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Geography, non-homotheticity, and industrialization: A quantitative analysis☆

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ABSTRACT

We propose a quantitative framework for the analysis of industrialization in which specialization in manufacturing or agriculture is driven by comparative advantage and non-homothetic preferences. Countries are integrated through trade but trade is not costless and geographic position matters. We use a number of analytical examples and a multi-country calibration to explain two important empirical regularities: (*i*) there is a strong positive correlation between proximity to large markets and levels of manufacturing activity; (*ii*) there is a positive correlation between the ratio of agricultural to manufacturing productivity and shares of manufacturing in GDP. Our calibrated model replicates these facts and also provides a better fit to cross-sectional data on manufacturing shares than frameworks which ignore the role of trade costs or non-homotheticity. We use the calibrated model to quantitatively analyze the effect of increases in agricultural productivity and a further lowering of trade barriers.

1. Introduction

This paper revisits a question with a long tradition in development economics. What explains industrialization, *i.e.*, the decline of agriculture's share in GDP and the corresponding rise of manufacturing (and later services)? Why do we observe such substantial differences in levels of industrialization around the world?

The literature on structural change has proposed a number of theories to explain these phenomena. The most influential approaches focus on differences in the income elasticity of demand across sectors (*e.g.*, Kongsamut et al., 2001; Murphy et al., 1989), sector-biased productivity growth (e.g., Ngai and Pissarides, 2007), or a combination of both (e.g., Caselli and Coleman, 2001; Duarte and Restuccia, 2010). Traditionally, these approaches have analyzed closed-economy models. More recently, several authors have provided extensions to open-economy settings and have shown that additional forces, such as comparative advantage, become relevant in such models and can substantially alter the results from the closed-economy literature.[2]

While analyzing the phenomenon of industrialization in open-economy models seems natural in today's integrated world economy, it is important to realize that trade is not costless and that distance and thus the geographic position of countries still matters. Indeed, a large literature in international trade and economic geography has highlighted the links between industrial specialization, trade and geography. For example, authors such as Krugman (1980), Krugman and Helpman (1985), Davis and Weinstein (2003) or Behrens et al. (2009a), to name but a few, have shown how market size and relative geographic position shape industrial specialization patterns. Eaton and Kortum (2002), Fieler (2011) and Eaton et al. (2011), among others, have used fully parameterized multi-country models with trade costs to explain observed trade patterns and to quantify the gains from trade.

In this paper, we propose a quantitative framework for the analysis of industrialization in which countries are integrated through trade, but where trade is not costless and geographic position matters. Building on a set of theoretical mechanisms well known in the trade and economic geography literature, we construct a multi-country model with costly trade augmented with a key ingredient of structural change models: non-homothetic preferences that lead to an income elasticity of

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[2] Important recent contributions in the literature on growth, industrialization and structural change in open economies or many-country models with free trade include Coleman (2007), Galor and Mountford (2008), Matsuyama (2009), and Yi and Zhang (2010).

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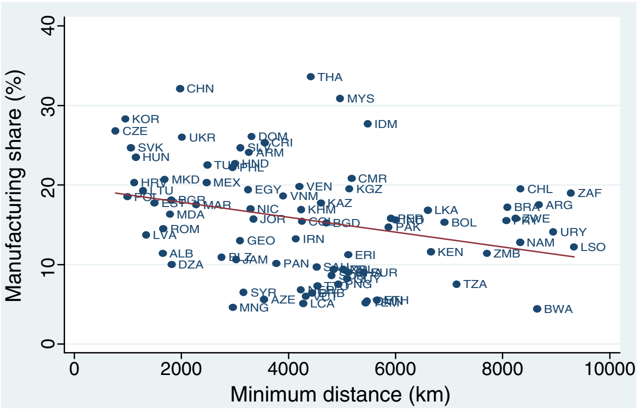

Fig. 1. GDP manufacturing shares and minimum distance to main markets (2000). *Notes*: Figure plots manufacturing shares in GDP (in %) against the minimum distance (in km) to either of the U.S., the European Union (Netherlands), or Japan. All data are for 2000. See Appendix A for data sources and country codes.

