of distance and exporter's income. Column (1) and (2) show that the distance elasticity heterogeneity in our model makes the income effect heterogeneity less signi cant. In contrast, Fajgelbaum and Khandelwal (2016) focus by assumption solely on the income effect heterogeneity.

4.3 Sectoral Results

We report AI gravity estimates by sectors in row (2)-(26) of Table 3. For reference, the aggregate estimation results are reported again in row (1), equal to column (1) in Table 1. The sectors are sorted in descending order by the coef cient of the interaction term of distance and exporter income. Overall, the disaggregated AI gravity model works well. The coef cients of the variables are, in most cases, signi cant and the estimates vary across sectors in a sensible way.

First, distance is a large impediment to sectoral trade: all estimated distance coef -

Table 3: AI Gravity Estimation by Sector

Import share per rm	Distance	Distance	Entry cost	Entry cost	Inc_im	Internal	Obs.	R-sq.

is almost ve times as large as the smallest value, 0.06, which implies a big difference

Figure 3: Latent Trade (q_{ij})

$D(p_{ij})$ of p_{ij} by equation (9), i.e.,[37]

$$p_{ij}(z)q_{ij}(z)/e_j = a_i \quad gb_i \ln(m_i w_i t_{ij}/\bar{p}_j) + f_i \ln r_j + gb_i \ln z. \tag{35}$$

The break-even-condition for good z is determined by the quantity $q_{ij}(z)$ at which average cost equals price:

$$p_{ij}(z) = w_i t_{ij}/z + F_{ij}/q_{ij}(z). \tag{36}$$

Denote the break-even quantity as $S(p_{ij})$. Figure 3 plots $D(p_{ij})$ against $S(p_{ij})$. p^c_{ij} is the choke price. Since $D(p_{ij})$ for the rm with the highest productivity draw z is everywhere below the break-even condition supply $S(p_{ij})$, no trade occurs. A hypothetical larger market $\hat{D}(p_{ij})$ for the highest productivity rm is tangent to the break-even-condition supply curve and generates the minimal level of quantity demanded $\tilde{q}_{ij}$ that initiates trade.

One way to induce the buyer to consume the break-even quantity $\tilde{q}_{ij}$ is to offer a

[37]Note z is the productivity of rm z. Firms from the same origins charge the same markup before drawing productivities.

buyer's price p^{v}_{ij}, the virtual price. [38] Trade occurs with a subsidy to the buyer equal to $\tilde{p}_{ij} \quad p^{v}_{ij}$, the virtual subsidy. An alternative hypothetical way to induce trade is central to this paper. Endow the buyer with the hypothetical quantity equal to $\tilde{q}_{ij} \quad q_{ij}$ (also equal to $\tilde{q}_{ij} + jq_{ij}j$). We use this distance from the negative value to the break-even demand to measure how far from break-even is the implied demand, i.e., how far from occurring is the trade. We term this distance latent resistance. In the negative region, the consumer would hypothetically sell the product if she or he has inventory. If the consumer owned the full amount $\tilde{q}_{ij} \quad q_{ij}$ to enable consumption $\tilde{q}_{ij}$, the amount $jq_{ij}j$ is sold in the world market at price $\tilde{p}_{ij}$ and the remainder is consumed in the amount $\tilde{q}_{ij}$. The latent resistance $\tilde{q}_{ij}$

with the constraint

$$h_t + h_f + h_r = 1. \tag{44}$$

By the properties of OLS, the coefficients h_t, h_f, and h_r provide us with a measure of how much of the variation in the LTB can be attributed to the effect of variable cost, fixed cost, and income, respectively. This helps us to identify which of the components is the more important one to cause non-partner relationships. Replacing the aggregate LTB and its three components with the corresponding sectoral variables, we can determine the variance decomposition for each sector.

The results are reported in Table 4. Row (1) shows the LTB decomposition for the aggregate trade. Variable cost (distance) explains 53%, fixed cost (entry cost) explains 24%, and income effect explains 23% of the zero flows. We report the results by sectors in row (2)-(26). The coefficients in all sectors are significantly positive and between zero and one. On average, variable cost explains 52%, Fixed cost explains 24%, and income effect explains 24% of the zero flows.

We find that the variable cost effect is larger than both fixed cost effect and income effect for all sectors except machines. Variable cost is strongest in affecting zeros in the other chemical, tobacco and petroleum sectors, and is weakest in the machine, rubber, and chemical sectors. Fixed cost impedes the occurrence of trade most in the iron steel and textile sectors, and least in the apparel and other chemical sectors. The income effect is the strongest in affecting zeros in the machinery and rubber sectors, and is weakest in the iron steel and non-ferrous metal sectors. The possible reason is that products in the former sectors are mainly exported from rich countries (e.g., machinery from Japan) and the zero flows are usually by poor importers. In contrast, the products in the latter sectors are produced by countries with all income levels and thus the income effect is limited for the zero flows.

6 Counterfactuals

The extensive margin effects of export promoting counterfactual reductions of trade costs are measured by the proportions of zeros that turn positive. [42] There are two sets of promotion policies. One is proportional to the export volume and acts as a negative variable cost, e.g., subsidy, tax and financial benefits, duty drawback, export insurance, and ex-

[42] We focus on the extensive margin change with the AIDS structure. See Novy (2013) for discussion on the intensive margin changes with the translog gravity.

