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A First Step to Identifying Underserved Foreign Markets

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Abstract

We describe a first step for identifying foreign markets that may be candidates for export expansion. The method compares export data to the amount of exports predicted by the gravity equation. We estimate four sets of gravity equation coefficients and use both in-sample and out-of-sample predictions. To illustrate our method, we use data from Washington agricultural industrial groups. We find many markets, particularly those in Europe, that are currently underserved by Washington agricultural exports, often by large amounts. We also identify overserved markets that can be further studied to provide lessons on what works for increasing exports.

Keywords: agriculture, exports, gravity

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Introduction

This paper describes a method for identifying foreign markets whose imports greatly deviate from simple trade model predictions. Finding these markets is a time-saving first step to identifying foreign markets that may be candidates for expanded exports. Unlike beginning with a list of markets ordered by trade flows, our approach controls for the basic explanatory variables of trade (distance, market size, and industry group), thus allowing an analyst to focus on more promising markets for export expansion by subsequently determining whether those markets have idiosyncratic or explanatory variables not in our model that drive the observed trade pattern. Identifying underserved markets has the potential to create significant economic benefits from targeted expansion of exports.

Our method compares export predictions from the gravity model of trade parameterized with four different sets of coefficient estimates to the actual export data and then ranks markets by the amount by which the export data differ from the models' predictions. We define markets with the biggest difference between actual exports and the models' export predictions as "underserved" markets. Our method also identifies "overserved" markets, those that have the greatest difference between actual exports and those predicted by the models. Overserved markets could be studied further to understand their success as export destinations. We do not construct a complicated trade model with many variables to fully account for the trade pattern observed in the data. Rather, we describe a method to identify markets and industry groups whose pattern of trade most deviates from a simple trade model so that those markets can be further analyzed for economically meaningful but potentially idiosyncratic factors.

There is a large existing literature on "international market selection." This literature, typically found in marketing journals, presents models with many different variables that try to assess the potential of foreign markets. The fundamental dichotomy in the many models in this literature is between (1) simplicity, so that the data required to assess markets are not too expensive, versus (2) the inclusion of speculative market potential variables, such as predictions of future market growth and cultural similarities. Good examples of this literature are Brouthers et al. (2009); Sakarya, Eckman, and Hylledard (2007); and Papadopoulos, Chen, and Thomas (2002). What these models often lack, however, is a foundation in international trade theory and empirics. Thus our goal is to present a method of international market selection that is simple in terms of data requirements, yet grounded in the economics of international trade and that quickly yields the most promising foreign markets for each industry group. Subsequent to applying our method is the more time-consuming idiosyncratic analysis of those markets that our first-step method has identified.

The gravity model is an immensely popular tool for analyzing international trade flows, though it has not typically been the basis for international market selection models. The empirical gravity model was first described by Tinbergen (1962) and has since been theoretically justified by Anderson (1979) and Anderson and van Wincoop (2003). The gravity model relates the economic size of the destination market, the economic size of the exporting market, and the physical distance between the two. It is widely applied to study trade flow patterns such as assessing the impact of trade agreements, currency unions, the border effect, and common language. For example, Hanson and Xiang (2002) use a gravity model to assess the importance

of barriers to trade. In another example, Subramanian and Wei (2007) use the gravity model to find a positive effect of the World Trade Organization on exports.

To illustrate our method, we study the case of the 24 Washington State agricultural industry groups.[1] We choose this case to study because agriculture and international sales are two important components of the Washington State economy. In 2013, GDP from food and agricultural sectors was $49.0 billion or 13% of the state's economy. In the same year, Washington exported more than $15.1 billion in food and agricultural products, ranking third among U.S. states.[2] We use export data from 2012–2014 for the 24 Washington agricultural industry groups to estimate the parameters needed for in-sample predictions of Washington agricultural exports by industry group. We also use export data from California's agricultural industry groups and export data from Washington's non-agricultural industry groups from 2012–2014 to estimate gravity equation parameters for out-of-sample predictions.

Within each of the in-sample and out-of-sample exercises, we estimate the coefficients for the gravity equation using two specifications and two estimators, giving us four sets of parameters. We take one set of parameters and apply them to the data on economic size and distance variables, giving us a prediction of exports from each Washington agricultural industry group to every market. We calculate the difference between that prediction and the actual data and then create a list of markets ordered by that difference. Next, we create an ordered list of market deviations using each of the other three sets of parameters. We call a market "underserved" if that market appears in the top 5% of at least three of the four rankings of differences between actual exports and predicted exports. Similarly, markets are "overserved" when that market appears in the bottom 5% of at least three of the four rankings.

We find that despite controlling for distance, market size, and industry group, many European markets are underserved by a wide range of Washington agricultural industry groups. In particular, Washington exports to Germany, Italy, Norway, and Turkey are much less than predicted for many industry groups. Brazil and Venezuela, for example, receive far fewer exports from many of Washington's agriculture industry groups than predicted by the gravity equation. In general, Washington exports to East Asia match or exceed gravity equation predictions. The Philippines, Canada, and Hong Kong are also overserved by many of Washington's agricultural industrial groups.

Under- and Overserved Markets

The gravity equation relates the economic size of the exporting and the importing country as measured by gross domestic product (GDP) and the distance between the two to export value:

$$X_{sj} = Y_s^{\beta_1} \cdot Y_j^{\beta_2} \cdot D_{sj}^{\beta_3} \cdot exp(\beta_0 + \varepsilon_{sj}). \quad (1)$$

[1] An industry group is a production classification made by the U.S Bureau of the Census that is more aggregated than an industry but more detailed than a sector. It corresponds to a four-digit North American Industry Classification Scheme (NAICS) code.
[2] Washington State Department of Agriculture: http://agr.wa.gov/aginwa (accessed July 19, 2016).

Equation (1) is the traditional form of the gravity equation and indicates that exports, X_{sj}, from state s to country j are proportional to state GDP, Y_s; GDP of trade partner country j, Y_j; and the geographic distance between state s and country j, D_{sj}. The parameter β_0 is a constant and ε_{sj} is the error term. Parameters β_1, β_2, and β_3 indicate the importance of each variable in determining exports. If the parameter values are known, the gravity equation (1) can generate a prediction of exports from state s to country j given data on the right-side variables of country sizes and distance.