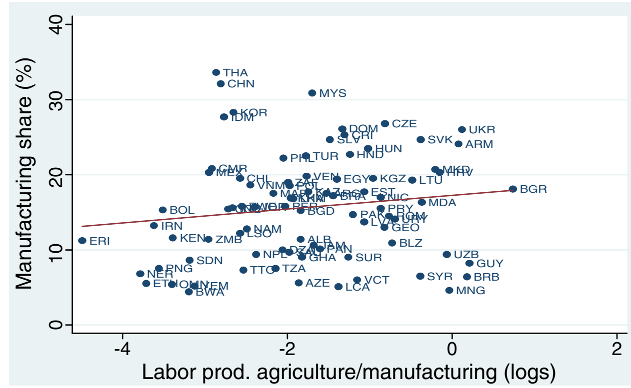

Fig. 2. GDP manufacturing shares and relative productivities (2000). *Notes*: Figure plots manufacturing shares in GDP (in %) against the ratio of labor productivity in agriculture relative to manufacturing. Labor productivity is measured as value added per worker, adjusted for cross-country price differences using sector-specific PPP exchange rates — see Section 2 and Appendix B for details. All data are for 2000. See Appendix A for data sources and country codes.

demand for manufacturing higher than for agriculture. We argue that such a framework is useful to understand two important empirical regularities, and provides a better fit to cross-sectional data on manufacturing shares than frameworks which ignore the role of economic geography.

The first observation that motivates our choice of framework is that proximity to foreign sources of demand seems to matter for industrialization. For example, it has long been noted that Hong Kong, Singapore, and Taiwan not only benefitted from an outward-oriented trade policy but also close proximity to the large Japanese market. A cursory look at the data suggests that distance to foreign markets has a more general relevance: Fig. 1 plots the manufacturing share in GDP against the minimum distance to the European Union, Japan and the U.S. for a cross-section of developing countries in 2000.[3] The figure shows that developing economies close to one of these main markets of the world have higher levels of industrialization as measured by manufacturing's share in GDP.

Our second observation is that a standard proxy for comparative advantage in agriculture, labor productivity in agriculture relative to manufacturing, is either positively or not at all correlated with manufacturing shares in the developing world. Fig. 2 plots these two variables against each other for a cross-section of developing countries for the year 2000.[4] The fitted line has a positive, albeit statistically insignificant slope. As we show in our more detailed econometric analysis in Section 2, extending the sample to include more countries and years leaves this positive correlation intact and actually makes it statistically significant as well.

By construction, the first of these two facts cannot be explained by closed-economy models of industrialization. But it also sits uneasily with open-economy models with free trade, in which geographic position is irrelevant. Fig. 2 is even more puzzling for open-economy theories of industrialization that stress the importance of comparative advantage. If countries are indeed integrated through trade and comparative advantage forces are active, should we not expect to find a *negative* correlation in the data?

In fact, both observations arise naturally in a model nesting non-homothetic preferences in a multi-country comparative-advantage trade model with positive but finite trade costs. In the model we propose below, developing countries closer to foreign sources of demand will experience higher demand for both the agricultural and manufacturing goods they produce than more distant countries, ceteris paribus. Following contributions to the international trade and economic geography literature (e.g., Hanson and Xiang, 2004; Murata, 2008), we outline conditions under which this translates into higher manufacturing shares in GDP. Most importantly, higher overall demand will lead to higher wages which, in the presence of non-homothetic preferences combined with positive trade costs, will shift local production towards the manufacturing sector. This effect is further reinforced if manufactured products are more differentiated than agricultural products. Trade costs for agricultural products also hamper the comparative-advantage mechanism put forward by free-trade models. High agricultural productivity leads to higher wages which, again because of the combination of agricultural trade costs and non-homothetic preferences, leads countries to specialize in manufacturing (we call this the "relative-demand effect" of agricultural productivity). The standard comparative-advantage effect, which would drive specialization patterns in the opposite direction, is also present but can be overcompensated by the relative-demand effect for intermediate levels of trade costs.

Having shown that our model can, in principle, explain our stylized facts, we proceed to a calibration of our model based on data from 107 developed and developing countries for the year 2000. The purpose of this calibration is threefold.

First, we show that the model also matches our stylized facts for empirically plausible parameter values. We choose parameters to match international trade and expenditure data, and demonstrate that our calibrated model generates the same positive correlations observed in the data between access to foreign markets and comparative advantage in agriculture, on the one hand, and manufacturing shares, on the other hand. Crucially, this is not true when we constrain our trade cost estimates to be equal to zero ('free trade') or infinitely high ('autarky'), or when we change parameter values to eliminate the non-homotheticity from the preferences in our model.

Secondly, we show that allowing for non-homotheticity and positive but finite levels of trade costs also improves the model's predictive

[3] We use the Netherlands as the approximate geographic center of the European Union in Fig. 1. Developing countries are defined as countries belonging to the income categories "low", "lower middle" and "upper middle" published by the World Bank (corresponding to less than 9265 USD in 1999). The simple OLS regression underlying the fitted line in Fig. 1 yields a negative slope coefficient which is statistically significant at the 1% level.

[4] Developing countries are defined as in footnote 3. Labor productivity is measured as value added per worker in agriculture and manufacturing, respectively, where value added is corrected for cross-country price differences using sector-specific PPP exchange rates (also see Section 2 and Appendix B). This is the proxy of choice in many studies of Ricardian comparative advantage, *e.g.* Golub and Hsieh (2000).