

# Accommodating Emerging Giants

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## **Abstract**

This paper studies how countries in different stages of development respond to the emergence of a poor, giant economy. A model is developed that highlights an important channel by which an emerging giant can affect growth in other countries, either positively or negatively, and an extension is developed that highlights how an emerging giant influences a country's structural transformation involving the manufacture and service sectors. Empirically, this paper documents how world prices have been affected by the recent emergence of China, and using data on Japan, Hong Kong, Singapore, South Korea, Malaysia, Thailand, Philippines, Indonesia, Australia, India, and Taiwan, evidence is presented that the predictions of the model are largely in line with how these countries evolved during the emergence of China.

# 1 Introduction

Throughout the 20th century, a minority of countries amassed incredible riches and thereby demonstrated to the world that sustained growth in per-capita income is possible. This experience led to the creation of growth theory as a thriving literature, a literature that is continuing to yield important insights even today. While growth in the frontier countries still continues, it seems the dominant economic event of the 21st century may be the emergence of relatively poor countries that are on a path to achieve per-capita income levels of the frontier countries. One by one, largely populated countries like China, India, Russia, Brazil, and many others, have adopted reforms that seem to have ignited sustained growth. The emergence of these giant economies will have important implications for the allocation of resources around the world, which is the study of this paper.

Specifically, this paper studies the implications of an emerging giant economy for the world's allocation of resources, and the consequences of this reallocation for welfare, aggregate growth, and structural transformation in countries in different stages of development. That is, as a large country embarks on a transition path that potentially takes it from being a relatively poor country to joining the ranks of the rich, is there an important sense in which the world's reallocation of resources leads some countries to experience a growth slowdown and others to experience a growth acceleration, and should this growth implication be associated with a reallocation of resources amongst various sectors in the economy? If so, which countries should be most affected, and why? This paper begins by developing a model that highlights a channel through which an emerging giant may significantly affect aggregate growth in other countries, either positively or negatively, and then proceeds to develop an extension to address the consequences of an emerging giant for a country's structural transformation within and between the manufacture and service sectors. Following a presentation of the model, evidence is presented that many of the predictions of the model are consistent with the behavior of various countries during the recent emergence of China.

Studying the effects of an emerging giant is closely related to the core question of international economics regarding the nature of production and trade, and the determination of product and factor prices. One important issue in this literature has been the distribution of benefits within a country resulting from trade with other countries; specifically, a substantial literature has argued that while overall an economy can benefit from trade, it may be that unskilled workers within some countries are worse off with trade. The framework for this prediction is provided by the Stolper-Samuelson Theorem regarding wage rate

determination in the Heckscher-Ohlin Model, with early empirical support given by Leamer (1996a, 1996b). One focus of this paper is a related distributional question, but at a country level. Surely the world is better off with an emerging giant, but there ought to be a sense in which countries heavily invested in the production of goods that the emerging giant exports are hurt by their emergence, and countries that largely import goods produced by an emerging giant are benefitted. In this sense a country's stage of development, or its comparative advantage in producing certain goods, may determine whether it is hurt or benefitted from an emerging giant. A primary aim of this paper is to develop a tractable model that is rich enough to explore these various issues, and to relate these issues to those of aggregate growth and structural transformation.

These questions have been central to the development of trade theory since its beginning in Ricardo's (1817) *Principles*. Regarding trade and growth, the channel by which one country affects aggregate growth in another through trade is by altering relative prices of traded goods, so in this sense this paper is related to the long history of examining aggregate growth implications of shocks in the terms of trade. Examining the consequences of terms-of-trade shocks originated in the Keynesian analysis of Harberger (1950) and Laursen and Metzler (1950) and then later in the neoclassical framework of Obstfeld (1982) and Svensson and Razin (1983), followed by the multi-country, dynamic, general equilibrium models of production and exchange of Stockman and Tesar (1995), Backus, et. al., (1992a, 1992b), and Baxter and Crucini (1993). Some significant recent attempts to find empirical support for the importance of terms-of-trade effects include work by Mendoza (1995) and Kose (2002), who argued that terms-of-trade shocks account for a substantial portion of the variation in output in developing economies.<sup>1</sup> The channel by which a terms of trade shock affects aggregate growth will be through the use of traded intermediate goods. The early literature on introducing intermediate goods into a theory of trade begins with McKinnon (1966) and Ethier (1979, 1982), and later by Helpman and Krugman (1985). More recently, Basu (1995) has argued that modeling intermediate goods in production can magnify cyclical fluctuations in a closed economy, much as it does in this paper. Examples of recent empirical work documenting the growing importance of traded intermediate goods in production are Campa and Goldberg (1997) and Hummels, Rapaport, and Yi (1998). Incorporating non-traded goods into a contemporary model of trade, which is related to the issue of structural

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<sup>1</sup>An important parallel development was spawned by the work of Prebisch (1950) and Singer (1950), and later in a neoclassical framework by Findlay (1980), who examined terms-of-trade effects on developing countries due to a change in primary commodity prices.

transformation between the manufacture and service sectors, began with Balassa (1964) and Samuelson (1964), who examined the implications of different productivity trends in the traded and non-traded sectors, as well as Komiya (1967) and Jones (1974), who studied the inter-connectivity of markets for traded and non-traded goods in a standard Heckscher-Ohlin framework amended to include non-traded goods; Greenwood (1984) is also an important early example that highlights the importance of non-traded goods when thinking about how a country reacts to shocks emanating from another country.<sup>2</sup>

As seems clear from the partial literature review just given, from a modeling standpoint the contribution of this paper stems from developing a tractable model that captures the many forces that seem relevant in discussing the general equilibrium effects of an emerging giant economy on the diverse set of countries that comprise the rest of the world. In doing so, this paper develops a tractable general equilibrium model with traded and non-traded goods, skilled and unskilled labor, and intermediate goods. Each feature will play a crucial role in generating predictions of the model that seem necessary to match features observed in the data. The second contribution of this paper is to use the general equilibrium model developed in this paper to address various issues regarding an emerging giant economy at an empirical level. This paper argues that various ideas from standard trade theory, taken together, can explain a variety of recent trends that may be the dominant economic events of the 21st century. This is surely a story worth telling.