Anderson and van Wincoop (2003) argue that unobserved characteristics of exporting states and importing countries may be important for estimating the parameters without bias. They call these unobserved unilateral characteristics "multilateral resistance terms." To account for them, we use fixed effects on the importing countries, d_j. Additionally, we are interested in predicting exports at the level of individual four-digit NAICS industry groups. Therefore, we control for observed and unobserved features of industry group n with fixed effects, g_n. The g_n controls allow the gravity effect to differ across products at the level of industry group. We transform the dependent variable into exports as the share of state income and log-linearize equation (1) to get

$$(2) \qquad \log\left(\frac{X_{sjn}}{Y_s}\right) = \beta_2 \log Y_j + \beta_3 \log D_{sj} + \sum_{j=1} \delta_j d_j + \sum_{n=1} \gamma_n g_n + \beta_0 + \varepsilon_{sjn},$$

where δ_j and γ_n are the coefficients on the country and industry-group binary variables. There is no variation across Washington industry groups from exchange rates; common official language; country-level historical factors; country-specific demand factors such as income, preferences, or tastes; or other variables often used in gravity equation analysis. Those variables are accounted for by the importing country effect, d_j. The industry group effect, g_n, accounts for industry group specific trade policies, industry group-level economies of scale, and other effects on groups of products. However, Y_j is co-linear with d_j in equation (2). Thus, we use one specification with the economic size of importing countries and another specification with a fixed effect for the importing country:

$$(3) \qquad \log\left(\frac{X_{sjn}}{Y_s}\right) = \beta_2 \log Y_j + \beta_3 \log D_{sj} + \sum_{n=1} \gamma_n g_n + \beta_0 + \varepsilon_{sjn}$$

$$(4) \qquad \log\left(\frac{X_{sjn}}{Y_s}\right) = \beta_3 \log D_{sj} + \sum_{j=1} \delta_j d_j + \sum_{n=1} \gamma_n g_n + \beta_0 + \varepsilon_{sjn}.$$

The distance parameter, β_3, comes from the variation in distance from all of the foreign markets in the sample.[3]

Observations with zero exports are common in trade data and in our data as well. As a consequence, log transformation generates missing values when exports are zero. To address this issue, Santos Silva and Tenreyro (2006) propose a nonlinear Poisson pseudo-maximum

[3] The presence of the country fixed effect creates a degree of multicollinearity with distance in specification (4). The presence of multicollinearity in specification (4) does not affect the robustness of our results, however. This is because (1) we still obtain statistically significant estimates despite the presence of multicollinearity, (2) multicollinearity does not prevent precise predictions, and (3) we base our results on the *rank ordering* of markets, which is not affected by changes to the point estimates from the regression used to make quantitative trade flow predictions as all markets are predicted using the same parameter estimates.

likelihood (PPML) estimator for which the log transformation is not needed. No specific distribution is required for the data. Arvis and Shephard (2013) show that the PPML is the only estimator that equalizes the totals of actual and modeled values. Though the PPML estimator has many benefits, it suffers from a lack of statistical power compared to OLS. Because OLS and PPML are both common in the literature of trade flow estimation, we use both approaches to estimate the parameters. Applying each of the two estimators to gravity specifications (3) and (4) yields four sets of estimated parameters. We then plug those estimated parameters back into the gravity equations along with data on the independent variables to calculate four predictions of Washington exports for each agricultural industry group to each country.

Regardless of the parameters, the gravity equation always predicts some amount of positive exports. Thus, all industry-markets with zero Washington exports in the data must be underserved. The question is the degree to which the zero exports in the data contrast with the amount of positive exports predicted by the gravity equations. For analysis, we partition the results into those industrial group markets in which there is a positive amount of Washington exports in the data and those in which the exports are zero in the data.

For each industrial group market observation with zero actual exports, we calculate the absolute difference from each of the four predicted values and actual exports. Then, for each industry group, we order the differences across all markets that also have zero exports using one set of parameter estimates at a time. This creates four lists of markets for each industry-group, ordered by the size of the difference between the predicted value and the actual value of exports. Each of the predictions is given equal weight. Next, we find the top 5% of market observations with the largest actual difference in each of the four lists. We define markets that exceed the 5% threshold in at least three of the four lists as *underserved* markets. The reason we require markets to be above the threshold on at least three of the lists is so that the market is thought to be underserved by each specification and each estimator at least once. We define markets that appear in at least three of the four bottom percent tails as *overserved* markets. For the non-zero export markets, we use a similar procedure except we use percentage difference instead of the actual difference to identify the under- and overserved industrial group markets. Using percentage difference controls for the size of the market.

To see how our procedure works, consider an out-of-sample exercise for the oilseeds and grains farming industry group (NAICS 1111). We split the observations into those markets receiving zero exports and those markets receiving positive exports.

The results for those markets receiving at least some exports are shown in Figure 1. Each panel in the figure is the list of markets ordered by the percentage difference from the model's prediction to the data using one of the sets of parameters obtained from running the data through specifications (3) and (4) with OLS and PPML. The y-axis of each panel is the ordered list of countries normalized into a percentile. The x-axis is the percentage difference between the model's prediction and actual exports, so that positive values indicate how much more that specification of the gravity equation predicts compared to the data.

