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The evolution of comparative advantage: Measurement and welfare implications

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ABSTRACT

Using novel estimates of sectoral total factor productivities for 72 countries across 5 decades we provide evidence of relative productivity convergence: productivity grew systematically faster in initially relatively less productive sectors. These changes have had a significant impact on trade volumes and patterns, and a non-negligible welfare impact. Had productivity in each country's manufacturing sector relative to the US remained the same as in the 1960s, trade volumes would be higher, cross-country export patterns more dissimilar, and intra-industry trade lower than in the data. Relative sectoral productivity convergence – holding average growth fixed – had a modest negative welfare impact.

1. Introduction

How does technology evolve over time? This question is important in many contexts, most notably in economic growth and international trade. Much of the economic growth literature focuses on *absolute* technological differences between countries. In the context of the one-sector model common in this literature, technological progress is unambiguously beneficial. Indeed, one reading of the growth literature is that most of the cross-country income differences are accounted for by technology, broadly construed (Klenow and Rodríguez-Clare, 1997; Hall and Jones, 1999).

By contrast, the Ricardian tradition in international trade emphasizes *relative* technological differences as the reason for international exchange and gains from trade. In the presence of multiple industries and relative sectoral productivity differences between countries, the welfare consequences of technological improvements depend crucially on which sectors experience productivity growth. For instance, it is well known that when productivity growth is biased towards sectors in which a country has a comparative disadvantage, the country and its trading partners may experience a welfare loss, relative to the alternative under which growth is balanced across sectors. Greater relative technological differences lead to larger gains from trade, and thus welfare could be reduced when countries become more similar to each other. This result goes back to at least Hicks (1953), and has been reiterated recently by Samuelson (2004) in the context of productivity growth in developing countries.

To fully account for the impact of technological progress on economic outcomes, it is thus important to understand not only the evolution of average country-level TFP, but also the changes in relative technology across sectors. Until now the

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literature has focused almost exclusively on estimating differences in technology at the country level. This paper examines the evolution of sector-level TFP over time and its implications. Using a large-scale industry-level dataset on production and bilateral trade, spanning 72 countries, 19 manufacturing sectors, and 5 decades, the analysis begins by estimating productivity in each country, sector, and decade, and documenting the changes in sectoral productivities between the 1960s and today. It then uses these estimates in a multi-sector Ricardian model of production and trade to quantify the implications of changing sectoral productivities on global trade patterns and welfare.

The main results can be summarized as follows. First, there is strong evidence of relative productivity convergence. Controlling for the average productivity growth of all sectors in a country, sectors that were relatively less productive initially grew systematically faster. The speed of convergence in sectoral productivities implied by the estimates is about 18% per decade, and is similar in magnitude in both developed and developing countries. The effect is present in all time periods, although the speed of convergence is somewhat slower in later decades.

Second, changes in sectoral productivity are important for understanding the evolution of trade volumes and trade patterns. The quantitative exercise begins by solving the full model under the observed pattern of sectoral productivities, and computing all the relevant model outcomes under this baseline case. The analysis then compares the baseline to two counterfactual scenarios. In the "No Convergence" counterfactual, productivity in each country and sector remains fixed to its 1960s value relative to the US. Over this period, most countries experienced both relative and absolute catch-up in productivity. To isolate just the relative component, the second, "No Relative Convergence", counterfactual instead assumes that each country's sectoral productivities grow at the same average rate observed between the 1960s and the 2000s, but its relative productivities remain as they were in the 1960s. Because average productivity is allowed to grow, this exercise isolates the role of relative – as opposed to absolute – productivity changes.

In the data, trade patterns became substantially more similar across countries. In the majority of sectors, the standard deviation of (log) world export shares across countries has fallen significantly between the 1960s and the 2000s. In addition, over the same period there has been a substantial increase in intra-industry trade (measured here by the Grubel–Lloyd index). As the baseline model is implemented on observed trade flows, it matches these two patterns well. The baseline also matches the average trade/GDP ratios observed in the data. In both counterfactuals, however, trade volumes as a share of GDP are 15–20% higher in the 2000s, implying that the rise in trade volumes over the past 5 decades would have been even higher had relative productivities not changed. The counterfactuals also produce a much smaller reduction in the dispersion in world export shares, and a much smaller increase in intra-industry trade than observed in the data. The trade outcomes are very similar in the two counterfactuals, which implies that the relative productivity changes are more salient for trade flows than absolute catch-up.

Finally, the productivity changes had an appreciable welfare impact. In the No Convergence counterfactual, welfare in the 2000s would be *lower* than in the baseline, 11.7% in the median OECD country and 16.4% in the median non-OECD country. In the No Relative Convergence counterfactual, however, welfare is *higher* than in the baseline, 1.34% in the OECD and 3% in the non-OECD at the median. Most countries caught up in average productivity between the 1960s and the 2000s, and the No Convergence counterfactual shows that they are better off from this net growth. However, the other counterfactual shows that the relative component in productivity changes has the opposite impact. Had countries grown at their observed average rate, but kept relative productivities unchanged, they would have been even better off.

To estimate productivity, the paper extends the methodology developed by Eaton and Kortum (2002) to a multi-sector framework. It is important to emphasize the advantages of our approach relative to the standard neoclassical methodology of computing measured TFP. The basic difficulty in directly measuring sectoral TFP in a large sample of countries and over time is the lack of comparable data on real sectoral output and inputs. By contrast, the procedure in this paper uses information on bilateral trade, and thus dramatically expands the set of countries, sectors, and time periods for which productivity can be estimated. The approach follows the insight of Eaton and Kortum (2002) that trade flows contain information on productivity.[1] Intuitively, if controlling for the typical gravity determinants of trade, a country spends relatively more on domestically produced goods in a particular sector, it is revealed to have either a high relative productivity or a low relative unit cost in that sector. Using data on factor and intermediate input prices, the procedure nets out the role of factor costs, yielding an estimate of relative productivity.

In addition, the approach in this paper extends the basic multi-sector Eaton–Kortum framework to incorporate many features that are important for reliably estimating underlying technology: multiple factors of production (labor and capital), differences in factor and intermediate input intensities across sectors, a realistic input–output matrix between the sectors, both inter- and intra-sectoral trade, and a non-traded sector. Finally, because our framework allows for international trade driven by both Ricardian and Heckscher–Ohlin forces, it takes explicit account of each country's participation in exports and imports, both of the final output, and of intermediate inputs used in production.

This paper is not the first to use international trade data to estimate technology parameters (see, among others Eaton and Kortum, 2002; Finicelli et al., 2009; Chor, 2010; Waugh, 2010; Hsieh and Ossa, 2011; Shikher, 2011, 2012; Costinot et al., 2012; Caliendo and Parro, 2015). Relative to existing contributions, the analysis below extends the multi-sector approach to a much greater set of countries, and, most importantly, over time. This makes it possible, for the first time, to examine not only the global cross-section of productivities, but also their evolution over the past 5 decades and the implications of those

[1] Measuring comparative advantage using trade flows has an antecedent in Balassa (1965)'s revealed comparative advantage approach.