In studying the effects of emerging giants on various countries around the world, among the various historical episodes studied is the growth slowdown in Japan in the 90s. Many explanations have been offered for this growth slowdown, ranging from a change in labor laws and the behavior of aggregate productivity (Hayashi and Prescott, 2002, and Fukao, et. al., 2004) to difficulties of the financial sector (Caballero, Hoshi, and Kashyap, 2004, and Dekle and Kletzer, 2005). An event as far reaching as a growth slowdown that lasts a decade or so surely has many causes, and each of the dimensions listed above may have some validity. This paper offers part of an explanation that is in many ways complementary

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<sup>2</sup>Regarding issues of structural transformation, an emerging related literature highlights the interplay between growth and the structural transformation of economies. Those papers that explicitly include a manufacture and service sector include Baumol (1967), Baumol, et.al. (1985), Echevarria (1997), Kongsamut, Rebelo, and Xie (2001), and Rogerson (2003). Also, a variety of papers focus on structural transformation involving the agricultural and manufacture sectors, such as Glomm (1992), Matsuyama (1992), Goodfriend and McDermott (1995), Laitner (2000), Caselli and Coleman (2001), Gollin, Parente, and Rogerson (2001), and Hansen and Prescott (2002). Pasinetti (1981) is a monograph that generally deals with the issue of structural change and technological progress.

to those papers. One benefit of this paper, though, is that it attempts to develop one common element that may be an important feature of a whole host of growth slowdowns.

The importance of studying emerging giants stems from their increasing importance in shaping the world economy. Of the roughly 6 billion people in the world today, about 5 billion live in lesser developed countries that were relatively closed during the 20th century. At the dawn of the 21st century most of the 5 billion live in countries that seem to be opening up and creating conditions for long-run growth. Perhaps the most noted is China, which began important reforms towards the end of the 20th century, but surely India and other large countries are not far behind. Historically, one can also view Japan beginning in the middle of the 20th century (and perhaps even western Europe during that same time period) in this light. Surely (hopefully) we will witness even more emerging giants in the future, perhaps even in our lifetime. The issue of emerging giants is important today and promises to be an even more important issue during the remainder of this century.

Sections 2 and 3 develop the basic model and various extensions. Section 4 examines some basic facts regarding the emergence of China towards the end of the 20th century, and presents evidence that the predictions of the model are largely in line with the data. Section 5 concludes.

## **2 A Model of an Emerging Giant**

One goal of this paper is to develop a tractable model that may capture how an emerging giant affects aggregate growth in other countries around the world. Getting this right would seem to involve, at a minimum, capturing how an emerging giant affects relative prices (and thereby the terms of trade) around the world, along with some mechanism by which a change in relative prices has a potentially significant affect on aggregate growth. The mechanism used here to magnify the effects of a relative price shock will be the use of traded intermediate goods in production. To focus this study on the rather complicated relationship among countries at a point in time, the model will abstract from issues of capital accumulation, which will mean that there are a whole host of important issues that this model will not be able to address.

## 2.1 Preferences, Technology, and Efficiency

The world economy consists of  $n \geq 1$  countries, two types of labor, and two goods. The two labor types are labeled type  $s$  and type  $u$ . One interpretation is as skilled and unskilled labor, but any grouping into different labor types that are imperfect substitutes in production is permissible. One good is produced with labor of type  $s$  (called Good  $s$ ) and the other good is produced with labor of type  $u$  (Good  $u$ ). Both goods are traded. Moreover, Good  $s$  is an intermediate input into the production of Good  $u$  (as well as itself), which captures the idea that equipment may be an input into assembly, but not vice versa. The next section considers an extension in which both goods are intermediate inputs. As an application of this setup, in this paper one country will be thought of as the emerging giant, and the remaining  $n - 1$  countries as countries in different stages of development.

Country  $j$  is endowed with a measure  $n_j$  of people,  $n_j^s$  of which are type  $s$  and  $n_j^u$  of which are type  $u$ . These supplies are exogenous.<sup>3</sup> Each person is endowed with one unit of time, which they supply as either type  $s$  or type  $u$  labor, depending on their type.

Production of Good  $i$  ( $i = s, u$ ) in Country  $j$  is given by the production function

$$F_j^i(n_j^i, m_j^i) = A_j^i (n_j^i)^{1-\sigma^i} (m_j^i)^{\sigma^i}, \quad (1)$$

where  $0 < \sigma^i < 1$ ,  $n_j^i$  is the appropriate labor input, and  $m_j^i$  is an intermediate input (which is Good  $s$ ). (In terms of notation, note that the superscript on  $n_j^i$  refers to the type of labor input and the superscript on  $m_j^i$  refers to the type of output being produced.)

Preferences for aggregate consumption for the population in Country  $j$  will be parameterized as

$$u_j(c_j^s, c_j^u) = \sum_i \alpha_j^i \log(c_j^i), \quad (2)$$

where  $c_j^s$  is consumption of Good  $s$ ,  $c_j^u$  is consumption of Good  $u$ ,  $\alpha_j^i > 0$  and  $\sum_i \alpha_j^i = 1$ . The assumption of log utility is certainly restrictive, perhaps even overly so, but it will turn out to be sufficient to at least begin to explore the connections among the various issues studied in this paper.