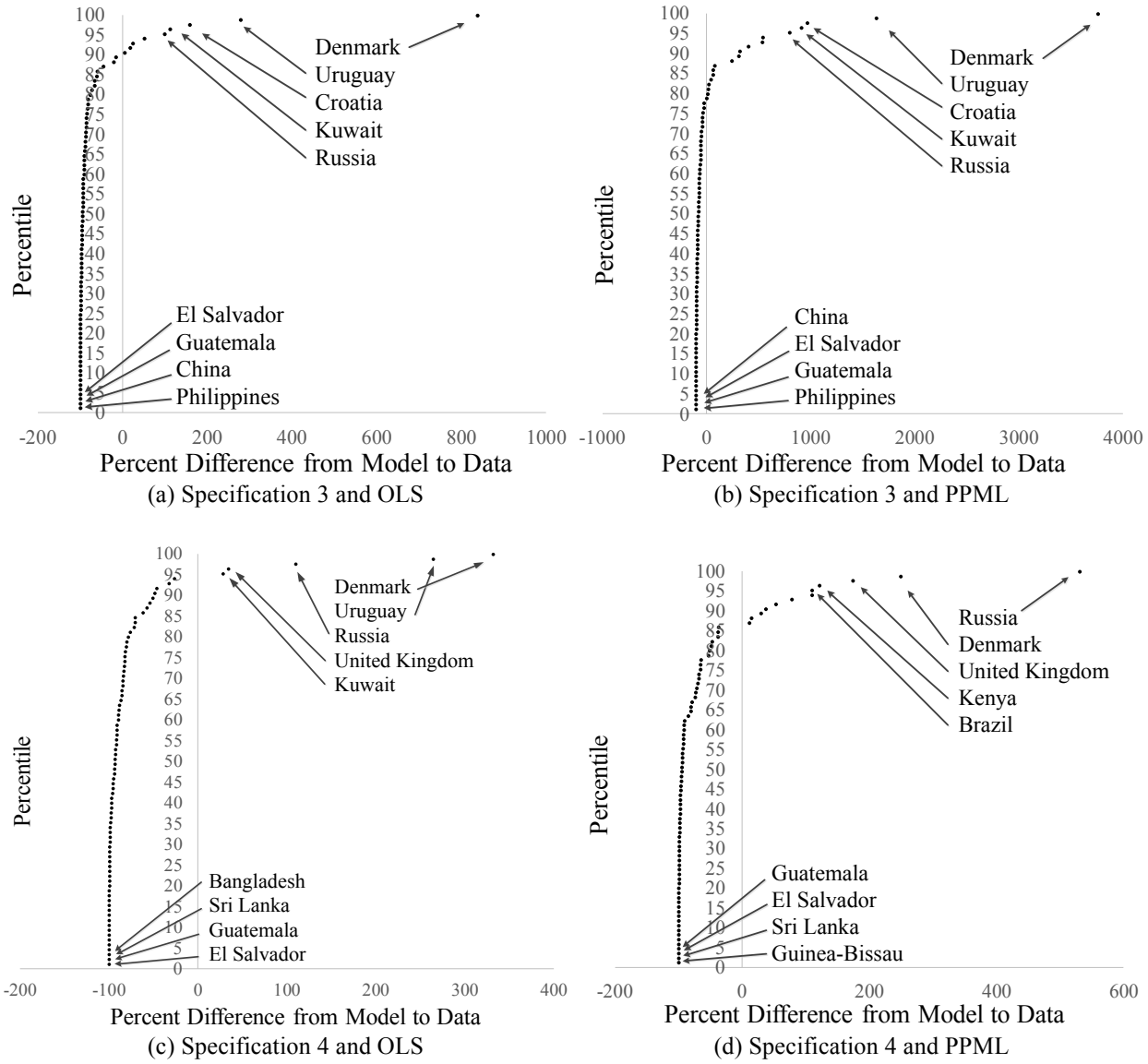


Figure 1. Out-of-Sample Exercise: Four Lists of Markets Ordered by Percent Difference from Data to Model Prediction for Oilseeds and Grains Farming (NAICS 1111) Exports.
Notes: Larger values indicate the model predicts more exports than the data show.

As can be seen from the top right of all four panels, the model predicts that Denmark should receive more exports than the data show it actually does. Denmark is the top market for three of the four panels, and the second top-most market in the fourth panel. Thus, Denmark fits our criteria of an ``underserved'' market. Kuwait, Russia, and Uruguay are other underserved markets. Although the United Kingdom appears near the top of all four panels, it is not in the top 5% of markets on at least three of the panels and so does not fit our criteria of an underserved market. We find that El Salvador, Guatemala, and the Philippines are overservered markets, as they appear in the bottom 5% of at least three of the four panels in Figure 1.

Figure 1 also predicts how much each market is under- or overserved. In panel (a), we find that Denmark is predicted by that particular model to receive eight times more exports than it actually receives, while in panel (c) it is predicted to receive about 350% more. This uncertainty about the *true* model is why we define under- and overserved markets using a relative threshold (the top and bottom 5% of ordered markets) and why we require a market to appear in at least three of the four gravity equation specifications. It is interesting that we find asymmetry in the results in that the percentage difference for the underserved markets is many times larger than for the overserved markets.

As is clear from Figure 1, the markets are distributed according to the difference between the models' predictions and the data, and sometimes there is no clear gap in that distribution for a clean demarcation of underserved or overserved markets. We choose the top and bottom 5% of markets as our threshold, though we could just have easily chosen any other. The reason we choose 5% is to identify the three or four *most* under- and overserved markets. We do not want a threshold that is so relaxed that the number of markets would be too long to be informative. Though we define under- and overserved markets with a 5% threshold for ease of reporting and understanding our results, the underlying results are continuous in nature.

Data

We perform two exercises using different sets of data. In the first exercise, we use data on Washington agricultural exports from 2012–2014 to estimate the parameters in specifications (3) and (4). The parameter estimates will be the values for the mean Washington agricultural export pattern. Since we also want to predict the data on Washington agricultural exports, this is an in-sample prediction exercise. There are two advantages of this method. First, the industry-group fixed effect controls for the amount of production so that we do not confuse low exports of industry group n generally with low production of industry group n in Washington specifically. Second, since we are using data from Washington agriculture, we know the high applicability of the results. The disadvantage is that because the results are in the context of the mean pattern of Washington agricultural exports, we cannot determine whether *all* of Washington's agricultural industrial groups are underserving a particular market. To do that, we combine data on California's agricultural exports with data on Washington's exports of non-agricultural industry groups only from 2012–2014. This out-of-sample prediction exercise allows us to determine whether any of Washington's agricultural industrial sectors deviate from the mean pattern of trade overall rather than from the mean pattern of Washington's agricultural trade.

The export data are the nominal value of Washington and California exports to 163 foreign destinations from 2012 to 2014 in 109 industry groups coded by the North American Industry Classification System (NAICS) and are obtained from WiserTrade.[4] Of the 109 four-digit NAICS industry groups, 24 are agricultural industrial groups. According to Cassey (2009), who discuss the sources and collection of these data, export data from Washington and California are of relatively good quality in the sense that they measure exports produced in those states rather than shipments from interior states. Also, zero observations are true values and not bottom codes. We deflate the nominal export data to 2009 values using the U.S. CPI index.[5] We then average

[4] http://www.wisertrade.org/home/portal/index.jsp (accessed July 19, 2016).
[5] https://research.stlouisfed.org/fred2/series/CPIAUCSL (accessed July 19, 2016).

the three years of data so that our results are not being driven by an idiosyncratic year. Even with this averaging, 8,976 observations (50.5% of the total) show zero exports. Because of the constant term in specifications (3) and (4), one industry group is dropped in each regression to avoid collinearity.

To measure economic size, GDP data from 2012 to 2014 for the 163 foreign markets are collected from the World Bank.[6] Washington and California GDP data are from the U.S. Bureau of Economic Analysis.[7] We deflate all GDP data by the U.S. CPI and then average as with the export data. The geographic distances between the two states and the foreign destinations are calculated using coordinates of country capitals and U.S. state population centroids. Though there are 163 foreign markets in our data, each of our distributions may have less than 163 points because we have partitioned the results into those with zero actual exports and those with positive actual exports. In specification (4), one foreign market is dropped in each regression to avoid collinearity with the country controls.

