EUROLICS Submission: Intercity Trade Among Turkish Provinces: Gravity and Network Approach

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1 Extended Abstract

Despite the globalization process domestic markets continue to be the dominant venues for the incomes of the majority of citizens. Most of commodity and service flows that constitute the GDP of an economy run through internal domestic markets. Domestic markets involve transactions among firms and households across different cities. Inter-city trade can be considered as a network. This trade network can be represented as a directed, weighted, incomplete, and asymmetric graph in which each city is a node and the bilateral trade links are the edges. The network is directed as each city is unlikely to trade at equal amounts from each other. The network is weighted because all links reflect some value of payment that is different for each city and each flow. The network is incomplete as not all cities in Turkey are connected with each other through trade. Finally, the network is asymmetric because for most cities customer partners (out-links) differs from the number of supplier partners (in-links).

In Turkey, The Ministry of Science, Technology and Industry provides intercity trade data for the recent years. First we construct the intercity trade network derived from the data for the year 2013, 2014 and 2017. Second, we use gravity model to explain the underlying data. Third, we analyse the network. Fourth, we follow, Kireyev and Leonidev (2015) [1] method to model and trace the network spillovers of a given shock (i.e. conflict with Russia) on the overall income and intercity trade volume.

In this paper, we attempt to examine trade flow networks among the provinces in Turkey. We employ data on trade between provinces and estimate a gravity model as the first stage of our analysis. We attribute trade above that predicted by the gravity model to the presence of shocks on trade flow networks. Gravity models have been extensively used to explain international trade flows with remarkable empirical success (for extensive reviews the reader is referred to Anderson, 2011; Anderson and Wincoop, 2004; Bergstrand and Egger, 2013 and Leamer and Levinsohn, 1995). Empirical work on intercity trade is scant but has proved to be consistent with the empirical literature on international trade flows. Buys et al. (2010) estimate a gravity model of inter-country trade in Sub-Saharan Africa which they use to predict and simulate international trade between capitals and other major cities. O'Sullivan and Ralston (1974) estimate a gravity model for intercity trade of animal and food production between 25 production centers and find that the model is able to forecast 70% of actual trade. Bossuyt et al. (2001) find evidence for the gravity model for Mesopotemian cities.

A standard gravity model of sales of city i to city j would take the following nonlinear form where $sales_{ij}$ represent sales by city i to city j, gdp_i and gdp_j are GDP of cities i and j, d_{ij} is distance between the two cities which is assumed to be inversely related to sales, and u_{ij} is a lognormally distributed error term.

$$ln(sales_{ij}) = \beta_0 + \beta_1 ln(gdp_i) + \beta_2 ln(gdp_j) + \beta_3 ln(d_{ij}) + \varepsilon_i \tag{1}$$

Regression results are presented in Table 1. We present OLS and IV estimates for each year. Literature on gravity models of trade treats GDP as endogenous. Anderson (2011) suggests that population can be used as an instrument for GDP. We treat GDP of the destination as endogenous and use population of the destination as the instrument. The gravity model is supported by the data in the sense that the distance variable has a negative and statistically significant coefficient. The estimate of distance seems to be robust across years and as well as robust to potential endogeneity. Both buyer's and seller's GDP are statistically significant in all models. The Wu-Hausman test supports the hypothesis that buyer's GDP is endogenous, so we use these estimated for the second stage of our analysis.

Table 1. Regression Results

Variable	OLS			IV		
	2013	2014	2017	2013	2014	2017
Log(d)	-0.28822 *** (0.06084)	-0.27598 *** (0.05776)	-0.28373 *** (0.05147)	-0.28165 *** (0.05982)	-0.26996 *** (0.06040)	-0.27783 *** (0.05230)
Buyer's GDP	1.70042*** (0.03548)	1.67384 *** (0.03339)	1.54423 *** (0.02952)	1.81915 *** (0.03756)	1.78300 *** (0.03593)	1.64925 *** (0.03301)
Seller's GDP	2.19883 *** (0.03548)	2.08037 *** (0.03339)	1.93057 *** (0.02952)	2.20043 *** (0.03898)	2.08184 *** (0.03602)	1.93199 *** (0.03336)
Intercept	-46.18743*** (0.91769)	-44.11266*** (0.87003)	-40.15435 *** (0.78561)	-48.16078 *** (1.10136)	-45.93954 (1.07476)***	-41.95495 *** (0.98223)
N	6480	6480	6480	6480	6480	6480
Adjusted R2	0.4859	0.4961	0.5196	0.4851	0.4952	0.5186
Wu-Hausman				129.7 ***	136.1 ***	150.3 ***

Notes: Robust standard errors are in parenthesis. *** represents statistical significance at 1 percent.

