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A global view of productivity growth in China☆

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ABSTRACT

How does a country's productivity growth affect worldwide real incomes through international trade? In this paper, we take this classic question to the data by measuring the spillover effects of China's productivity growth. Using a quantitative trade model, we first estimate China's productivity growth between 1995 and 2007 and then isolate what would have happened to real incomes around the world if only China's productivity had changed. We find that the spillover effects are small for all countries in our sample, ranging from a cumulative real income loss of at most −0.2% to a cumulative real income gain of at most 0.2%.

1. Introduction

One of the classic insights of international trade theory is that a country's productivity growth can affect other countries' real incomes through international trade. This is perhaps best known from traditional models of inter-industry trade which show that real incomes can change as a result of terms-of-trade effects (Hicks, 1953). But it is also implied by newer models of intra-industry trade which illustrate that there can further be profit-shifting (Venables, 1985) or firm delocation effects (Venables, 1987). Importantly, the sign of these spillover effects is theoretically ambiguous so that countries could benefit or suffer from a trading partner's productivity growth.

These classic analyses have gained new relevance in light of China's spectacular productivity growth. For example, they clarify under what conditions China's rise might harm its trading partners thereby addressing widely held concerns. As we will review in detail later on, China's trading partners would suffer from adverse terms-of-trade effects if China's productivity growth was biased towards industries in which China is a net importer. Moreover, they would suffer from detrimental profit shifting effects if productivity growth was biased towards industries in which firms are particularly profitable. Finally, they would suffer from harmful firm delocation effects if productivity growth was biased towards industries in which consumers are particularly sensitive to changes in domestic variety.

In this paper, we use a quantitative general equilibrium trade model to measure the spillover effects of China's productivity growth. Our model nests the three spillover effects identified by the theoretical literature and specifies a rich economic environment featuring multiple sectors, multiple factors, realistic input-output linkages, and so on. Our approach is to first estimate China's industry-level productivity growth and then use our model to calculate what would have happened to real incomes around the world if only China's productivity had changed. We need a model for this calculation because we want to isolate the spillover effects of China's productivity growth controlling for all other shocks which simultaneously affect the world economy.

Our main finding is that the spillover effects of China's productivity growth are small. Focusing on the years 1995–2007 and the 14 largest economies in the world, we find that the cumulative real income effects range from a loss of at most −0.2% to a gain of at most 0.2% with the average effect being zero. There are two main reasons for this result. First, Chinese imports actually only account for a small share of total expenditure averaging a mere 1.3% in 2007. Second,

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China's productivity growth does not exhibit any strong biases of the sort described earlier so that the resulting terms-of-trade, firm delocation, and profit shifting effects do not have a clear sign.

Despite the considerable attention our subject received in the theoretical literature, there is relatively little related empirical work. Our paper is preceded mainly by Eaton and Kortum (2002) who illustrate their seminal framework by quantifying the spillover effects of hypothetical US and German productivity shocks on other OECD countries. Eaton and Kortum's framework features only terms-of-trade effects but no firm delocation or profit shifting effects and therefore ignores some of the channels through which productivity shocks transmit. Also, it predicts full specialization according to comparative advantage but allows only for aggregate productivity shocks so that productivity growth is always export-biased in effect.[1]

Having said this, additional work has emerged since the first draft of our paper. Probably most closely related is the work by Di Giovanni et al. (2014) who also consider the welfare effects of China's productivity growth. While our analysis has an ex post nature isolating the spillover effects of actual productivity shocks, Di Giovanni et al. (2014) take an ex ante approach simulating the spillover effects of hypothetical growth scenarios. Our exercise is also in a similar spirit as the analysis by Levchenko and Zhang (2016) who measure the evolution of sectoral productivities in the world economy over multiple decades. Their main point is that there has been productivity convergence in the sense that productivity grew faster in sectors that were less productive initially.

In terms of its question, our paper is also related to the work of Autor et al. (2013) which investigates the local labor market consequences of Chinese import competition in the US. Their main finding is that local labor markets which are more exposed to Chinese import competition also have higher unemployment, lower labor market participation, and reduced wages. The same is true for the work of Bloom et al. (2016) which examines the impact of Chinese import competition on technical change in the EU. Their main punchline is that Chinese import competition lead to increased technical change within firms and reallocated employment between firms towards more technologically advanced firms.

The remainder of this paper is organized as follows: Section 2 presents an illustrative model designed to convey our methodology in the clearest possible way. Section 3 extends this illustrative model along a number of dimensions to develop a more realistic quantitative framework. Section 4 turns to the empirical application in which we use this more realistic framework for our calculations and presents the data, the parameter estimation, and the results.