Under- and Overserved Markets

Table 1. Parameter Estimates

Data	**In-Sample Estimates**				**Out-of-Sample Estimates**			
Equation	**3**	**3**	**4**	**4**	**3**	**3**	**4**	**4**
Estimator	**OLS**	**PPML**	**OLS**	**PPML**	**OLS**	**PPML**	**OLS**	**PPML**
Y_j	0.741***	1.297	-		0.839***	0.871***		
	(0.034)	(4.210)	-		(0.012)	(0.058)		
D_{sj}	-0.971***	-0.707	-7.544***	-7.622	-1.201***	-0.756**	-2.587**	-1.657*
	(0.205)	(16.475)	(0.985)	(3,301.793)	(0.065)	(0.388)	(0.390)	(1.037)
Cons.	-23.392***	-37.723	50.888***	52.333	-27.274***	-30.465***	9.868***	1.728
	(1.969)	(185.205)	(7.709)	(25,352.300)	(0.639)	(3.463)	(3.008)	(8.130)
N	1,265	3,912	1,265	3,912	8,791	17,767	8,791	17,767
$\widehat{R^2}$	0.388	0.286	0.615	0.342	0.503	0.329	0.649	0.367

Notes: Single, double, and triple asterisks (*, **, ***) indicate significance at the 90%, 95%, and 99% level. Values in parentheses are standard errors clustered at the industry group-country level.

Table 1 lists the parameter values we estimate using the data and that we use in the various models to make export predictions. Despite some quantitative differences in the estimates obtained from OLS and PPML within specifications (3) and (4), the estimates for the coefficient on the foreign market GDP are largely in line with the literature, as are the parameter estimates for bilateral distance under specification (3) for both in-sample and out-of-sample exercises. The estimates for the coefficient on bilateral distance for specification (4) in the out-of-sample exercise are slightly larger in absolute value but also within the range of findings in the literature. The point estimates for the in-sample exercise for specification (4) are, however, several times larger than those estimated by either OLS or PPML in the literature. This result reflects the unique data we use in that the industry group fixed effects for the in-sample exercise account for the amount of production of the industry group. Though the point estimates are in line with the literature for in-sample PPML results for specification (3), they are not statistically significant.

[6] http://data.worldbank.org/indicator/NY.GDP.MKTP.CD (accessed July 19, 2016).
[7] https://research.stlouisfed.org/fred2/release?rid=140 (accessed July 19, 2016).

This is due to the poor power of the PPML estimator and is one empirical drawback of that method. Because there is some disagreement in the rank ordering of the predictions from each model, we require an underserved market to appear in the top 5% of three out of four lists. Spearman correlations between the predictions range from 0.99 to 0.67 for markets with positive trade.

In-Sample Results

We begin by looking at the results for the in-sample exercise. For each of the 24 agricultural industry groups, Table 2 indicates underserved markets with zero exports, underserved markets with positive exports, and overserved markets as defined by our criteria. Recall that we use absolute difference for those markets that receive zero exports in the data, whereas we use percentage difference for those markets that receive positive exports in the data.

Consider the first row of Table 2: oilseeds and grains (NAICS 1111). Although 78 markets do not receive any oilseed and grain exports from Washington, none of the markets that receive zero exports fall into our definition of an underserved market because there is no market in the top 5% in at least three of the four ordered lists of markets. According to our criteria, we find three markets receiving positive exports that are underserved by oilseeds and grains. These are Denmark, Kuwait, and Uruguay. We also find that Washington exports more oilseeds and grains to El Salvador and Guatemala than predicted by the gravity equation. Keep in mind that the in-sample results show markets that deviate from the mean trade pattern of Washington agricultural industry groups. We find that all 24 industry groups underserve at least one market, though forestry products only underserve Mexico.

Whereas Table 2 lists the under- and overserved markets by industry group, Table 3 lists markets by the number of industry groups that underserve or overserve it. The top portion of the table lists the markets that receive zero exports from the greatest number of industry groups, as well as the names of those industry groups. Six Washington industry groups do not export to Venezuela, five for India, and four for Spain. Although Italy, Denmark, and Taiwan receive some exports from the listed industry groups, they receive fewer exports than expected in those industry groups. Note that although industry groups such as mushrooms and nurseries appear for multiple countries, no industry group appears in every row. This suggests that the absence of mushroom and nursery product exports has more to do with those specific markets than with the industry group in Washington overall. Hong Kong and the Philippines are overserved by the greatest number of Washington agricultural industry groups.

Figure 2 shows the geographic distribution of under- and overserved markets according to the in-sample predictions. The figure shows the number of industry groups we find underserving each market receiving zero exports for panel (a), positive exports for panel (b), and overserving each market in panel (c). The figure is a graphical representation of Table 3. Though it is useful to see the geographic distribution of markets, it can also mislead because of the small geographic size of many European countries.

