



# Import sourcing of Chinese cities: Order versus randomness<sup>☆</sup>



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## ABSTRACT

Capitalizing on the geographic detail of Chinese customs data, we show that buyer heterogeneity plays a major role in import sourcing. Hierarchy compliance, a core prediction of supply-focused models, is tested by measuring the frequency with which cities import a narrowly defined good from the country observed to be the preferred source in the province. Hierarchy violation is widespread: 92% of province goods have at least one non-compliant city. We show that introducing granular importers into a standard heterogeneous firm model leads to a prediction of 73% compliance, close to the observed average of 66%. Extending the model to allow buyers from a city to share an orientation towards specific source countries, we calibrate a heterogeneity parameter to match the average observed compliance rate. The results imply that the supply side explains on average 44% of the variance in city-level sourcing probabilities, leaving the majority of variation due to heterogeneity in buyers across cities.

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## 1. Introduction

The availability of disaggregated customs data has expanded the set of phenomena to be understood and incorporated into trade models. Following the empirical insight of Bernard and Jensen (1999) that good firms become exporters, models based on Melitz (2003) have emphasized heterogeneity across exporters, combined with fixed costs, as the drivers of trade outcomes. A supplier hierarchy emerges where better firms export to more markets and to more difficult markets. Bilateral zeros occur when no firm from a given origin is good enough to export to a particular market. With a few

exceptions, the literature has neglected the role of heterogeneity across individual importers. Standard models typically assume a representative consumer wishing to buy all the varieties available in her market. Establishing the importance of demand-side heterogeneity requires a methodology and data capable of neutralizing the plausible forms of supply-side variation. The purpose of this paper is to show that a model of heterogeneous, granular consumers can explain key features of micro import patterns.

We model consumers who purchase their preferred variety from heterogeneous firms based on relative prices, quality, and idiosyncratic taste shocks. Consistent with the pattern observed in Chinese data, goods reach destination cities by passing through a provincial transport hub. Multiplicative hub-and-spoke transport costs imply that all cities face the same relative prices and have a common ranking of products in terms of quality-adjusted prices.

Our model delivers hierarchical sourcing with a continuum of consumers but admits hierarchy violations in the case of granular consumers. When there is a continuum of tastes across consumers, all importing cities buy from the source country offering the variety with the lowest quality-adjusted price. This is because the continuum assumption leads the aggregate market of heterogeneous consumers to behave like a representative consumer with a love of variety. Thus, the Helpman et al. (2008) model is a special case of our

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model with a continuum of consumers.<sup>1</sup> With love of variety in the aggregate, larger cities import additional, less preferred varieties, as well the best one. The reason is that with larger demand, more firms from more countries will be able to cover fixed market entry costs. The hierarchy prediction we assess is that *whenever there is a non-empty set of sources selected at the city level, it should include the best source.*

The replacement of the continuum with granular consumers leads naturally to hierarchy violations. While supply-side factors influence the likelihood consumers purchase from different sources, idiosyncratic taste shocks may result in no consumers in a city selecting the source that the aggregated provincial outcomes reveal to host the best supplier. Non-compliance with hierarchy, therefore, derives from variation in the granular realizations of taste draws.

Recent work has considered two aspects of demand heterogeneity that are related but quite distinct from the focus of this paper. First, papers such as Halpern et al. (2015) and Antràs et al. (2014) model importing firms as heterogeneous in their productivity. They assume that these firms pay extra fixed costs to add import varieties to the purchase set. This leads to sourcing sets that are increasing in the productivity of the importer. A second type of heterogeneity is considered by Di Comite et al. (2014). In their model, countries can have “taste mismatches” that lead to zero trade flows. The Di Comite et al. (2014) model has representative consumers in each country so it is not designed to capture granular heterogeneity across consumers *within* nations.

We build on a small literature using granularity to explain the incidence of zeros in trade. Armenter and Koren (2014) predict the frequency of zeros in the country–industry trade matrix of the United States and the number of countries to whom US firms export. Eaton et al. (2013) investigate the number of bilateral trade zeros that would occur in a model with finite number of independent firms. Neither of these papers sets out to explain hierarchy violation. Armenter and Koren (2014) do not provide an economic model suitable for assessing hierarchy. Eaton et al. (2013) acknowledge that their model with granular exporters still yields hierarchy, stating in their conclusion, “By stripping out additional sources of heterogeneity, firms from the same source will enter markets according to a strict hierarchy (i.e. a firm will always sell in an easy-to-enter market if it sells in a more difficult market.)” Combining consumer granularity and buyer–seller shocks, our model produces both zeros and hierarchy non-compliance.