A feasible allocation for the world economy is a choice of  $c_j^i$ ,  $n_j^i$ , and  $m_j^i$ , for  $i = s, u$  and  $j = 1, \dots, n$ , that satisfies the constraints

$$\sum_{j=1}^n c_j^s + \sum_{j=1}^n \sum_i m_j^i \leq \sum_{j=1}^n A_j^s (n_j^s)^{1-\sigma^s} (m_j^s)^{\sigma^s}, \quad (3)$$

$$\sum_{j=1}^n c_j^u \leq \sum_{j=1}^n A_j^u (n_j^u)^{1-\sigma^u} (m_j^u)^{\sigma^u}. \quad (4)$$

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<sup>3</sup>An appendix, available upon request, studies a model in which these supplies are endogenously determined.

For utility weights  $\lambda_j$ , an efficient allocation is a choice from the feasible set that maximizes the weighted utility function:

$$\sum_{j=1}^n \lambda_j \sum_i \alpha_j^i \log(c_j^i). \quad (5)$$

Standard arguments can be invoked to prove that a solution to this problem exists, and that this solution is unique.

At this point it will be helpful to define what is meant by an emerging giant. By an emerging giant is meant three things: that the country is (1) large, (2) poor, and (3) experiencing relatively high GDP growth that seems to be sustainable for some time. That the country is large is reflected in the fact that the country has a large population relative to the rest of the world. That the country is poor is reflected in a relatively low level of per-capita GDP. That the country is experiencing relatively high and sustainable growth rates in per-capita GDP means that the country is on a path of convergence to the per-capita income levels of developed countries. Of course, the country must be “open” too, in the sense that it must be willing to trade with the rest of the world.

## 2.2 The Competitive Equilibrium

From the social welfare theorems of Debreu (1954) we know that the efficient solution, given the stated continuity and convexity assumptions, can be decentralized as a competitive equilibrium in which firms operate in a purely competitive market to maximize profits and people choose consumption and trade with each other at competitively determined prices to maximize individual utility. Here the conditions that a competitive equilibrium must satisfy will be explicitly stated, as this formulation will be useful for deriving how equilibrium prices and quantities depend on various exogenous events.

Since both goods are traded they will trade at the same price around the world. Denote final goods prices by  $p^i$  for  $i = s, u$ . Let the price of Good  $s$  be the numeraire, so that  $p^s = 1$ . Denote the wage rate in units of Good  $s$  paid to type  $i$  labor by  $w_j^i$ .

Firm profits are given by

$$\pi_j^i = p^i A_j^i (n_j^i)^{1-\sigma^i} (m_j^i)^{\sigma^i} - w_j^i n_j^i - m_j^i. \quad (6)$$

Firms operate in a perfectly competitive environment to maximize profits given prices and wages. In an entirely standard way, profit maximization leads to the following conditions:

$$w_j^i = p^i (1 - \sigma^i) A_j^i (m_j^i / n_j^i)^{\sigma^i}, \quad (7)$$

$$1 = p^i \sigma^i A_j^i (m_j^i / n_j^i)^{\sigma^i - 1}. \quad (8)$$



Consumers in country  $j$  choose consumption  $(c_j^s, c_j^u)$  to solve the following problem:

$$\max \sum_i \alpha_j^i \log(c_j^i) \quad (9)$$

subject to:

$$\sum_i p^i c_j^i = W_j. \quad (10)$$

Utility is homothetic and each individual in Country  $j$  has the same utility function, hence aggregating across consumers with different income levels will yield the same aggregate demand functions as that for a representative consumer maximizing utility subject to a level of wealth for the entire economy. Aggregate wealth is given by  $W_j = \sum_i w_j^i n_j^i$ . The solution to the above problem is given by the aggregate demand functions  $c_j^i = \alpha_j^i W_j / p^i$ .

Let  $y_j^i$  denote output of Good  $i$  by Country  $j$ . The worldwide equilibrium conditions can be summarized by the following equations (for  $i = s, u$  and  $j = 1, \dots, n$ ):

$$y_j^i = (A_j^i)^{\frac{1}{1-\sigma^i}} (\sigma^i p^i)^{\frac{\sigma^i}{1-\sigma^i}} n_j^i, \quad (11)$$

$$m_j^i = (\sigma^i p^i A_j^i)^{\frac{1}{1-\sigma^i}} n_j^i, \quad (12)$$

$$w_j^i = (1 - \sigma^i) (\sigma^i)^{\frac{\sigma^i}{1-\sigma^i}} (p^i A_j^i)^{\frac{1}{1-\sigma^i}} \quad (13)$$

$$W_j = w_j^u n_j^u + w_j^s n_j^s, \quad (14)$$

$$c_j^i = \alpha_j^i W_j / p^i, \quad (15)$$

$$\sum_{j=1}^n y_j^u = \sum_{j=1}^n c_j^u, \quad (16)$$

$$\sum_{j=1}^n y_j^s = \sum_{j=1}^n \sum_i m_j^i + \sum_{j=1}^n c_j^s. \quad (17)$$

A worldwide equilibrium can be characterized as a solution  $y_j^i, m_j^i, w_j^i, c_j^i, W_j$ , and  $p^u$ , for given values of  $A_j^i$  and  $n_j^i$ , to these equations. This system represents  $9n + 2$  equations in  $9n + 1$  unknowns, where one equation is redundant (Walras' Law).