Table 2. Under- and Overserved Markets by Industry Group: In-Sample Predictions

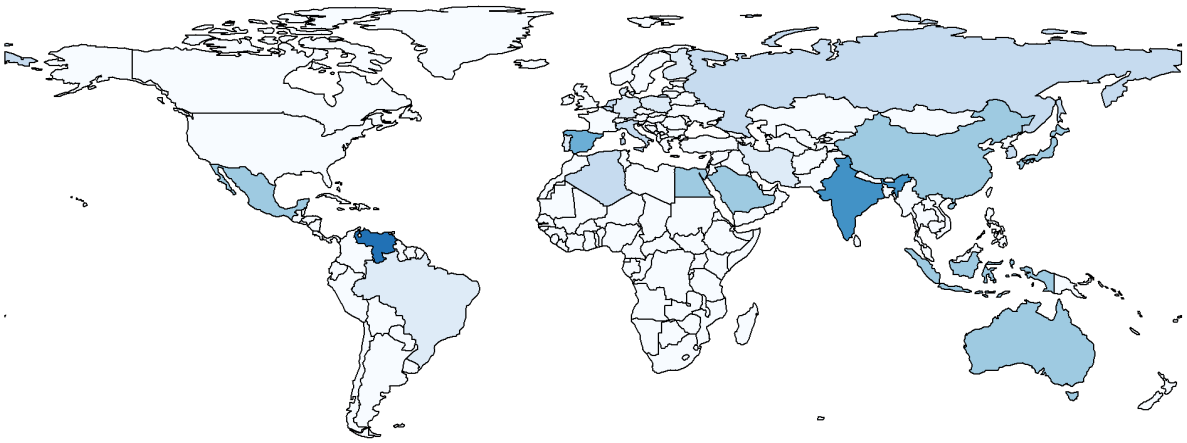
NAICS	Industry Group	Underserved: Zero Exports	Underserved: Positive Exports	Overserved
1111	Oilseeds & grains		Denmark, Kuwait, Uruguay	El Salvador, Guatemala
1112	Vegetables & melons	Finland	Bangladesh, China, Switzerland	
1113	Fruit & tree nuts	Poland, Portugal	Germany, Italy, Ukraine	
1114	Mushrooms & nursery	Australia, India, Indonesia, Saudi Arabia, Venezuela	Taiwan	Belgium, Netherlands
1119	Other agriculture	Venezuela	Bangladesh, Pakistan, South Africa	Oman, United Arab Emirates
1121	Cattle	China, Japan, South Korea	United Kingdom	Canada
1122	Swine	China, Japan, Mexico	Canada	Peru
1123	Poultry & eggs	South Korea	Japan	Hong Kong
1124	Sheep & goats	Mexico, Japan, Saudi Arabia	Canada	Philippines
1125	Farmed fish	Australia, India, Indonesia, Netherlands	Taiwan	Peru
1129	Other animals	Australia, India, Indonesia, Spain	Belgium, Taiwan	Greece
1132	Forestry products	Mexico		
1133	Timber & logs	Brazil, Venezuela	Indonesia	Japan
1141	Fish		El Salvador, Pakistan, Saudi Arabia	Lithuania, Mauritius Ukraine
3111	Animal foods	Italy, Netherlands, Russia	Mexico	Philippines
3112	Grain & oilseed milling	Belgium, Denmark	Germany, Norway	Philippines
3113	Sugar & confectionery	Italy, Spain, Venezuela	Colombia France	Hong Kong, Singapore
3114	Fruit &vegetable preserves	Egypt	Denmark, Italy, Nigeria	Panama
3115	Dairy products	Germany, Spain	Denmark, Guatemala, United Kingdom	Sri Lanka
3116	Meat products	Belgium, India, Saudi Arabia	Brazil, France	Hong Kong
3117	Sea food (canned)	Saudi Arabia, Venezuela	Colombia, Malaysia	United Kingdom
3118	Bakery & tortilla	India, Russia, Spain	Italy, Peru	Canada
3119	Foods (NESOI)	Egypt, Iran	Finland, Poland, Sweden, Turkey,	
3121	Beverages	Egypt, Venezuela	Turkey, Portugal	Cambodia, Tonga

Notes: Countries are ordered alphabetically.

Table 3. Number of Industry Groups by Market: In-Sample Predictions

Market	No.	Industry Groups
		Underserved: Zero exports
Venezuela	6	Mushrooms & nursery, Other agriculture, Timber & logs, Sugar & confectionary, Sea food (canned), Beverages
India	5	Mushrooms & nursery, Farmed fish, Other animals, Meat, Bakery & tortilla
Spain	4	Other animals, Sugar & confectionary, Dairy, Bakery & tortilla
Australia	3	Mushrooms & nursery, Farmed fish, Other animals
China	3	Cattle, Swine, Sheep & goats
Egypt	3	Fruit & vegetable preserves, Foods (Nesoi), Beverages
Indonesia	3	Mushrooms & nursery, Farmed fish, Other animnals
Japan	3	Cattle, Swine, Sheep & goats
Mexico	3	Swine, Sheep & goats, Forestry products
Saudi Arabia	3	Mushrooms & nursery, Meat, Sea food (canned)
Belgium	2	Grain & oilseed milling, Meat
Italy	2	Animal foods, Sugar & confectionary
Netherlands	2	Farmed fish, Animal foods
Russia	2	Animal foods, Bakery & tortilla
South Korea	2	Cattle, Poultry & eggs
		Underserved: Positive exports
Italy	4	Fruit & tree nuts, Fruit & vegetable preserves, Dairy, Bakery & tortilla
Denmark	3	Oilseeds & grains, Fruit & vegetable preserves, Dairy
Taiwan	3	Mushrooms & nursery, Farmed fish, Other animals
Bangladesh	2	Vegetables & melons, Other agriculture
Canada	2	Swine, Sheep & goats
Colombia	2	Sugar & confectionery
France	2	Sugar & confectionery, Meat
Germany	2	Fruit & tree nuts, Grain & oilseed milling
Pakistan	2	Other agriculture, Fish
Turkey	2	Foods (Nesoi), Beverages
United Kingdom	2	Cattle, Dairy
		Overserved
Hong Kong	3	Poultry & eggs, Sugar & confectionery, Meat
Philippines	3	Sheep & goats, Animal foods, Grain & oilseed milling
Canada	2	Cattle, Bakery & tortilla
Peru	2	Swine, Farmed fish

Notes: Includes all countries with more than one underserved or overserved industry group. For each country, industry groups are ordered by NAICS code.



(a) Underserved: Zero exports

(b) Underserved: Positive Exports

(c) Overserved

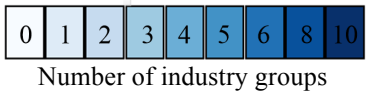


Figure 2. Geographic pattern from in-sample predictions

Because the in-sample predictions are obtained by using data on Washington agricultural industry groups, we know the results have high applicability. But since the results are deviations from the mean trade pattern of Washington agriculture, we cannot know whether any of the industry groups deviate from the mean of the overall pattern of trade.

We turn to out-of-sample predictions to answer that question.

Out-of-Sample Results

Table 4 is the same as Table 2 except that it contains the results from the out-of-sample exercise. Compared to Table 2, the number of countries listed for each industry group may increase. For example, we did not find any country receiving zero exports in oilseeds and grains that fit our criteria of being underserved according to the in-sample exercise. But in the out-of-sample exercise we find that Norway and Switzerland receive zero exports from Washington and do fit our criteria for being underserved. When there are at least some exports, we find Denmark, Uruguay, and Kuwait are underserved, as with the in-sample results. But our out-of-sample exercise also finds that Russia is an underserved market for oilseeds and grains, as seen in Figure 1. We add the Philippines to the list of overserved markets, in addition to El Salvador and Guatemala. Identifying new underserved markets with the out-of-sample exercise occurs in many other industry groups.

Like Table 3, Table 5 lists the number of industry groups for each under- or overserved market. Of the 24 agricultural industry groups, Norway does not receive exports from and is underserved by ten of them. Norway is followed by Germany, India, and Saudi Arabia at five industry groups each. In the category of countries that receive some exports, Italy is underserved by six industry groups, followed by Turkey with four. The Philippines is overserved by eight industry groups.

Figure 3 shows the geographic distribution of under- and overserved markets according to the out-of-sample predictions. Similar to Figure 2, we find a concentration of underserved markets in Europe, with a few others in South America and Central Asia.