Table 4: Latent Trade Bias Decomposition

Latent trade bias		Distance	Entry cost	Income
(1)	Aggregate	0.533***	0.237***	0.230***
		(0.00)	(0.00)	(0.00)
(2)	OthChem	0.641***	0.182***	0.177***
		(0.00)	(0.00)	(0.00)
(3)	Tobacco	0.634***	0.196***	0.170***
		(0.00)	(0.00)	(0.00)
(4)	Petroleum	0.615***	0.218***	0.167***
		(0.00)	(0.00)	(0.00)
(5)	Footwear	0.595***	0.215***	0.190***
		(0.00)	(0.00)	(0.00)
(6)	NonMetal	0.581***	0.225***	0.194***
		(0.00)	(0.00)	(0.00)
(7)	Beverages	0.577***	0.237***	0.186***
		(0.00)	(0.00)	(0.00)
(8)	Paper	0.576***	0.191***	0.233***
		(0.00)	(0.00)	(0.00)
(9)	Plastic	0.561***	0.234***	0.205***
		(0.00)	(0.00)	(0.00)
(10)	Wood	0.553***	0.235***	0.212***
		(0.00)	(0.00)	(0.00)

change rate management.[43] The other set works as a negative xed cost, e.g., providing information, facilitating links, helping with licensing and regulation requirements, and negotiating bilateral fair treatment in the application of regulations. The estimated model permits measurement of the effects of the two types of promotion policies on zero trade ows.

First of all, we calculate the latent values of the trade shares with zero ows by the AI gravity equation (20), i.e.,

$$\hat{s}_{ij}/ N_i = \frac{Y_i}{Y}/ N_i \quad \hat{g}\hat{b}_i^{0} \ln\left(\frac{t_{ij}}{\hat{\ }}\right.$$

Table 5: Zero-to-One Transitions from Reducing Bilateral Costs

		reducing VC by			reducing FC by		
		10%	50%	100%	10%	50%	100%
(1)	Footwear	0.78	0.99	1.00	0.29	0.31	0.36
(2)	OthChem	0.76	0.98	0.99	0.25	0.27	0.35
(3)	Petroleum	0.78	0.98	0.98	0.33	0.35	0.42
(4)	NonMetal	0.50	0.81	0.96	0.15	0.17	0.21
(5)	Food	0.42	0.78	0.95	0.11	0.14	0.22
(6)	ProfSci	0.55	0.89	0.95	0.19	0.24	0.37
(7)	Tobacco	0.61	0.84	0.90	0.24	0.26	0.30
(8)	Electrics	0.61	0.83	0.86	0.26	0.28	0.35
(9)	Printing	0.49	0.81	0.86	0.16	0.18	0.37
(10)	Textiles	0.31	0.69	0.85	0.10	0.12	0.25
(11)	MetalProd	0.57	0.76	0.78	0.36	0.39	0.42
(12)	Wood	0.45	0.69	0.78	0.15	0.19	0.25
(13)	Machines	0.49	0.69	0.78	0.36	0.43	0.55
(14)	Rubber	0.54	0.73	0.75	0.33	0.36	0.40
(15)	Paper	0.51	0.70	0.74	0.19	0.22	0.27
(16)	IronSteel	0.39	0.69	0.74	0.12	0.15	0.25
(17)	Transport	0.42	0.63	0.70	0.20	0.26	0.41
(18)	Beverages	0.43	0.65	0.70	0.13	0.16	0.21
(19)	IndChem	0.36	0.59	0.69	0.18	0.24	0.36
(20)	Plastic	0.40	0.65	0.69	0.14	0.17	0.25
(21)	Glass	0.40	0.60	0.67	0.24	0.28	0.35
(22)	Leather	0.44	0.61	0.66	0.25	0.29	0.37
(23)	NfMetals	0.36	0.58	0.65	0.15	0.18	0.31
(24)	Apparel	0.42	0.60	0.65	0.24	0.30	0.39
(25)	Furniture	0.40	0.58	0.64	0.18	0.24	0.33
	Mean	0.50	0.73	0.80	0.21	0.25	0.33
	St. d.	0.13	0.13	0.12	0.08	0.08	0.08

Notes: Table reports the decrease (%) in number of zeros if bilateral trade costs are reduced.

Table 6: Zero-to-One Transitions with 10% Decrease in Bilateral Costs: by Income Groups

		poor exporter			rich exporter		
		# of zeros	reducing VC	reducing FC	# of zeros	reducing VC	reducing FC
(1)	Machines	21	0.71	0.53	3	0.02	0.00
(2)	Electrics	21	0.85	0.38	3	0.06	0.00
(3)	Textiles	21	0.52	0.13	6	0.11	0.07
(4)	Food	22	0.74	0.19	6	0.05	0.02
(5)	MetalProd	23	0.92	0.59	5	0.03	0.00
(6)	Apparel	24	0.81	0.46	9	0.02	0.01
(7)	OthChem	27	0.89	0.22	5	0.58	0.29
(8)	Transport						