Both Armenter and Koren (2014) and Eaton et al. (2013) utilize a simple probability formula for the likelihood of a zero trade flow under independence. Namely, if there are  $n$  individual shipments or firms and each has a probability  $\pi$  of selling in a market, then the probability of no sales is  $(1 - \pi)^n$ . Armenter and Koren (2014) use shipment shares to measure these probabilities whereas Eaton et al. (2013) construct them by estimating parameters of a gravity model. Our focus is whether cities import from the top source. If we knew that probability to be  $\pi_1$ , then the probability of compliance by a city receiving  $n_d$  shipments is  $1 - (1 - \pi_1)^{n_d}$ . The expected value of hierarchy compliance across cities is the average of these probabilities for cities that import the good. Applying this formula and using the realized shipment share of the top source as  $\pi_1$ , we find expected hierarchy compliance to average 72%, remarkably close to the observed compliance rate of 66%. Unfortunately, with a small number of shipments, the realized share of the top source is a biased estimate of  $\pi_1$ . This bias motivates use of a method to calculate expected compliance that does not require an estimate of  $\pi_1$ .

Our method determines the expected number of cities that would be represented in the *realized* shipments of a source country. For each province–good, we draw (without replacement) the observed number of shipments of the realized top source from an urn consisting of all city shipments. Repeating via Monte Carlo simulation and averaging the results yield expected hierarchy compliance of 73%.

The finding that an expectation relying on the assumption of independence predicts excessive compliance—and therefore too few zeros—also appears in the prior work on granularity. Armenter and Koren (2014) find that their random model under-predicts the frequency of zeros in the country–industry trade matrix of the United States. Whereas their model predicts 72% zeros, there are 82% zeros in the data. Their model also under-predicts the fraction of exporters selling to just one country (45% versus 64%). Examining the full bilateral trade matrix of 92 countries, Eaton et al. (2013) also find too few zeros. Their random model predicts that on average each country should export to 77% of its 91 partners, which is higher than the 65% observed in their data.

The under-prediction of zeros in granular models can be eliminated by allowing for non-independence. First, we extend the random model by incorporating a source-specific demand shock that affects all shipments purchased by an importing city. Then we modify the draws-from-urn method to let the probabilities that source  $s$  draws a shipment of city  $d$  vary according to the data generating process implied by the model. This permits calibration of the parameter governing the variation in the city–source demand shock to exactly match the average compliance rate in the data. This exercise reveals that city–source orientation plays a major role: variation in traditional supply-side determinants of trading patterns accounts for 44% on average of sourcing probabilities of cities, leaving the majority of variation due to heterogeneity in buyers across cities.

Prior work has identified departures from hierarchy structures in exporting and importing. Eaton et al. (2011) find that only 52% of French exporters sell to the most popular export market (Belgium), a violation of the proposition that if a product is profitable in one foreign market, it should also be profitable in easier foreign markets. Antràs et al. (2014) report that 41% of US importers do not import from Canada, the source most commonly used by American importing firms. Looking within exporters, Bernard et al. (2011) find that firms fail to export their most popular product to markets where they export less popular products 33% of the time. Partly to respond to such violations, these papers introduce some form of buyer–seller shocks. While we also conclude that buyer–seller shocks are important, we believe that it is valuable to measure the pervasiveness of hierarchy violations within a data structure that can rule out conventional supply-side explanations. In particular, the absence of a hub-and-spoke transport structure could explain why a firm in southern France might export to Spain, but not Belgium, or why an importer in Texas might choose Mexican suppliers over Canadians. Our disaggregated geographic data, where the hub-and-spoke assumption fits well, combined with conditioning on positive imports of the product, permit us to isolate the role of heterogeneity in the preferred sources of buyers.

The next section establishes the hierarchy prediction in a model with heterogeneous firms and consumers. In Section 3 we define our hierarchy statistic, describe the data, and measure the extent of hierarchy compliance. We present the model with granular consumers in Section 4 and demonstrate that it closely fits the data. Section 5 develops a version of the random model that allows for a cities’ shipments to be oriented towards specific source countries. We calibrate the model to match the average amount of compliance observed in the data and assess the importance of buyer–seller idiosyncratic factors. The final section summarizes the results and discusses their implications.

<sup>1</sup> Anderson et al. (1992) fully explore the equivalence between heterogeneous consumers and the representative consumer models.

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