Table 4. Underserved and Overserved Markets by Industry Group: Out-of-Sample Predictions

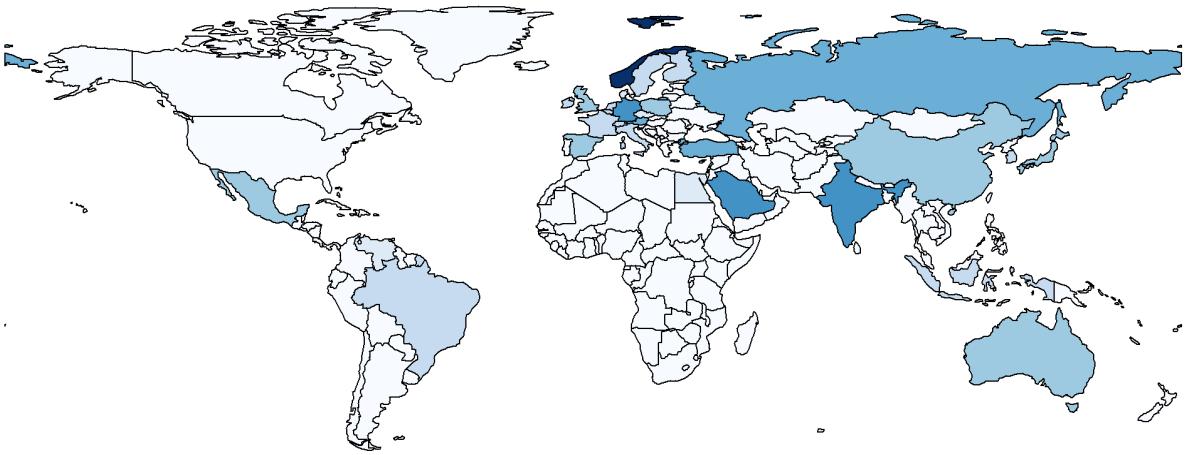
NAICS	Industry Group	Underserved: Zero exports	Underserved: Positive exports	Overserved
1111	Oilseeds & grains	Norway, Switzerland	Denmark, Kuwait, Russia, Uruguay	El Salvador, Guatemala, Philippines
1112	Vegetables & melons	Austria, Finland, Poland, Norway	Bangladesh, Italy, Switzerland	Dominican Republic, Nicaragua
1113	Fruit & tree nuts	Austria, Ireland, Poland	Argentina, Italy, Turkey, Ukraine	Vietnam
1114	Mushrooms & nursery	Arabia, Australia, Indonesia, Saudi India	Brazil, Taiwan	Belgium, Netherlands
1119	Other agriculture	Austria, Norway, Venezuela	Bangladesh, Pakistan, South Africa, Switzerland	Oman, United Arab Emirates
1121	Cattle	China, Germany, Japan, South Korea	United Kingdom	Canada
1122	Swine	China, Germany, Japan, Mexico, United Kingdom	Canada	
1123	Poultry & eggs	Germany, Russia, South Korea, United Kingdom	Mexico	Hong Kong
1124	Sheep & goats	Mexico, United Kingdom, Germany, China, Japan	Canada	Philippines
1125	Farmed fish	Australia, India, Netherlands	Taiwan	
1129	Other animals	Australia, Brazil, India, Indonesia, Saudi Arabia	Belgium, Taiwan	Greece
1132	Forestry products	Mexico, Russia, Saudi Arabia		Dominican Republic
1133	Timber & logs	Brazil, Norway, Sweden, Turkey	Indonesia, Italy	Japan
1141	Fish	Austria, Czech Republic, Qatar	Argentina, Bahamas, El Salvador, Kazakhstan, Pakistan	Georgia, Lithuania, Ukraine
3111	Animal foods	France, Italy, Netherlands, Norway, Russia, Turkey	Mexico	Philippines
3112	Grain & oilseed milling	Belgium, Denmark, Poland, Turkey	Ireland, Norway	Philippines, Vietnam
3113	Sugar & confectionery	Italy, Spain, Turkey	Brazil, Colombia France	Hong Kong, Japan
3114	Fruit &vegetable preserves	Finland, Norway	Denmark, Italy, Poland, Nigeria	Philippines
3115	Dairy products	Germany, Norway, Spain, Switzerland	Italy, United Kingdom	Indonesia, Philippines, SriLanka
3116	Meat products	Belgium, India, Norway, Saudi Arabia, Sweden	Brazil, France, Switzerland	Hong Kong, Philippines, Vietnam
3117	Sea food (canned)	Norway, Saudi Arabia	Turkey, Malaysia	United Kingdom
3118	Bakery & tortilla	France, India, Norway, Russia, Spain	Italy, Netherlands, Peru	Canada, Philippines, Japan
3119	Foods (NESOI)	Egypt	Finland, Kazakhstan, Poland, Sweden, Turkey	Belgium
3121	Beverages	Ireland	Azerbaijan, Portugal, Turkey	Cambodia, Solomon Islands

Notes: Countries are ordered alphabetically.

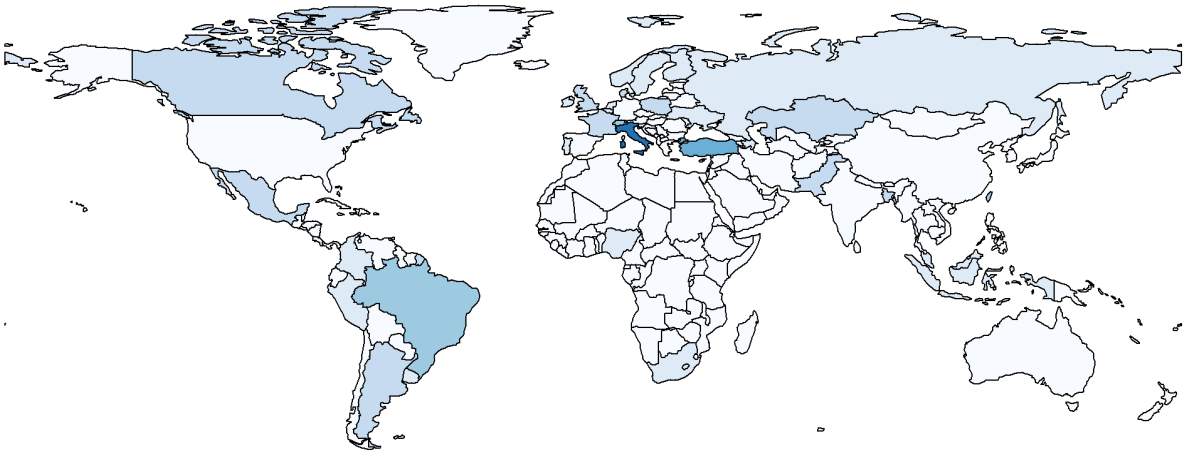
Table 5. Number of Industry Groups by Market: Out-of-Sample Predictions