Table 7: Ethiopia's New Markets of Leather Export with Trade Cost Reductions

Table 8: Zero-to-One Transitions from Reducing Unilateral Costs

		reducing VC by			reducing FC by		
		10%	50%	100%	10%	50%	100%
(1)	Footwear	0.29	0.34	0.55	0.29	0.31	0.34
(2)	Petroleum	0.33	0.34	0.46	0.33	0.35	0.41
(3)	MetalProd	0.36	0.40	0.46	0.36	0.39	0.42
(4)	Electrics	0.26	0.33	0.44	0.26	0.28	0.35
(5)	OthChem	0.25	0.27	0.43	0.25	0.27	0.34
(6)	Machines	0.34	0.37	0.39	0.36	0.43	0.54
(7)	Rubber	0.33	0.35	0.37	0.33	0.36	0.40
(8)	Tobacco	0.24	0.25	0.33	0.24	0.26	0.29
(9)	Leather	0.24	0.28	0.31	0.25	0.28	0.35
(10)	Apparel	0.24	0.28	0.31	0.24	0.30	0.38
(11)	Paper	0.19	0.23	0.30	0.19	0.22	0.27
(12)	Glass	0.23	0.25	0.26	0.23	0.28	0.34
(13)	Furniture	0.18	0.21	0.26	0.18	0.24	0.33
(14)	Transport	0.20	0.24	0.26	0.20	0.26	0.40
(15)	Wood	0.14	0.17	0.25	0.15	0.18	0.25
(16)	Beverages	0.12	0.14	0.25	0.13	0.15	0.20
(17)	Food	0.12	0.12	0.22	0.11	0.13	0.21
(18)	NonMetal	0.14	0.14	0.21	0.15	0.17	0.20
(19)	IndChem	0.18	0.19	0.21	0.18	0.23	0.35
(20)	Plastic	0.13	0.15	0.19	0.14	0.17	0.25
(21)	NfMetals	0.14	0.17	0.19	0.15	0.18	0.30
(22)	Printing	0.15	0.14	0.19	0.16	0.18	0.34
(23)	ProfSci	0.19	0.18	0.18	0.19	0.24	0.35
(24)	IronSteel	0.12	0.12	0.16	0.12	0.15	0.23
(25)	Textiles	0.10	0.09	0.12	0.10	0.12	0.21
	Mean	0.21	0.23	0.29	0.21	0.24	0.32
	St. d.	0.08	0.09	0.11	0.08	0.08	0.08

Notes: Table reports the decrease (%) in number of zeros if unilateral trade costs are reduced.

Table 9: Robustness: Alternative Measures of Number of Goods

Import share per rm	(1) N_i =Extensive Margin	(2) N_i =No. of Firms	(3) N_i =ln GDP
Distance	-1.1585	-0.6438	

Table 10: Robustness: Alternative Fixed Cost

		Distance	Dist. Inc_ex	Days & proc.	Days & proc.	Inc _im Inc_ex	Internal	Obs.
Import share per rm			Inc_ex		Inc_ex	Inc_ex		
(1)	Aggregate	-1.12***	0.12***	-0.22***	0.03***	0.04*	2.77***	5625
		(0.03)	(0.00)	(0.02)	(0.00)	(0.02)	(0.08)	
(2)	Beverages	-2.35***	0.25***	-0.61***	0.07***	0.11**	3.53***	5625
		(0.06)	(0.01)	(0.06)	(0.01)	(0.05)	(0.18)	
(3)	Furniture	-2.42***	0.25***	-0.83***	0.09***	0.18***	4.30***	5625
		(0.06)	(0.01)	(0.06)	(0.01)	(0.06)	(0.19)	
(4)	Tobacco	-2.64***	0.24***	-0.52***	0.06***	0.13*	0.95***	5625
		(0.08)	(0.01)	(0.09)	(0.01)	(0.08)	(0.25)	
(5)	Petroleum	-2.28***	0.22***	-0.17***	0.02**	-0.02	1.33***	5625
		(0.07)	(0.01)	(0.06)	(0.01)	(0.06)	(0.20)	
(6)	NonMetal	-2.05***	0.21***	-0.29***	0.03***	0.03	3.29***	5625
		(0.06)	(0.01)	(0.05)	(0.01)	(0.05)	(0.18)	
(7)	Leather	-1.68***	0.18***	-0.35***	0.04***	0.13***	1.57***	5625
		(0.05)	(0.01)	(0.05)	(0.01)	(0.05)	(0.16)	
(8)	Plastic	-1.61***	0.17***	-0.19***	0.02***	0.03	2.35***	5625
		(0.04)	(0.00)	(0.04)	(0.00)	(0.04)	(0.13)	
(9)	Food	-1.61***	0.17***	-0.31***	0.04***	0.04	3.66***	5625
		(0.04)	(0.00)	(0.04)	(0.00)	(0.04)	(0.13)	
(10)	NfMetals	-1.55***	0.16***	-0.56***	0.06***	0.09**	1.24***	5625
		(0.04)	(0.00)	(0.04)	(0.01)	(0.04)	(0.13)	
(11)	Glass	-1.38***	0.14***	-0.34***	0.04***	0.13***	2.14***	5625
		(0.04)	(0.00)	(0.04)	(0.00)	(0.04)	(0.13)	
(12)	Wood	-1.37***	0.14***	-0.17***	0.02***	0.03	1.96***	5625
		(0.03)	(0.00)	(0.03)	(0.00)	(0.03)	(0.10)	
(13)	Printing	-1.35***	0.14***	-0.04	0.00	-0.07*	3.77***	5625
		(0.04)	(0.00)	(0.04)	(0.00)	(0.04)	(0.13)	
(14)	Footwear	-1.16***	0.12***	-0.05	0.01	-0.01	1.11***	5625
		(0.04)	(0.00)	(0.03)	(0.00)	(0.03)	(0.11)	
(15)	Paper	-1.08***	0.11***	0.00	0.00	0.02	1.49***	5625
		(0.03)	(0.00)	(0.02)	(0.00)	(0.02)	(0.09)	
(16)	Apparel	-1.07***	0.11***	-0.30***	0.03***	0.08***	1.80***	5625
		(0.02)	(0.00)	(0.02)	(0.00)	(0.02)	(0.08)	
(17)	OthChem	-0.95***	0.10***	-0.09***	0.01***	0.01	1.43***	5625
		(0.02)	(0.00)	(0.02)	(0.00)	(0.02)	(0.07)	
(18)	Transport	-0.98***	0.10***	-0.45***	0.05***	0.10***	1.51***	5625
		(0.02)	(0.00)	(0.02)	(0.00)	(0.02)	(0.07)	
(19)	IronSteel	-0.94***	0.09***	-0.39***	0.04***	0.04	1.64***	5625
		(0.03)	(0.00)	(0.03)	(0.00)	(0.03)	(0.10)	
(20)	ProfSci	-0.81***	0.09***	-0.10***	0.01***	-0.01	1.22***	5625
		(0.03)	(0.00)	(0.03)	(0.00)	(0.03)	(0.10)	
(21)	Textiles	-0.80***	0.08***	-0.42***	0.05***	0.04**	1.57***	5625
		(0.02)	(0.00)	(0.02)	(0.00)	(0.02)	(0.07)	
(22)	Electrics	-0.66***	0.07***	-0.07**	0.01**	0.03	1.30***	5625

