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From Ideas to Trade: how technology affects exports

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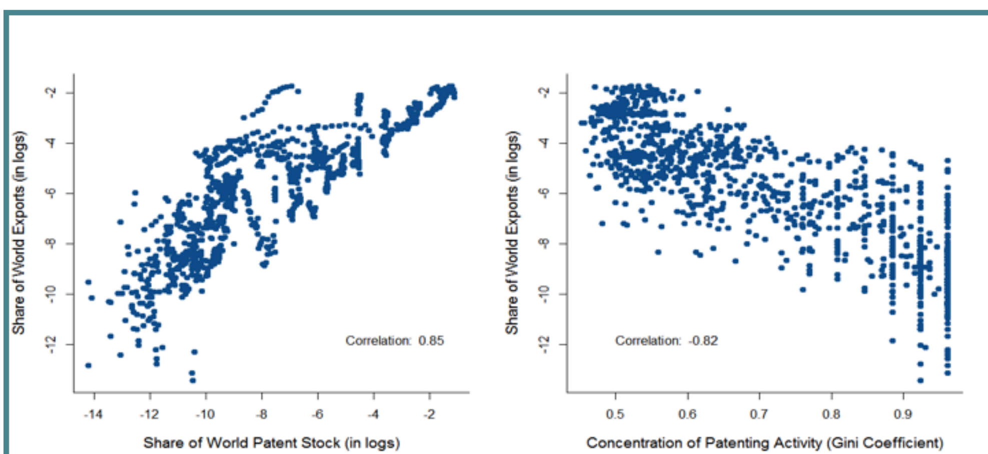
Introduction

One of the oldest and most well known theories of international trade, the Ricardian theory, highlights the role of technological dispersion as the key driver of bilateral trade. Differences in technological capabilities across sectors and across countries determine who exports which good. Countries will benefit by specializing in those goods in which they have a comparative advantage and exchanging them for the other goods. Eaton and Kortum (2002), henceforth EK, develop a general equilibrium model that extends the Ricardian framework to many countries and many goods, capturing how the opposing forces of technology and geographic barriers affect bilateral trade. Their seminal model, however, assumes that technological dispersion is the same for every country. In essence, this means that either all countries in the world are technologically diversified across their industries or they are all specialized, but we cannot have both.

In contrast, we show in Figure 1 that countries differ *both* in the stock and the dispersion of technology. Using patent counts to measure the stock of technology, the left panel shows a positive association between technological stock and exports. Each dot represents a country-year, from a pool of 84 countries over the period 1985-2000. The right panel uses the Gini coefficient to measure dispersion of patenting activity across sectors and reveals two new stylized facts in the trade literature: that the allocation of patenting activity varies dispersion-wise across countries and years, and that it is highly correlated with bilateral trade. So the relevant question is: how do the stock and allocation of technology affect exports?

Figure 1



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The model

We build on EK and develop a Ricardian model where the process of innovation determines both the stock and dispersion of technology in each country. Each country produces many goods, and their prices depend on: productivity, trade costs, and input costs. Each good's productivity is drawn (independently) from a country-specific Frechet distribution that depends on two parameters: T (that represents the stock of technology) and O (that represents the dispersion of technology). Since costs are assumed given, the values of these parameters will determine the prices of the goods.

Our model predicts that, like in the EK model, a higher stock of technology and lower relative costs foster exports. Unlike in the EK model, a country's overall comparative advantage (which determines overall exports) depends on technological dispersion. Intuitively, our model contains an extra term with the interaction between dispersion and input costs. In particular, technological dispersion governs the advantage of having lower input costs. A lower dispersion benefits countries with lower input costs since their exports are determined by these and not technological differences. The opposite happens when technological dispersion is high, since exports for these countries are determined by differences in technology and not costs.