Market	No.	Industry Groups
		Underserved: Zero Exports
Norway	10	Oilseeds & grains, Vegetables & melons, Other agriculture, Timber & logs, Animal foods, Fruit & vegetable preserves , Dairy, Meat Sea food (canned), Bakery & tortilla
Germany	5	Cattle, Swine, Poultry & eggs, Sheep & goats, Dairy products
India	5	Mushrooms & nursery, Farmed fish, Other animals, Meat, Bakery & tortilla
Saudi Arabia	5	Mushrooms & nursery , Other animals, Forestry products, Meat , Sea food (canned)
Austria	4	Vegetables & melons, Fruit & tree nuts, Other agriculture, Fish
Russia	4	Poultry & eggs, Forestry products, Animal foods, Bakery & tortilla
Turkey	4	Timber & logs, Animal foods, Grain & oilseed milling, Sugar & confectionery
Australia	3	Mushrooms & nursery, Farmed fish, Other animals
China	3	Cattle, Swine, Sheep & goats
Japan	3	Cattle, Swine, Sheep & goats
Mexico	3	Swine, Sheep & goats, Forestry products
Poland	3	Vegetables & melons, Fruit & tree nuts, Grain & oilseed milling
Spain	3	Sugar & confectionery, Dairy, Bakery & tortilla
United Kingdom	3	Swine, Poultry & eggs, Sheep & goats
Belgium	2	Grain & oilseed milling, Meat
Brazil	2	Other animals, Timber & logs
Finland	2	Vegetables & melons, Fruit & vegetable preserves
France	2	Animal foods, Bakery & tortilla
Ireland	2	Fruit & tree nuts, Beverages
Indonesia	2	Mushrooms & nursery, Other animals
Italy	2	Animal foods, Sugar & confectionery
Netherlands	2	Farmed fish, Animal foods
Sweden	2	Timber and logs, Meat products
Switzerland	2	Oilseeds & grains, Dairy
South Korea	2	Cattle, Poultry & eggs
		Underserved: Positive Exports
Italy	6	Vegetables & melons, Fruit & tree nuts, Timber & logs, Fruit & vegetable preserves, Dairy, Sea food (canned)
Turkey	4	Fruit & tree nuts, Sea food (canned), Foods (Nesoi), Beverages
Brazil	3	Mushrooms & nursery, Sugar & confectionery, Meat
Switzerland	3	Vegetables & melons, Other agriculture, Meat
Taiwan	3	Mushrooms & nursery, Farmed fish, Other animals
Argentina	2	Fruit & tree nuts, Fish
Bangladesh	2	Vegetables & melons, Other agriculture
Canada	2	Swine, Sheep & goats
France	2	Sugar & confectionery, Meat
Kazakhstan	2	Fish, Foods (Nesoi)
Mexico	2	Poultry and eggs, Animal foods
Pakistan	2	Other agriculture, Fish
Poland	2	Fruit & vegetable preserves, Foods (Nesoi)
United Kingdom	2	Cattle
		Overserved
Philippines	8	Oilseeds & grains, Sheep & goats, Animal foods, Grain & oilseed milling, Fruit & vegetable preserves, Dairy, Meat, Bakery & tortilla
Hong Kong	3	Poultry & eggs, Sugar & confectionery, Meat
Japan	3	Timber & logs, Sugar & confectionery, Bakery& tortilla
Vietnam	3	Fruit & tree nuts, Grain & oilseed milling, Meat
Belgium	2	Mushrooms & nursery, Foods (Nesoi)
Canada	2	Cattle, Bakery & tortilla
Dominican Rep.	2	Vegetables & melons, Forestry products

Notes: Includes all countries with more than one underserved or overserved industry group. For each country, industry groups are ordered by NAICS code.



(a) Underserved: Zero Exports



(b) Underserved: Positive Exports

(c) Overserved

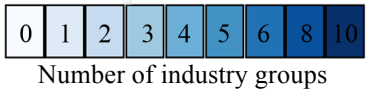


Figure 3. Geographic Pattern from Out-of-Sample Predictions

Many of Washington's underserved markets are in the European Union, but not all countries in the European Union are underserved. For example, Eastern European countries such as Romania, Estonia, Bulgaria, and Slovakia are not underserved by any industry group. If markets were underserved due to European Union rules or trade restrictions, then all countries in the European Union should be underserved, which we find not to be the case. Outside of the European Union, many Washington agricultural industry groups underserve Norway. We examine Norway in more detail below.

On the other hand, Washington exports match or exceed predicted exports to to East Asia, even controlling for the fact that Washington is among the closest states to East Asian markets. Taiwan, however, is an exception. No industry group overserves Taiwan. Rather, Washington State industry groups—including mushrooms, nursery, and related products; farmed fish and related products; and other animals—underserve Taiwan according to our criteria in both the in-sample and out-sample exercises. We study Taiwan further below.

Japan is an interesting market in that it is underserved by three industry groups (cattle; swine; and sheep, goats, and fine animal hair) but also overserved by three different industry groups (timber and logs; sugar and confectionery products; and bakery and tortilla products). This result coincides with the previous legal barrier greatly restricting Washington from exporting more cattle, swine, and sheep to Japan. Something similar may be happening in Canada, which is overserved by cattle and bakery and tortilla products but underserved by swine and sheep, goats, and fine animal hair.[8] Mexico, though it is a NAFTA member, is underserved by poultry and eggs as well as animal foods. Mexico is also the only market we find to be underserved by forestry products.

These results identify markets and industry groups with exports that deviate from a gravity model prediction of exports. Since the gravity model accounts for trade patterns with bilateral distance and market size, the fact that some markets and industry groups deviate from the gravity model prediction means the actual trade pattern is driven by other, non-gravity factors. The examples of Japan, Canada, and Mexico illustrate the benefits of our method in that we learned that some of Washington's industry groups need further analysis to understand the trade pattern. That deeper analysis may make it possible to identify opportunities for increased exports.

Two Case Studies

Our method has identified a few foreign markets that are underserved by Washington's agricultural industry groups. We undertake a slightly more detailed analysis of Norway and Taiwan to understand what variables outside those in the gravity equation may explain the trade pattern and assess whether there are opportunities to expand sales.