start operating a business.[47] It is a nonmonetary measure of fixed cost to supplement the entry cost, which is a monetary measure. We take an average of these nonmonetary costs from the exporter and importer sides as the bilateral measure. By construction, entry days & proc. reflects regulation costs that should not depend on a firm's volume of exports to a particular country. The purpose of using the alternative fixed cost variable is to check whether the distance coefficient patterns in Table 3 are driven by the measurement of fixed costs. We find that the coefficients on distance and its interaction with exporter income are very similar to the baseline table. This implies that the result regarding the heterogeneity of the distance elasticity is robust. And the order of the sectoral results is close to the baseline results also, suggesting that the relative degree of the elasticity dispersion among sectors is also robust. The coefficients of entry days & proc. and its interaction term with income are significant for most sectors. The results are robust.

8 Conclusion

This paper applies Almost Ideal Demand System (AIDS) preferences to the firm heterogeneity framework and derives an AI gravity equation that explains zero trade flows theoretically in a tractable form used for estimation. Latent trade inferred from the estimated model is used to measure the distance from observed zeros to trade. Heterogeneous price and income elasticities interact with variable and fixed cost heterogeneity to explain the zeros. Variance decomposition of distance from trade apportions the relative importance of fixed and variable cost variation.

The predicted latent trade value has potentially important policy implications. Trade promotion policies could be targeted toward potential markets on the margin that are much closer to zero. The marginal effect of a fixed cost reduction in turning zero trade to positive is smaller than that of a variable cost reduction, but still significant.

Our empirical results are based on country-level ISIC3 trade flows, but our methods naturally extend to applications using firm-level data to appropriately target export promotion policies and to inform firm entry decisions independent of explicit promotion policies. On the importer side, the estimated model could suggest potential sources of

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Appendix for:
"Latent Exports: Almost Ideal Gravity and Zeros"

A Appendix to Model

A.1 Reservation Prices

Denote M as the maximum number of products in the world. We will allow for a subset of goods to have zero shares. To be precise, suppose that $s(w) > 0$ for $w = 1, ..., N$, while $s(w) = 0$ for $w = N + 1, ..., M$

Substitute the right hand side of (47) into the full price index. The result is

$$\ln \bar{p} = \frac{\ln \bar{p}^{+} + \gamma^{-1} \sum_{w=N+1}^{M} a(w)}{1 - \sum_{w=N+1}^{M} b(w)}. \tag{48}$$

Equation (53) holds for all destinations j and is basically a j-specific price index effect. So it is presumably absorbed in the regressor with fixed effects for multilateral resistance.

Our additional analytic concern is for counterfactual changes in variable cost and fixed cost and their effect on the price index (53). The experiments we run are exemplified by a scalar $0 < \lambda < 1$ that shrinks all t_{ij} proportionately. Thus a fall in λ lowers t_{ij}. Consider a fall in λ, $d \ln \lambda < 0$, a globally applied proportionate decrease in trade costs.

Over some interval there may be no change in N, the extensive margin, hence $\ln \bar{p}$ falls by $d \ln \lambda / [1 - \sum_{w=N+1}^{M} b(w)]$. The more important case for our counterfactual experiments is where N rises as a result of λ falling. It is now convenient to revert to continuous w, hence sums become integrals. In the numerator of (53), a fall in λ raises N and hence it lowers the second term by $\gamma^{-1} a(N)$. In the first term of the numerator, $\ln \bar{p}^{+}$ increases by $b(N) \ln p(N)$. The denominator of (53) changes by $-b(N)/[1 - \int_{w=N+1}^{M} b(w)dw]^2$. Our procedure is focused on the direct N fixed impact, which intuitively suggests that cutting all VC equiproportionately will keep decreasing $\ln \bar{p}$, hence the direct impact effect may well dominate the variable N effects. As for the variable N effects: the fall in the term $\gamma^{-1} a(N)$ has the same sign as the N fixed impact.