To derive various qualitative features of the equilibrium it will help to derive an excess supply function for Good  $u$  from Country  $j$  as it depends on the price  $p^u$ . This excess supply function will be defined such that along this curve the labor market clears. Since the price  $p^u$  is constant across countries, it will turn out to be useful to represent this excess supply function in units of Good  $s$ . In particular, define the Good  $u$  excess supply function from Country  $j$  as  $Z_j = p^u (y_j^u - c_j^u)$ , where, for a given  $p^u$ , eqs. (11)-(15) hold. By Walras' Law a price  $p^u$  that clears the market for Good  $u$  will also clear the market for Good  $s$ , and hence such a price will equilibrate the world economy. From the equilibrium conditions just listed, this excess supply function can be written as

$$Z_j = (1 - \alpha_j^u (1 - \sigma^u)) (\sigma^u)^{\frac{\sigma^u}{1-\sigma^u}} (p^u A_j^u)^{\frac{1}{1-\sigma^u}} n_j^u - \alpha_j^u (1 - \sigma^s) (\sigma^s)^{\frac{\sigma^s}{1-\sigma^s}} (A_j^s)^{\frac{1}{1-\sigma^s}} n_j^s \quad (18)$$

Clearly this excess supply function is a strictly-increasing function of  $p^u$ , and hence so too is the world excess supply function

$$Z = \sum_{j=1}^n Z_j. \quad (19)$$

The equilibrium price  $p^u$  is the price such that  $Z = 0$ , which can be written as

$$p^u = \left( \frac{\sum_{j=1}^n \alpha_j^u (1 - \sigma^s) (\sigma^s)^{\frac{\sigma^s}{1-\sigma^s}} (A_j^s)^{\frac{1}{1-\sigma^s}} n_j^s}{\sum_{j=1}^n (1 - \alpha_j^u (1 - \sigma^u)) (\sigma^u)^{\frac{\sigma^u}{1-\sigma^u}} (A_j^u)^{\frac{1}{1-\sigma^u}} n_j^u} \right)^{1-\sigma^u} \quad (20)$$

As can be seen from eq. (20), a rise in  $A_j^u$  will lead to a fall in  $p^u$ , and a rise in  $A_j^s$  will lead to a rise in  $p^u$ . That an emerging giant is poor suggests that it has a very large ratio  $n_j^u/n_j^s$ . This feature will mean that even if both  $A_j^u$  and  $A_j^s$  rise (and indeed, that perhaps the ratio  $A_j^s/A_j^u$  rises, as might be expected for an emerging giant), then we should still expect  $p^u$  to fall. Formally, using eq. (20), it follows that if  $A_j^u$  rises then  $p^u$  falls as long as

$$\frac{d(A_j^s)^{\frac{1}{1-\sigma^s}}}{d(A_j^u)^{\frac{1}{1-\sigma^u}}} \leq \frac{(1 - \alpha_j^u (1 - \sigma^u)) (\sigma^u)^{\frac{\sigma^u}{1-\sigma^u}} n_j^u}{\alpha_j^u (1 - \sigma^s) (\sigma^s)^{\frac{\sigma^s}{1-\sigma^s}} n_j^s} \left( \frac{\sum_{j=1}^n \alpha_j^u (1 - \sigma^s) (\sigma^s)^{\frac{\sigma^s}{1-\sigma^s}} (A_j^s)^{\frac{1}{1-\sigma^s}} n_j^s}{\sum_{j=1}^n (1 - \alpha_j^u (1 - \sigma^u)) (\sigma^u)^{\frac{\sigma^u}{1-\sigma^u}} (A_j^u)^{\frac{1}{1-\sigma^u}} n_j^u} \right). \quad (21)$$

Note that the right side becomes arbitrarily large as  $n_j^u/n_j^s$  becomes arbitrarily large. That an emerging giant is large suggests that it has a very large level of  $n_j^u$  relative to the rest of the world, so a rise in  $A_j^u$  should have a relatively large effect on worldwide prices.

Consider, now, a central result in this model: a fall in  $p^u$ , keeping productivity constant in Country  $j$ , will lead to a fall in aggregate real-value added in Country  $j$ . To prove this result, note that the value added in units of Good  $s$  from producing Good  $i$  is given by:

$$w_j^i n_j^i = p_j^i y_j^i - m_j^i. \quad (22)$$

The value added in units of Good  $i$  can thus be written as

$$\frac{w_j^i n_j^i}{p_j^i} = y_j^i - \frac{m_j^i}{p_j^i}. \quad (23)$$

Hence, aggregate real-value added using base year prices denoted by  $p_b^i$  is given by:

$$W_j^b = w_j^s n_j^s + p_b^u \frac{w_j^u n_j^u}{p^u}. \quad (24)$$

Note that this measure of real output can be written as

$$W_j^b = (1 - \sigma^s) (\sigma^s)^{\frac{\sigma^s}{1-\sigma^s}} (A_j^s)^{\frac{1}{1-\sigma^s}} n_j^s + p_b^u (1 - \sigma^u) (p^u \sigma^u)^{\frac{\sigma^u}{1-\sigma^u}} (A_j^u)^{\frac{1}{1-\sigma^u}} n_j^u. \quad (25)$$

Keeping levels of productivity constant, a fall in  $p^u$  will lead to a fall in aggregate real-value added. Indeed, the percentage change in aggregate real-value added due to a one percent change in  $p^u$ , evaluated at  $p^u = p_b^u$ , is given by

$$\frac{p^u}{W_j^b} \frac{dW_j^b}{dp^u} = \frac{\sigma^u}{1 - \sigma^u} \frac{w_j^u n_j^u}{W_j}. \quad (26)$$

The effect will be larger the larger is labor's share devoted to the production of Good  $u$ .

By construction the entire effect of a change in the relative price  $p^u$  on aggregate real-value added is due to the presence of price-elastic intermediate goods in production. A fall in  $p^u$  makes intermediate goods relatively expensive in the production of Good  $u$ , hence leading to a fall in intermediate goods used to produce Good  $u$ . The production of Good  $s$  is unaffected, as the relative price of its intermediate goods (relative to its output price) is unaffected. Except for the country whose productivity rose in the Good  $u$  sector, the production of Good  $u$  will fall. Aggregate real-value added will fall in the rest of the world, especially for countries heavily invested in the production of Good  $u$ .