2. Illustrative model

2.1. Setup

Our illustrative model is based on a simple multi-country and multi-sector version of Krugman (1980). Households supply a fixed amount L_j of labor and make their consumption choices according to the following nested Cobb–Douglas–CES preferences:

$$U_j = \prod_{s=1}^{S} \left(\sum_{i=1}^{N} \int_0^{M_{is}^e} x_{ijs}(\nu_{is})^{\frac{\sigma_s - 1}{\sigma_s}} d\nu_{is} \right)^{\frac{\sigma_s}{\sigma_s - 1}\mu_{js}} \tag{1}$$

where N is the number of countries, S is the number of industries, M_{is}^e is the number of entrants in industry s of country i, x_{ijs} is the quantity of an industry s variety from country i consumed in country j, μ_{js} is the fraction of country j income spent on industry s varieties, and $\sigma_s > 1$ is the elasticity of substitution between industry s varieties.

Firms have monopoly power over a single variety and produce according to the following inverse production functions:

$$l_{is} = f_{is}^e + \sum_{j=1}^{N} \frac{\tau_{ijs} x_{ijs}}{\varphi_{is}} \tag{2}$$

where l_{is} is the labor requirement of an industry s firm from country i, φ_{is} is the productivity of an industry s firm from country i, τ_{ijs} is an iceberg trade barrier applying to industry s shipments from country i to country j, and f_{is}^e is a fixed cost of entry. Notice that firms are homogeneous within countries and industries but not across countries and industries which gives rise to Ricardian comparative advantage.

We consider two versions of our model, one with free entry and one without. In the version with free entry, $f_{is}^e > 0$ and M_{is}^e adjusts until profits are zero for all firms. In the version without free entry, $f_{is}^e = 0$ and M_{is}^e is taken as given so that profits are positive for all firms. As we will see, the spillover effects of productivity shocks differ across these two versions both qualitatively as well as quantitatively. They can be thought of as capturing long-run and short-run adjustments and we will therefore refer to them as "long-run version" and "short-run version" from now on.

2.2. Equilibrium for given productivities

Utility maximization yields the familiar demands $x_{ijs} = \frac{p_{ijs}^{-\sigma_s}}{P_{js}^{1-\sigma_s}} \mu_{js} E_j$, where p_{ijs} is the price of an industry s variety from country i in country j, $P_{js} = \left(\sum_{i=1}^{N} M_{is}^e p_{ijs}^{1-\sigma_s} \right)^{\frac{1}{1-\sigma_s}}$ is the ideal price index in industry s of country j, and E_j is the total expenditure in country j. Profit maximization implies that firms charge a constant markup over marginal costs giving rise to the standard pricing formula $p_{ijs} = \frac{\sigma_s}{\sigma_s - 1} \frac{w_i \tau_{ijs}}{\varphi_{is}}$, where w_i is the wage rate in country i. Using these formulas, it should be easy to verify that the equilibrium for given productivities can be characterized by the following four conditions in which π_{is} denote the profits of an industry s firm in country i:

$$E_i = w_i L_i + \sum_{s=1}^{S} M_{is}^e \pi_{is} \tag{3}$$

$$P_{js} = \left(\sum_{i=1}^{N} M_{is}^e \left(\frac{\sigma_s}{\sigma_s - 1} \frac{w_i \tau_{ij}}{\varphi_{is}} \right)^{1-\sigma_s} \right)^{\frac{1}{1-\sigma_s}} \tag{4}$$

$$\pi_{is} + w_i f_{is}^e = \frac{1}{\sigma_s} \sum_{j=1}^{N} \left(\frac{\sigma_s}{\sigma_s - 1} \frac{w_i \tau_{ijs}}{\varphi_{is} P_{js}} \right)^{1-\sigma_s} \mu_{js} E_j \tag{5}$$

$$w_i L_i = \sum_{s=1}^{S} M_{is}^e \left(\pi_{is} (\sigma_s - 1) + w_i f_{is}^e \sigma_s \right) \tag{6}$$

The first condition captures that total income consists of labor income and profit income and the second is the formula for the ideal price index after substituting the pricing rule. The third condition follows from the fact that firm profits are given by a constant share of firm revenues minus fixed entry costs and the last imposes that labor income has to equal the sum of industry labor costs. To obtain the long-run version of the model, we set $\pi_{is} = 0$ and treat M_{is}^e as endogenous. To obtain the short-run version, we instead set $f_{is}^e = 0$ and treat π_{is} as endogenous. In both cases we get $2NS + 2N$ equations in $2NS + 2N$ unknowns with the unknowns being $\{E_i, w_i, M_{is}^e, P_{is}\}$ and $\{E_i, w_i, \pi_{is}, P_{is}\}$, respectively.

[1] Fieler (2011) provides a similar exercise in an Eaton and Kortum (2002) model with non-homothetic preferences.