Even though the gravity model is supported by the data, we are only able to explain half of the variation in intercity sales. We make use of network analysis to analyze the remaining variation. An important contribution of this paper is its employment of network approach on inter-city trade flows. In this paper we find that the overall network effect (covering not only the first-round but all-round spillovers) can be twice as large as the direct effect.

The closest study is on international shocks and spillovers over international trade networks. by Kireyev and Leonidov (2015) [1]. They propose a method for assessing international spillovers from nominal demand shocks. It quantifies the impact of a shock in one country on all other countries. The paper underlines the fact that the network effects in shock spillovers can be substantial, comparable, and often exceed the initial shock.

Assume a negative shock on any city. Its purchases will be affected negatively. Assuming that its marginal propensity to consume is 1, the decline in nominal demand of the epicenter city is ΔY_i. It follows immediately that its purchases decline by ΔM_i.

A sales-matrix where rows denote the sales of cities and columns denote the purchases of the cities is W_{ij}. The initial demand shock ΔM_i is distributed proportionally among suppliers to the epicenter city and by definition creates a vector of shocks to their sales revenue. The shock to sales revenue creates a cascade of sales shocks in first neighbours $\Delta \overrightarrow{M_j}$. The key assumption on the spillover dynamics is that for some, but not for all cities, decline in sales revenue can lead to a drop in income and hence demand, contemporaneously or with a lag.

A negative purchasing power shock of an epicenter city will translate to sales shocks of the cities directly selling to the epicenter city. That is

$\Delta M_j = \sum_{i=1}^{n} \Delta w_{ij}$ where Δw_{ij} is the drop of sales of city i to city j. Naturally declines will be proportional to the city i's sales share in city j's total purchases.

$$\Delta w_{ij} = w_{ij} \frac{\Delta M_j}{M_j} \tag{2}$$

Consequently new inter-city sales matrix $\overrightarrow{W} = W - \Delta W$ will be obtained. The decline in sales revenue $\overrightarrow{S} = W \frac{\Delta \overrightarrow{M}}{M}$.

In some cities decline in sales revenue will lead to decline in purchases.

$$\frac{\Delta\overrightarrow{M_i}}{M_i} = \alpha_i + \beta_i(\frac{\Delta S_i}{S_i}) + \varepsilon_i \tag{3}$$

Equivalently,

$$\Delta\overrightarrow{M_i} = M_i(1-(1-\frac{\Delta S_i}{S_i})^{\beta_i}) \tag{4}$$

We vary the shocks to İstanbul's income, hence its total purchases from other cities decline % 5 to % 23 and simultaneously change the sensitivity parameter β (Absorption parameter in the figures below) from 0.5. to 0.95. The non-linear distribution of total network effects are illustrated in the Figure 1 below.

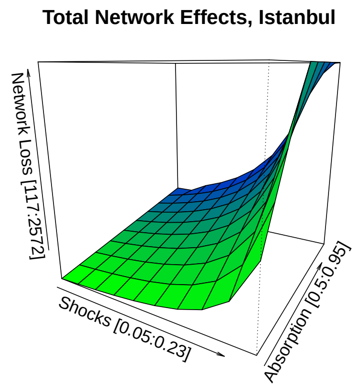

Figure 1: Loss in Total Trade due to Shocks to İstanbul

Even a minor shock of % 10 will lead to a substantial total network effect. Thus the unexplained part of the trade flows among cities by the gravity model can be attributed to the network spillover effects of small exogenous shocks.

References

[1] Alexei Kireyev and Andrei Leonidov. Network effects of international shocks and spillovers. IMF Working Paper 15/149, July 2015.