Of course, of more fundamental concern is the effect of an emerging giant on a country's welfare. The effect on welfare can be summarized as follows: if Good  $u$  is imported, a fall in  $p^u$  leads to a rise in utility; conversely, if Good  $u$  is exported, a fall in  $p^u$  leads to a fall in utility. The proof of this result is standard in the trade literature. If the allocation within a country is efficient (which it is in this paper), then the resources within a country can be thought of as being allocated according a social planner maximizing utility of residents of that country. If a country is importing Good  $u$  and the price of Good  $u$  falls, then by not reallocating any domestic resources (which is feasible), the planner can import more of Good  $u$ . Hence, the country must be better off by a fall in this relative price. Conversely, if a country is exporting Good  $u$  and the price of Good  $u$  falls, then the current level of consumption and utility are no longer in the feasible set; moreover, any optimal reallocation of resources must lead to a lower level of utility, as such a reallocation was in the feasible set prior to the fall in the price of Good  $u$ . Note that the effect on welfare of an emerging giant need not be the same sign as the effect on growth. With unchanged productivity, a fall in  $p^u$  will always lead to a fall in aggregate real-value added, but may lead to either a rise or fall in welfare. The next section develops an extension in which either aggregate real-value added or welfare can rise or fall.

### 3 Extensions of the Model

#### 3.1 Composite Intermediate Good

In the model just considered, no country experiences a rise in real GDP due to the emergence of a giant economy. This implication, which seems unreasonable, is due to the assumption that goods produced in relative abundance by the emerging giant are not themselves used as intermediate inputs into producing other goods. This assumption will be relaxed in this section. Specifically, this section considers an extension in which the intermediate good is a composite good comprised of both Good  $s$  and Good  $u$ . In such a setting, a fall in the price of Good  $u$  leads to a fall in the price of the composite intermediate good in the production of Good  $s$  (relative to the price of Good  $s$ ), and thereby leads to an expansion of this sector. For some countries an expansion in the Good  $s$  sector may balance out the contraction in the Good  $u$  sector, thereby leading to a rise in aggregate real-value added.

Consider the production function as before, except that now the intermediate good  $m_j^i$  is a composite good produced with  $z_j^{si}$  units of Good  $s$  and  $z_j^{ui}$  units of Good  $u$  according to the Cobb-Douglas technology

$$m_j^i = (z_j^{si})^{\gamma^i} (z_j^{ui})^{1-\gamma^i}. \quad (27)$$

Just to clarify the notation,  $z_j^{ki}$  is the quantity of Good  $k$  used to produce Good  $i$  (through the composite intermediate good  $m_j^i$ ) in Country  $j$ . Note that the minimum cost combination of  $z_j^{si}$  and  $z_j^{ui}$  to produce one unit of intermediate good  $m_j^i$  is given by the solution to

$$\min \quad z_j^{si} + p^u z_j^{ui} \quad (28)$$

$$\text{subject to} \quad (z_j^{si})^{\gamma^i} (z_j^{ui})^{1-\gamma^i} = 1 \quad (29)$$

The solution to this problem is given by

$$z_j^{si} = \left( \frac{\gamma^i p^u}{1 - \gamma^i} \right)^{1-\gamma^i}, \quad (30)$$

$$z_j^{ui} = \left( \frac{\gamma^i p^u}{1 - \gamma^i} \right)^{-\gamma^i}. \quad (31)$$

The minimum cost of providing one unit of  $m_j^i$  is thus given by

$$q^i = (\gamma^i)^{-\gamma^i} (1 - \gamma^i)^{\gamma^i-1} (p^u)^{1-\gamma^i}. \quad (32)$$

Using this result, firms can simply be thought of as choosing  $n_j^i$  and  $m_j^i$  to maximize profits given by

$$\pi_j^i = p^i A_j^i (n_j^i)^{1-\sigma^i} (m_j^i)^{\sigma^i} - w_j^i n_j^i - q^i m_j^i. \quad (33)$$

Consumers behave as in the previous model.

To shorten the notation, define

$$\Gamma^i = (\gamma^i)^{\gamma^i} (1 - \gamma^i)^{1-\gamma^i}. \quad (34)$$

It is straightforward to show that the equilibrium satisfies the following equations:

$$y_j^u = (A_j^u)^{\frac{1}{1-\sigma^u}} (\sigma^u \Gamma^u)^{\frac{\sigma^u}{1-\sigma^u}} (p^u)^{\frac{\sigma^u \gamma^u}{1-\sigma^u}} n_j^u, \quad (35)$$

$$y_j^s = (A_j^s)^{\frac{1}{1-\sigma^s}} (\sigma^s \Gamma^s)^{\frac{\sigma^s}{1-\sigma^s}} (p^u)^{\frac{\sigma^s (\gamma^s - 1)}{1-\sigma^s}} n_j^s, \quad (36)$$

$$m_j^u = (\sigma^u \Gamma^u A_j^u)^{\frac{1}{1-\sigma^u}} (p^u)^{\frac{\gamma^u}{1-\sigma^u}} n_j^u, \quad (37)$$

$$m_j^s = (\sigma^s \Gamma^s A_j^s)^{\frac{1}{1-\sigma^s}} (p^u)^{\frac{\gamma^s - 1}{1-\sigma^s}} n_j^s, \quad (38)$$

$$z_j^{ui} = \left( \frac{\gamma^i p^u}{1 - \gamma^i} \right)^{-\gamma^i} m_j^i, \quad (39)$$

$$z_j^{si} = \left( \frac{\gamma^i p^u}{1 - \gamma^i} \right)^{1-\gamma^i} m_j^i, \quad (40)$$

$$w_j^u = (1 - \sigma^u) (\sigma^u \Gamma^u)^{\frac{\sigma^u}{1-\sigma^u}} (A_j^u)^{\frac{1}{1-\sigma^u}} (p^u)^{\frac{(\gamma^u - 1)\sigma^u + 1}{1-\sigma^u}} \quad (41)$$