Finally, consider the non-homothetic case $f(w) \neq 0$ for the goods $w = N+1, \ldots, M$. Following Deaton and Muellbauer (1980), the Stone price index in equation (2) is approximated by prices weighted by observed shares, i.e.,

$$\ln Q = \sum_{w=1}^{N} s(w) \ln p(w) \tag{49}$$

and the summation of the share equation is

$$0 = \sum_{w=N+1}^{M} a(w) - \gamma \ln \bar{p} + \gamma \left(\sum_{w=N+1}^{M} b(w) \right) \ln \bar{p}^{+} + \gamma \left(\sum_{w=N+1}^{M} b(w) \right) \ln \bar{p} \tag{50}$$

$$+ \left(\sum_{w=N+1}^{M} f(w) \right) \ln (e/Q) \tag{51}$$

Then

$$\ln \bar{p} = g^{1} å$$

B Appendix to Tables and Figures

Table B.1: Country List by GDP

	ISO	country		ISO	country
1	USA	United States	39	PHL	Philippines
2	JPN	Japan	40	NGA	Nigeria
3	DEU	Germany	41	HUN	Hungary
4	CHN	China	42	UKR	Ukraine
5	GBR	United Kingdom	43	NZL	New Zealand
6	FRA	France	44	PER	Peru
7	ITA	Italy	45	KAZ	Kazakstan
8	CAN	Canada	46	VNM	Viet Nam
9	ESP	Spain	47	MAR	Morocco
10	BRA	Brazil	48	SVK	Slovakia
11	RUS	Russia	49	ECU	Ecuador
12	IND	India	50	SVN	Slovenia
13	KOR	Korea	51	BGR	Bulgaria
14	MEX	Mexico	52	TUN	Tunisia
15	AUS	Australia	53	LTU	Lithuania
16	NLD	Netherlands	54	LKA	Sri Lanka
17	TUR	Turkey	55	KEN	Kenya
18	SWE	Sweden	56	AZE	Azerbaijan
19	CHE	Switzerland	57	LVA	Latvia
20	IDN	Indonesia	58	URY	Uruguay
21	POL	Poland	59	YEM	Yemen
22	AUT	Austria	60	EST	Estonia
23	NOR	Norway	61	ISL	Iceland
24	DNK	Denmark	62	JOR	Jordan
25	ZAF	South Africa	63	ETH	Ethiopia
26	GRC	Greece	64	GHA	Ghana
27	IRL	Ireland	65	TZA	Tanzania
28	FIN	Finland	66	ALB	Albania
29	THA	Thailand	67	GEO	Georgia
30	PRT	Portugal	68	ARM	Armenia
31	HKG	Hong Kong	69	MKD	Macedonia
32	MYS	Malaysia	70	MDG	Madagascar
33	CHL	Chile	71	NER	Niger
34	CZE	Czech	72	MDA	Moldova
35	COL	Colombia	73	TJK	Tajikistan
36	SGP	Singapore	74	KGZ	Kyrgyzstan
37	PAK	Pakistan	75	MNG	Mongolia
38	ROM	Romania			

Notes: Table lists the sample of countries in our paper. The countries are sorted by GDP in descending order.