In other words, what matters is the covariance between relative input costs and technological dispersion. A country exports more when this covariance is negative, meaning that competitors with higher costs have lower technological dispersion. In addition, an interesting feature of our framework is that when we impose a common dispersion of technology across countries the model simplifies to the EK model. This allows for a direct comparison and assessment of the gains of our more general framework. We derive a gravity equation and study how changes in a country's costs and technological dispersion affect trade flows:

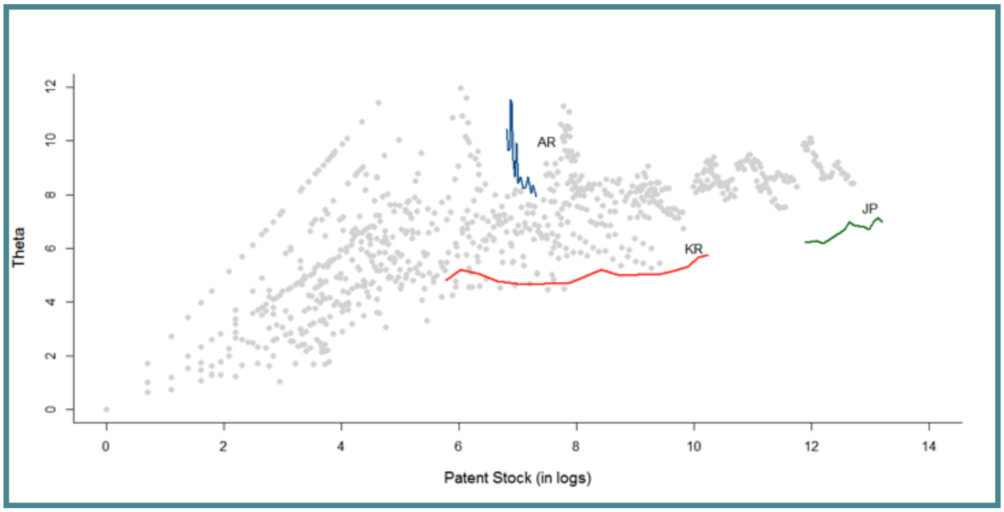
$$\ln \frac{X_{ni}}{X_n} = \ln T_i - \ln \left(\sum_{k=1}^{N} T_k \left(\frac{c_k d_{nk}}{c_i d_{ni}} \right)^{-\theta} \right) + \sum_{k=1}^{N} \alpha_k \ln \left(\frac{d_{nk} c_k}{d_{ni} c_i} \right) (\theta_k - \theta)$$

where country i is the exporter and n is the importer. The first term represents the stock of technology or absolute advantage, the second term represents the world competitiveness (how much cheaper the rest of the world is compared to i), and the third term is the comparative advantage term (that represents the cost-technology covariance described above).

The data

In order to test effects of technological innovation on bilateral exports we create a novel dataset of historical patents (the longest to date) and use these to construct measures of the stock and dispersion of technology by country and year. Specifically, we take patent grants at the United States Patent and Trademark Office (USPTO) from 1836 to 2000 and add geographic location (country of origin) based on the inventor's residence. We use patent counts by country and year as our measure for the stock of knowledge and create a measure of technological dispersion across each economy by estimating the Eaton and Kortum (2010) idea-generating model that serves as the microfoundation of EK. We plot our technological measures in Figure 2, where each dot represents a country-year. Three countries are followed in time: Argentina, Korea, and Japan. Korea has increased its patent stock in time considerably, but dispersion has remained stable. Japan has increased both the stock (which is the highest by far) and dispersion of technology. The latter implies a more even distribution of technological capabilities in time. Argentina follows the opposite path: the allocation of technological know-how became more uneven, meaning that all new technology has been added to the sectors the most technologically advanced sectors (thus increasing the intra-country gap).

Figure 2



What we find

Since our measures of technological innovation are consistent with the theory, we can use them to assess our theoretical predictions. We use data on exports, patents, input costs, income, expenditures, and bilateral pair characteristics for 84 developed and developing exporters in the period 1983-2000 to test our model. Our results indicate that technological innovation matters for trade through both the stock of patents and their dispersion across industries. In line with traditional Ricardian literature, a higher technological stock fosters exports while higher (relative) input costs dampen them. In addition, we confirm our model's predictions that the covariance between input costs and technological dispersion explains part of the variation in bilateral exports. In particular, the more expensive (in terms of relative costs) countries will benefit from a more uneven allocation of technological capabilities. In other words, they need to allocate all of their (new) technology in their best sectors to compensate for the high costs and be competitive at least in these.

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