$$w_j^s = (1 - \sigma^s) (\sigma^s \Gamma^s)^{\frac{\sigma^s}{1-\sigma^s}} (A_j^s)^{\frac{1}{1-\sigma^s}} (p^u)^{\frac{(\gamma^s - 1)\sigma^s}{1-\sigma^s}} \quad (42)$$

$$W_j = w_j^u n_j^u + w_j^s n_j^s, \quad (43)$$

$$c_j^i = \alpha_j^i W_j / p^i, \quad (44)$$

$$\sum_{j=1}^n y_j^u = \sum_{j=1}^n \sum_i z_j^{ui} + \sum_{j=1}^n c_j^u, \quad (45)$$

$$\sum_{j=1}^n y_j^s = \sum_{j=1}^n \sum_i z_j^{si} + \sum_{j=1}^n c_j^s. \quad (46)$$

Using these equations we can again define the Good  $u$  excess supply function for Country  $j$  as

$$Z_j = p^u (y_j^u - \sum_i z_j^{ui} - c_j^u). \quad (47)$$

Note that Good  $u$  is now used as an intermediate good, so its demand as an intermediate good must be subtracted from overall supply in order to compute this excess supply function. The world equilibrium price  $p^u$  is again one such that the world excess supply of Good  $u$  equals zero:  $Z = 0$ . It is straightforward to derive that each country's Good  $u$  excess supply

function is given by

$$Z_j = \left( 1 - \alpha_j^u(1 - \sigma^u) - \sigma^u \Gamma^u \left( \frac{\gamma^u}{1 - \gamma^u} \right)^{-\gamma^u} \right) (\sigma^u \Gamma^u)^{\frac{\sigma^u}{1 - \sigma^u}} (A_j^u)^{\frac{1}{1 - \sigma^u}} (p^u)^{\frac{\sigma^u \gamma^u}{1 - \sigma^u} + 1} n_j^u \\ - \left( \alpha_j^u(1 - \sigma^s) + \sigma^s \Gamma^s \left( \frac{\gamma^s}{1 - \gamma^s} \right)^{-\gamma^s} \right) (\sigma^s \Gamma^s)^{\frac{\sigma^s}{1 - \sigma^s}} (A_j^s)^{\frac{1}{1 - \sigma^s}} (p^u)^{\frac{(\gamma^s - 1)\sigma^s}{1 - \sigma^s}} n_j^s. \quad (48)$$

A closed-form expression for the equilibrium value of  $p^u$  is now easily derived as

$$p^u = \left( \frac{\sum_{j=1}^n \left( \alpha_j^u(1 - \sigma^s) + \sigma^s \Gamma^s \left( \frac{\gamma^s}{1 - \gamma^s} \right)^{-\gamma^s} \right) (\sigma^s \Gamma^s)^{\frac{\sigma^s}{1 - \sigma^s}} (A_j^s)^{\frac{1}{1 - \sigma^s}} n_j^s}{\sum_{j=1}^n \left( 1 - \alpha_j^u(1 - \sigma^u) - \sigma^u \Gamma^u \left( \frac{\gamma^u}{1 - \gamma^u} \right)^{-\gamma^u} \right) (\sigma^u \Gamma^u)^{\frac{\sigma^u}{1 - \sigma^u}} (A_j^u)^{\frac{1}{1 - \sigma^u}} n_j^u} \right)^{exponent} \quad (49)$$

where

$$exponent = \frac{1}{\frac{1}{1 - \sigma^u} + \frac{(\gamma^u - 1)\sigma^u}{1 - \sigma^u} - \frac{(\gamma^s - 1)\sigma^s}{1 - \sigma^s}}.$$

Note that if  $\gamma^u = \gamma^s = 1$  (and thereby  $\Gamma^u = \Gamma^s = 1$ ), then the solution for  $p^u$  is the same as before.

Aggregate real-value added using base year prices can now be written as

$$W_j^b = w_j^s n_j^s + p_b^u \frac{w_j^u n_j^u}{p^u} \quad (50)$$

$$= (1 - \sigma^s) (\sigma^s \Gamma^s)^{\frac{\sigma^s}{1 - \sigma^s}} (A_j^s)^{\frac{1}{1 - \sigma^s}} (p^u)^{\frac{(\gamma^s - 1)\sigma^s}{1 - \sigma^s}} n_j^s \\ + p_b^u (1 - \sigma^u) (\sigma^u \Gamma^u)^{\frac{\sigma^u}{1 - \sigma^u}} (A_j^u)^{\frac{1}{1 - \sigma^u}} (p^u)^{\frac{\gamma^u \sigma^u}{1 - \sigma^u}} n_j^u. \quad (51)$$

The first term falls with  $p^u$  while the latter term rises with  $p^u$ , reflecting the result that the Good  $s$  and Good  $u$  sectors move in opposite directions. A country that only produces goods that do not compete with those produced in relative abundance by an emerging giant, but rather uses those goods as intermediate goods, will experience a rise in aggregate real-value added. A country that only produces goods that compete with those produced in relative abundance by an emerging giant will experience a fall in aggregate real-value added.