Figure B.1: Zero Trade Flows by Country Pairs: Machines Sector

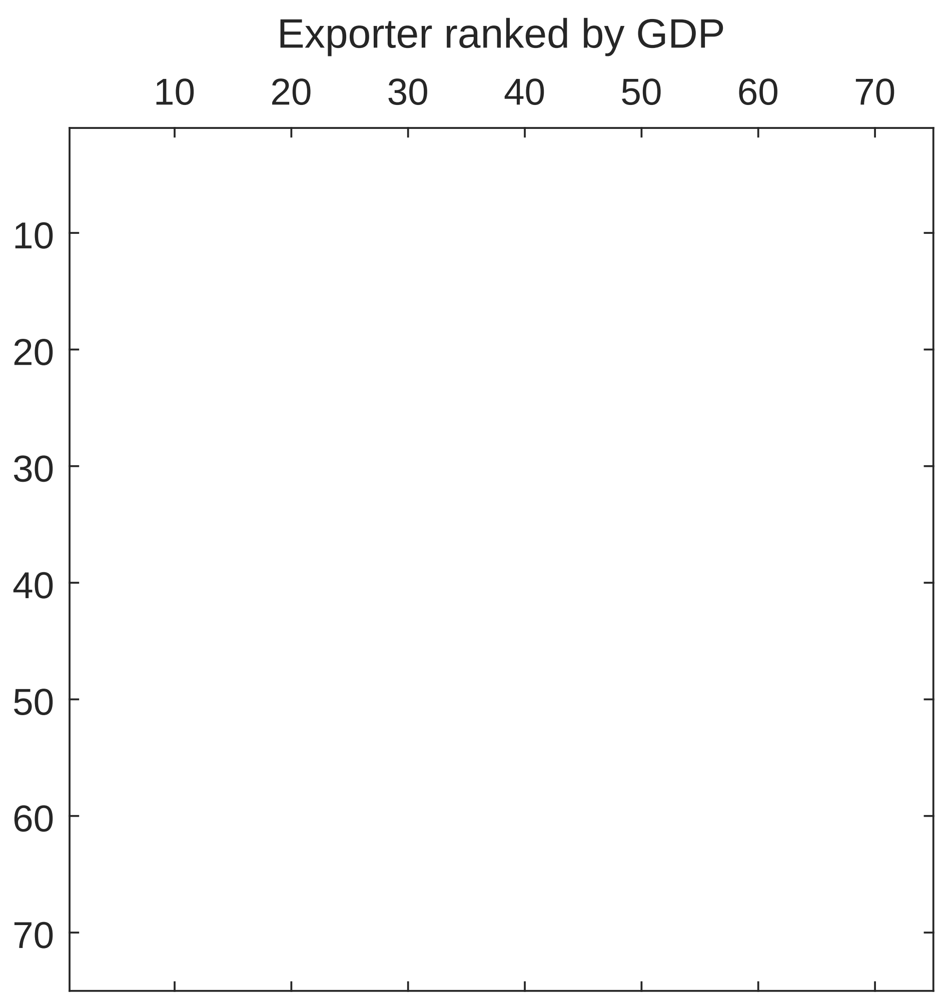


Figure B.2: Zero Trade Flows by Country Pairs: Tobacco Sector

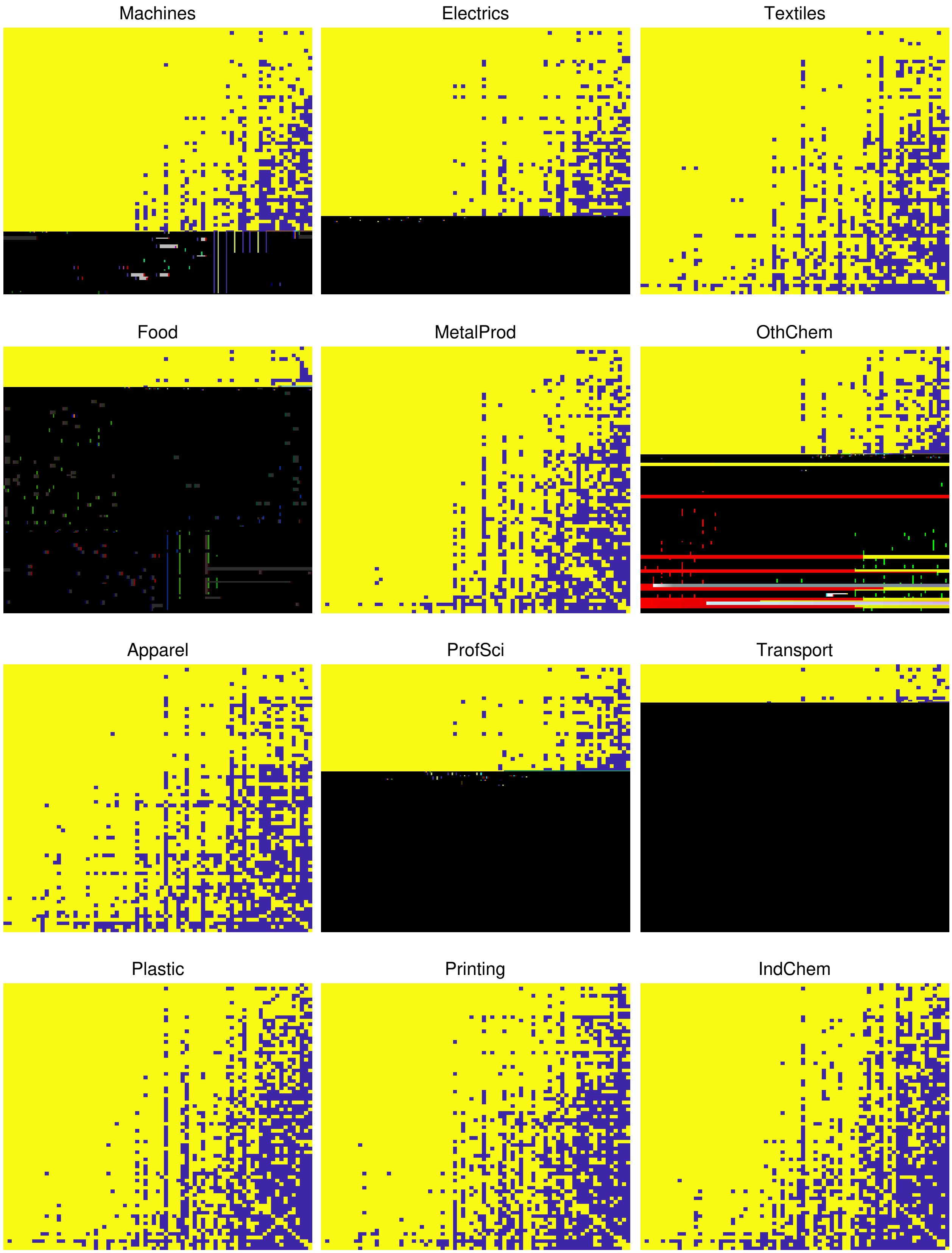


Figure B.3: Zero Trade Flows by Country Pairs: All Other Sectors I

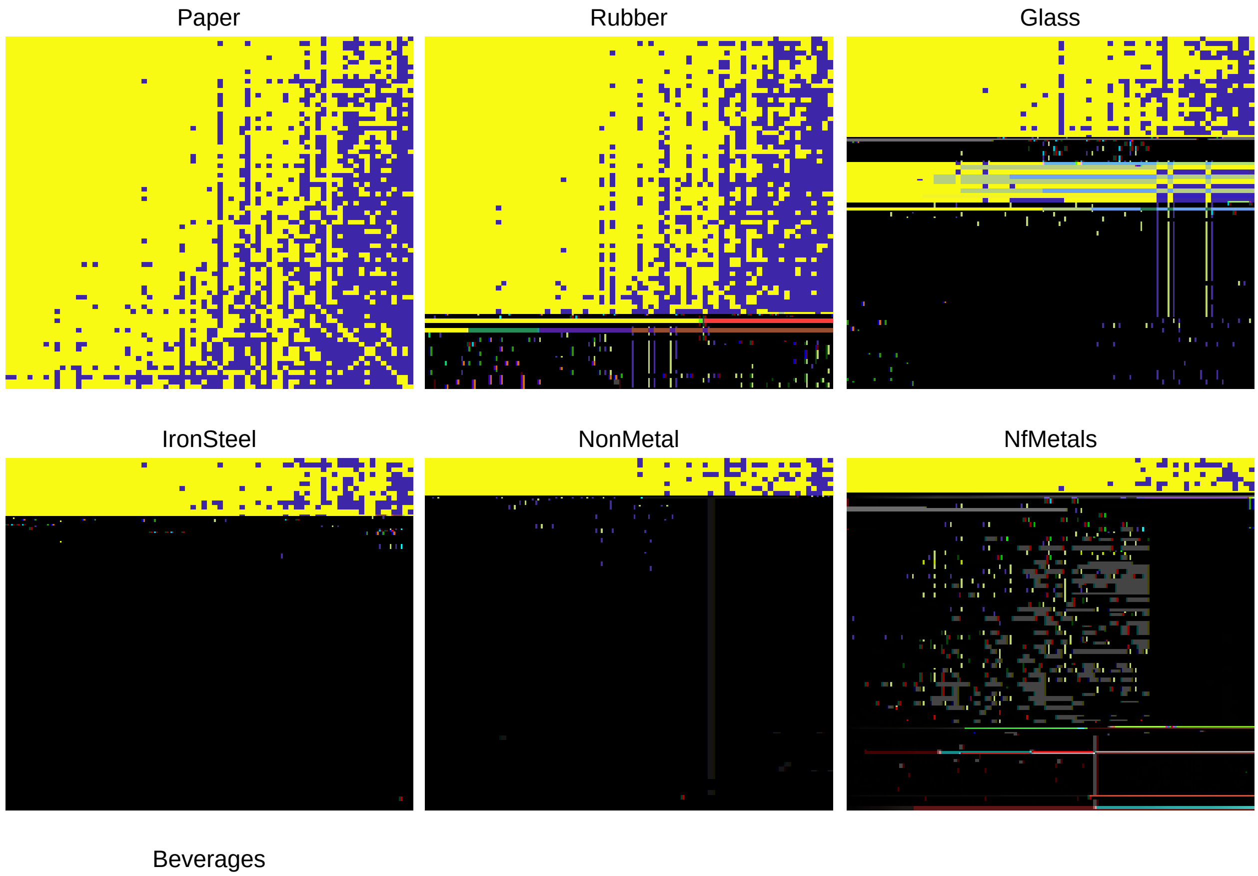


Figure B.4: Zero Trade Flows by Country Pairs: All Other Sectors II

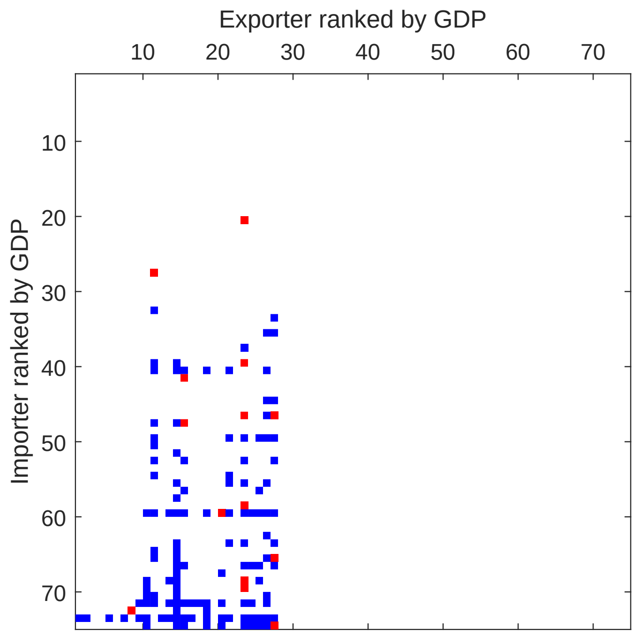
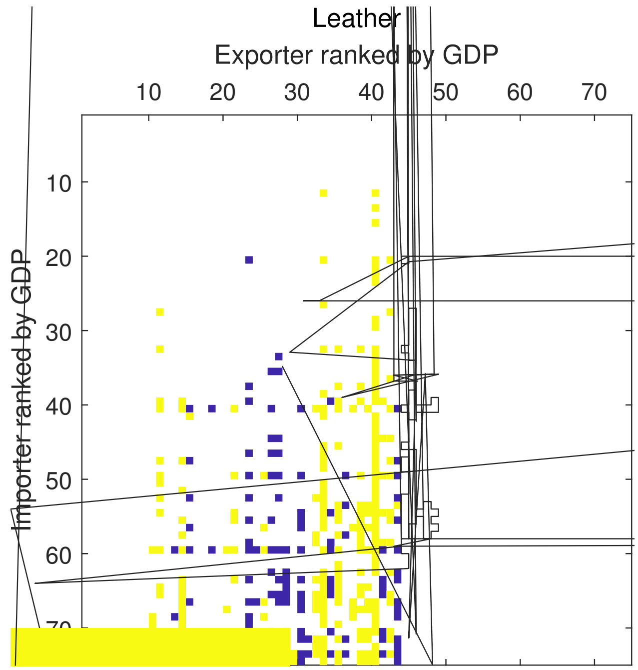


Figure B.5: Zero Flow Prediction: Leather Sector

Figure B.6: Latent Trade Examples



Leather
Exporter ranked by GDP
10
20
30
40
50
60
70
Importer ranked by GDP

Table B.2: Number of Zero Flows by Exporter and Sector (75 countries)

Exporter	Tobacco	Petroleum	Furniture	Wood	Footwear	Beverages	NonMetal	NfMetals	IronSteel	Glass	Leather	Rubber	Paper	IndChem	Plastic	ProfSci	Printing	Transport	OthChem	Apparel	MetalProd	Food	Textiles	Machines	Electrics	Mean

where $f(.)$ is the standard normal probability density function, and $\bar{X}$ denotes the vector of mean values.