Norway is perhaps the leading market in terms of being underserved by many of Washington's agricultural industry groups. Norway, even though not a European Union country, follows most EU policies and import regulations. As can be seen from Table 4, Norway receives zero canned seafood from Washington. One reason for this that is outside of the model is that Norway is itself

[8] http://consumersunion.org/news/whats-all-the-fuss-about-the-canadian-border-and-beef-imports/ (accessed May 29, 2017).

a global leader in exports of canned fish. However, Norway imports canned fish products from Denmark, Iceland, Peru, Russia, and the United Kingdom, so the fact that Norway has a comparative advantage in canned seafood products does not fully explain why Washington exports zero canned seafood products there. The United Kingdom, another market with a comparative advantage in canned seafood products, is by comparison overserved by Washington. We might think that Norway represents huge export potential given that it does not impose a tariff on canned seafood products,[9] but Norway does ban imports of genetically modified foods, including the farm-raised salmon commonly canned and exported from Washington. Norway's potential as a market for these products is therefore limited.

There is potential for Washington to increase exports to Norway of fish oils, canned groundfish, and non-farmed canned salmon without the need to alter Norway's trade restriction. Thus we think there is a possibility of limited trade expansion from Washington to Norway in canned seafood. Many of Washington's other industry groups have limited export potential to Norway for the same reason: restrictions on imports of genetically modified foods. Without federal assistance to modify Norway's ban on the import of genetically modified foods, other markets may be better candidates for immediate export expansion.

Taiwan is one of the largest markets for the United States and Washington.[10] Washington is Taiwan's third-largest trading partner, yet we find it is underserved by three industry groups in both the in-sample and out-of-sample exercises, despite the fact that Washington does not underserve many other East Asian markets. The industry groups are mushrooms and nursery products, farmed fish, and other animals. We find that Taiwan has a comparative advantage in the production of and is a net exporter to the United States of mushrooms and farmed fish.[11] The reason we identify Taiwan as being underserved in these markets is that the gravity model does not distinguish between countries that have comparative advantage and disadvantage at the industry-group level. Similar to Norway, though Taiwan is a net exporter of farmed fish, it does import other types of farmed fish from China, Vietnam, Norway, and Chile. There are no explicit import restrictions on U.S exports. It may indeed be possible for Washington's farmed fish industry group to target Taiwan for expanded exports, in particular if the industry group can identify a type of farmed fish that is not obtainable from Taiwan's other trading partners.

Conclusion

We identify markets that are under- and overserved by Washington's 24 agricultural industry groups using four sets of parameters for the gravity equation. We document deviations in the trade pattern from the mean pattern of Washington's agricultural trade and the mean pattern of overall trade using in-sample and out-of-sample predictions. Our purpose is to describe a method of identifying underserved markets that could be applied to any state or industrial sector in order to take the first, but by no means final, step in drawing attention to markets that are candidates for targeted export expansion.

[9] http://www.fao.org/docrep/005/Y4325E/y4325e0a.htm (accessed May 29, 2017)
[10] https://ustr.gov/countries-regions/china/taiwan (accessed May 29, 2017)
[11] https://www.usitc.gov/publications/332/pub1746.pdf (accessed May 29, 2017)

For the case of Washington agricultural industry groups, we find that many European countries are underserved by more than a few of Washington's agricultural industry groups. Norway, Italy, and Germany receive far fewer exports from Washington than our models predict in many different agricultural industry groups. India and Brazil are other examples. These may be good markets to study to understand whether there is a systemic cause or unrealized potential for expansion. Another market that seems worthy of a closer look for expansion is Taiwan. Given Washington's success in exporting to the Philippines, Vietnam, Hong Kong, and Japan, lessons from those countries might be applied to increase exports to Taiwan.

We have identified markets that are most under- and overserved, though others could be considered as well, depending on the thresholds used and criteria applied. While we have identified under- and overserved markets with respect to what the gravity equation predicts, we have not attempted to understand *why* certain markets are under- or overserved. For some markets, it could be that tariffs or phytosanitary restrictions prevent Washington from exporting the number of goods the state otherwise would. In other cases, the issue could be logistical, a lack of consumer demand from preferences, or historical accident. In other cases, it could be because the market is itself a global export leader in a particular industry group.

While we do not attempt to identify the causes for the trade patterns we document, we believe that a list of under- and overserved markets will assist industry groups in focusing attention on markets that could potentially lead to the largest increase in exports and give direction for further study to determine whether trade expansion is possible. Because our method is based on comparing actual trade patterns to those predicted by the simple gravity equation (and that model predicts trade patterns from bilateral distance and market sizes only), there are certainly many other factors affecting trade patterns. The next step is for policy analysts or industry experts to determine the extent to which other factors matter and whether there are chances for export expansion through steps such as better logistics and marketing.

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References

Anderson, J. E. 1979. “A Theoretical Foundation for the Gravity Equation.” *American Economic Review* 69:106–116.

Anderson, J.E., and E. van Wincoop. 2003. “Gravity with Gravitas: A Solution to the Border Puzzle.” *American Economic Review* 93:170–192.

Arvis, J. F., and B. Shepherd. 2013. “The Poisson Quasi-maximum Likelihood Estimator: A Solution to the Adding Up Problem in Gravity Models.” *Applied Economics Letters* 20:515–519.

Brouthers, L. E., S. Mukhopandhyay, T. J. Wilkinson, and K. D. Brouthers. 2009. "International Market Selection and Subsidiary Performance: A Neural Network Approach." *Journal of World Business* 44:262–273.

Cassey, A. J. 2009. "State Export Data: Origin of Movement vs. Origin of Production." *Journal of Economic and Social Measurement* 34:241–268.

Hanson, G. H., and C. Xiang. 2002. "The Home Market Effect and Bilateral Trade Patterns." Working paper, National Bureau of Economic Research.

Papadopoulos, N., H. Chen, and D. R. Thomas. 2002. "Toward a Tradeoff Model for International Market Selection." *International Business Review* 11: 165–192.

Sakarya, S., M. Eckman, and K.H. Hyllegard. 2007. "Market Selection for International Expansion: Assessing Opportunities in Emerging Markets." *International Marketing Review* 24:208–238.

Santos Silva, J., and S. Tenreyro. 2006. "The Log of Gravity." *Review of Economics and Statistics* 88:641–658.

Subramanian, A., and S. J. Wei. 2007. "The WTO Promotes Trade, Strongly but Unevenly." *Journal of International Economics* 72:151–175.

Tinbergen, J. 1962. "An Analysis of World Trade Flows." In J. Tinbergen, ed. *Shaping the World Economy*, pp. 1–117. New York, Twentieth Century Fund.