It can be easily shown that the elasticity of aggregate real-value added in base year prices with respect to  $p^u$ , evaluated at  $p^u = p_b^u$ , is given by

$$\frac{p^u}{W_j^b} \frac{dW_j^b}{dp^u} = -(1 - \gamma^s) \frac{\sigma^s}{1 - \sigma^s} \frac{w_j^s n_j^s}{W_j} + \gamma^u \frac{\sigma^u}{1 - \sigma^u} \frac{w_j^u n_j^u}{W_j} \\ = -(1 - \gamma^s) \frac{\sigma^s}{1 - \sigma^s} + \left( \gamma^u \frac{\sigma^u}{1 - \sigma^u} + (1 - \gamma^s) \frac{\sigma^s}{1 - \sigma^s} \right) \frac{w_j^u n_j^u}{W_j}. \quad (52)$$

The previous model is a special case in which  $\gamma^s = \gamma^u = 1$ , so that Good  $u$  is not used to produce intermediate goods. If  $\gamma^s = \gamma^u = 0$  then only Good  $u$  is an intermediate input, so a fall in the price  $p^u$  will lead to a rise in aggregate real-value added for all countries. This equation captures the central prediction of the model relating aggregate real-value added to an emerging giant: the elasticity of aggregate real-value added with respect to the price of a set of goods can be positive or negative, but is monotonically related to labor's share in producing that set of goods. This relationship will prove valuable in searching for empirical support for this model.

The effect on welfare due to an emerging giant is the same as before: due to a fall in  $p^u$ , welfare rises for those countries that import Good  $u$  and falls for those countries that export Good  $u$ . It is informative to contrast this result with the effect on growth due to an emerging giant: due to a fall in  $p^u$ , growth rises for those countries that have a sufficiently low labor's share in the production of Good  $u$  and falls for those countries that have a sufficiently high labor's share in the production of Good  $u$ . Although they are related, either welfare or growth can rise or fall in response to a fall in  $p^u$ . Note also that the effect on the terms of trade are the same direction as the effect on welfare: due to a fall in  $p^u$ , the terms of trade rises for those countries that import Good  $u$  and falls for those countries that export Good  $u$ . In this sense, the effect on welfare seems better captured by movements in the terms of trade, and the effect on growth seems better captured by movements in the relative price  $p^u$ .

### 3.2 Non-Traded Goods and Structural Transformation

This section considers an extension of the model that studies the potential impact of an emerging giant on the allocation of employment and other resources between various sectors, either within manufacturing or between the manufacture and service sectors (i.e., the traded and non-traded sectors). In this sense this extension is an attempt to study the importance of an emerging giant to a trade-induced structural transformation and to relate this structural transformation to the same forces driving aggregate growth and welfare. In addition to delivering fairly standard results on the pattern of production, trade, and wages, this extension will deliver the following two insights. First, this extension does indeed deliver an important margin by which labor is reallocated between various manufacture sectors, as well as between the manufacture and service sectors as a whole, in response to a change in the relative price of a subset of manufacture goods. Second, even in this richer setting with non-traded goods the predictions of the model regarding overall output are similar to that

in the model in which all goods are traded.

### 3.2.1 The Model

As before, consider a world economy that consists of  $n \geq 1$  countries and two types of labor. The two types of labor are again labeled type  $s$  and type  $u$ , and the supplies of these two types of labor are again exogenous at levels denoted by  $n_j^s$  and  $n_j^u$  respectively. What's different about this model is that now four goods are produced. The four goods will be labeled as Good  $ik$  for  $i = s, u$  and  $k = t, n$ . Good  $st$  is a traded manufacture good produced with type  $s$  labor (e.g., equipment), Good  $sn$  is a non-traded service good produced with type  $s$  labor (e.g., professional services), Good  $ut$  is a traded manufacture good produced with type  $u$  labor (e.g., textiles or assembly), and Good  $un$  is a non-traded service good produced with type  $u$  labor (e.g., fast food). Along the lines of the benchmark model, Good  $st$  is an intermediate input into the production of the other goods (as well as itself).

Production of Good  $ik$  in Country  $j$  is given by the production function

$$F_j^{ik}(n_j^{ik}, m_j^{ik}) = A_j^{ik} (n_j^{ik})^{1-\sigma^{ik}} (m_j^{ik})^{\sigma^{ik}}, \quad (53)$$

where  $0 < \sigma^{ik} < 1$ ,  $n_j^{ik}$  is the labor input that is appropriate for producing Good  $ik$ , and  $m_j^{ik}$  is an intermediate input (which is Good  $st$ ).

Each person is endowed with one unit of time, which they supply as either type  $s$  or type  $u$  labor, depending on their type. Labor of type  $i$  can be supplied to produce either Good  $it$  or Good  $in$ . Preferences for aggregate consumption for the population in Country  $j$  will be parameterized as

$$u_j(c_j^{st}, c_j^{sn}, c_j^{ut}, c_j^{un}) = \sum_{i,k} \alpha_j^{ik} \log(c_j^{ik}), \quad (54)$$

where  $\alpha_j^{ik} > 0$  and  $\sum_{i,k} \alpha_j^{ik} = 1$ .

As in the previous analysis, to derive various properties of the equilibrium it will be convenient to derive the conditions that a competitive equilibrium must satisfy.<sup>4</sup> Denote

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<sup>4</sup>The presence of non-traded goods does not complicate the equivalence between the competitive equilibrium and the socially optimum allocation. Beyond noting that the assumptions of Debreu are satisfied, perhaps the simplest way to see this is to re-interpret the world economy with non-traded goods and immobile labor as an integrated economy in where there are  $2(n+1)$  goods and  $2n$  different types of labor. Consumers of type  $j$  have preferences only for four of these goods (say, Goods 1, 2, 3 +  $2(j-1)$ , and 4 +  $2(j-1)$ ) and production of firms of type  $i$  in Country  $j$  is similarly defined over the appropriate labor type and a common intermediate input good. This setup, which is nothing but a re-labeling of the original problem, is then



final goods prices by  $p_j^{ik}$ . Let the traded Good  $st$  be the numeraire, so that  $p_j^{st} = 1$  for each Country  $j$ , and denote the worldwide price of the traded Good  $ut$  by  $p^{ut}$ , so that  $p_j^{ut} = p^{ut}$  for each Country  $j$ . As before, denote the wage rate paid to type  $i$  labor by  $w_j^i$ .