The results are reported in Table C.3. Row (1) shows the marginal changes in trade probability for the aggregate trade. One standard deviation decrease in VC improves the trade probability by 5 percentage points, while one standard deviation decrease in FC improves the trade probability by 3 percentage points. Since there are many fewer zeros in aggregate trade, we further report the results by sectors in row (2)-(26). All numbers are positive which implies lowering trade cost increases the trade probability. On average, one standard deviation decrease in VC improves the trade probability by 10 percentage points, while one standard deviation decrease in FC improves the trade probability by 2 percentage points. To visualize the results, Figure C.9 plots the results of marginal effects of VC and FC on trade probability respectively,of

Table C.3: Marginal Effect on Trade Probability

		Variable cost		Fixed cost	
(1)	Aggregate	.046	(.0119)	.0282	(.0088)
(2)	Petroleum	.149	(.0116)	.0143	(.0089)
(3)	Wood	.1471	(.012)	.03	(.0101)
(4)	Tobacco	.145	(.0097)	.0224	(.0084)
(5)	Paper	.1327	(.0121)	.0049	(.0093)
(6)	NfMetals	.1238	(.012)	.0339	(.0095)
(7)	IronSteel	.1208	(.0121)	.0352	(.0095)
(8)	OthChem	.1201	(.0122)	.0053	(.009)
(9)	Footwear	.1179	(.0119)	.0072	(.0094)
(10)	MetalProd	.1044	(.0122)	.0073	(.0091)
(11)	Apparel	.1038	(.0122)	.0267	(.0094)
(12)	Rubber	.1016	(.0121)	.0141	(.0092)
(13)	IndChem	.1004	(.0122)	.032	(.0094)
(14)	NonMetal	.0979	(.012)	.0166	(.0092)
(15)	Glass	.0971	(.0121)	.0307	(.0094)
(16)	Beverages	.0884	(.012)	.0275	(.0094)
(17)	Textiles	.0879	(.0121)	.0407	(.0092)
(18)	Plastic	.0853	(.0121)	.0184	(.0092)
(19)	Transport	.0848	(.0122)	.0507	(.0092)
(20)	Leather	.0829	(.012)	.0146	(.0096)
(21)	Machines	.0826	(.0121)	.0346	(.009)
(22)	Furniture	.0811	(.012)	.0325	(.0099)
(23)	Food	.0605	(.0121)	.0294	(.009)
(24)	Printing	.0579	(.0122)	.0226	(.0091)
(25)	Electrics	.057	(.0121)	.0049	(.009)
(26)	ProfSci	.0563	(.0121)	.0062	(.0092)
	Mean	.0995		.0225	
	St. d.	.0276		.0127	

Notes: Table reports the marginal effect of one-standard-deviation decrease in trade costs on trade probability by estimating equation (54). Robust standard errors in parentheses.

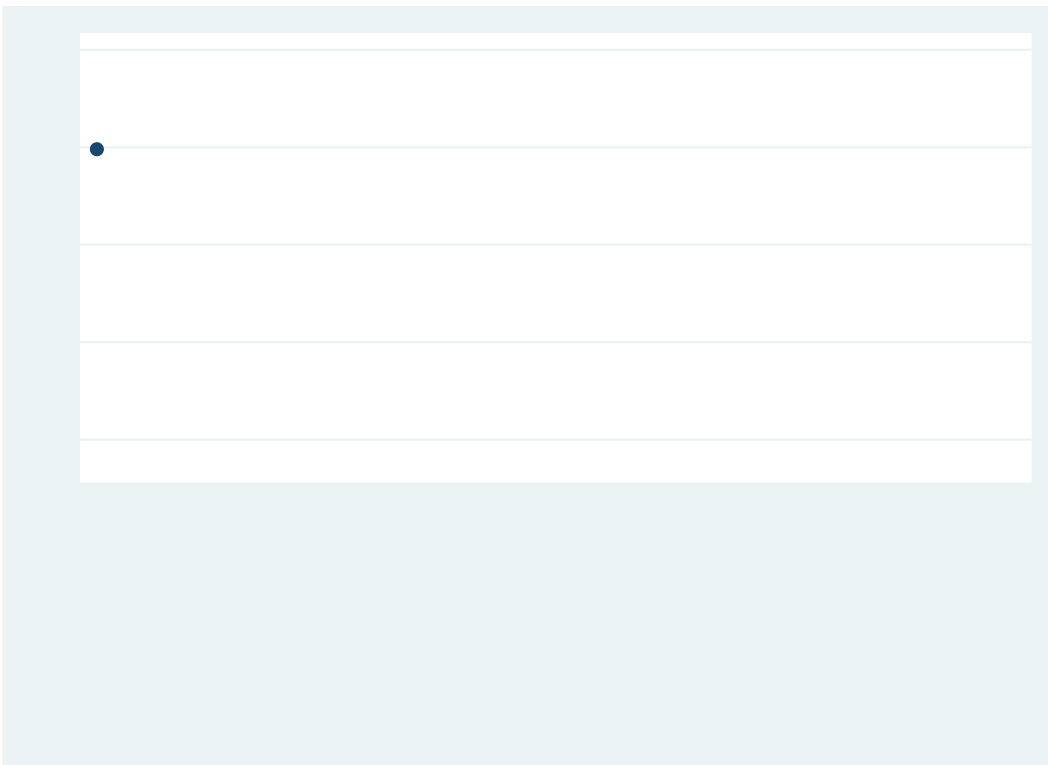


Figure C.9: Marginal Effect on Trade Probability