Firm profits in Sector  $ik$  for  $i = s, u$  and  $k = t, n$  are given by

$$\pi_j^{ik} = p_j^{ik} A_j^{ik} (n_j^{ik})^{1-\sigma^{ik}} (m_j^{ik})^{\sigma^{ik}} - w_j^i n_j^{ik} - m_j^{ik}. \quad (55)$$

Firms operate in a perfectly competitive environment to maximize profit given prices and wages. In an entirely standard way, profit maximization leads to the following conditions:

$$w_j^i \geq p_j^{ik} (1 - \sigma^{ik}) A_j^{ik} (m_j^{ik} / n_j^{ik})^{\sigma^{ik}} \quad \text{with equality if } n_j^{ik} > 0, \quad (56)$$

$$1 \geq p_j^{ik} \sigma^{ik} A_j^{ik} (m_j^{ik} / n_j^{ik})^{\sigma^{ik}-1} \quad \text{with equality if } n_j^{ik} > 0. \quad (57)$$

Consumers in country  $j$  choose consumption  $(c_j^{st}, c_j^{sn}, c_j^{ut}, c_j^{un})$  to solve the following problem:

$$\max \sum_{i,k} \alpha_j^{ik} \log(c_j^{ik}) \quad (58)$$

subject to:

$$\sum_{i,k} p_j^{ik} c_j^{ik} = W_j. \quad (59)$$

As before, the solution to the above problem is again given by the aggregate demand functions  $c_j^{ik} = \alpha_j^{ik} W_j / p_j^{ik}$ , where aggregate wealth for Country  $j$  is given by  $W_j = w_j^u n_j^u + w_j^s n_j^s$ .

The equilibrium conditions can be summarized by the following equations (for  $i = s, u$  and  $k = t, n$ ):

$$y_j^{ik} = (A_j^{ik})^{\frac{1}{1-\sigma^{ik}}} (\sigma^{ik} p_j^{ik})^{\frac{\sigma^{ik}}{1-\sigma^{ik}}} n_j^{ik}, \quad (60)$$

$$m_j^{ik} = (\sigma^{ik} p_j^{ik} A_j^{ik})^{\frac{1}{1-\sigma^{ik}}} n_j^{ik}, \quad (61)$$

$$n_j^i = n_j^{it} + n_j^{in}, \quad (62)$$

$$w_j^i \geq (1 - \sigma^{ik}) (\sigma^{ik})^{\frac{\sigma^{ik}}{1-\sigma^{ik}}} (p_j^{ik} A_j^{ik})^{\frac{1}{1-\sigma^{ik}}} \quad \text{with equality if } n_j^{ik} > 0, \quad (63)$$

$$W_j = w_j^u n_j^u + w_j^s n_j^s, \quad (64)$$

$$c_j^{ik} = \alpha_j^{ik} W_j / p_j^{ik}, \quad (65)$$

$$y_j^{in} = c_j^{in}, \quad (66)$$

$$\sum_{j=1}^n y_j^{ut} = \sum_{j=1}^n c_j^{ut}, \quad (67)$$

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an entirely standard one in which consumers have heterogeneous preferences defined over multiple goods produced with a concave technology. As before, there is sufficient structure on this problem to ensure that an efficient solution exists and that there exists only one such solution (for each choice of utility weights).

$$\sum_{j=1}^n y_j^{st} = \sum_{j=1}^n \sum_{i,k} m_j^{ik} + \sum_{j=1}^n c_j^{st}, \quad (68)$$

$$p_j^{st} = 1, \quad (69)$$

$$p_j^{ut} = p^{ut}. \quad (70)$$

As before, to derive various qualitative features of the equilibrium it will help to derive an excess supply function for Good  $ut$  from Country  $j$  as it depends on the price  $p^{ut}$ . This excess supply function will be defined such that along this curve the market for Goods  $sn$  and  $un$  (the service goods), as well as the labor market, clear. Since the price  $p^{ut}$  is constant across countries, it will turn out to be useful to represent this excess supply function in units of Good  $st$ . In particular, define the Good  $ut$  excess supply function from Country  $j$  as

$$Z_j = p^{ut}(y_j^{ut} - c_j^{ut}), \quad (71)$$

where, for a given  $p^{ut}$ , eqs. (60)-(66) and eqs. (69)-(70) hold. It will be shown below that this function is well defined. By Walras Law a price  $p^{ut}$  that clears the market for Good  $ut$  will also clear the market for Good  $st$ , and hence such a price will equilibrate the world economy.

Given  $p^{ut}$ , Country  $j$  will either produce Goods  $sn$ ,  $ut$ , and  $un$  (referred to as Region I), Goods  $st$ ,  $sn$ ,  $ut$ , and  $un$  (Region II), or Goods  $st$ ,  $sn$ , and  $un$  (Region III). That is, the country will always produce the non-traded service Goods  $sn$  and  $un$ , and it will either produce one or both of the traded manufacture goods. The Appendix contains a general treatment of this model, including a discussion of what determines in which region each country will locate. This section focuses only on Region II in which Country  $j$  chooses to produce some quantity of all four goods, as this would seem to be the most empirically relevant region.

Suppose Country  $j$  locates in Region II. Since Good  $ut$  is produced, the type  $u$  wage rate is given by eq. (63) with equality for  $ik = ut$  and  $p_j^{ut}$  replaced by  $p^{ut}$ :

$$w_j^u = (1 - \sigma^{ut})(\sigma^{ut})^{\frac{\sigma^{ut}}{1-\sigma^{ut}}} (p^{ut} A_j^{ut})^{\frac{1}{1-\sigma^{ut}}}. \quad (72)$$

Since Good  $st$  is produced, the skilled wage rate is given by eq. (63) with equality for  $ik = st$  and  $p_j^{st}$  replaced by 1:

$$w_j^s = (1 - \sigma^{st})(\sigma^{st})^{\frac{\sigma^{st}}{1-\sigma^{st}}} (A_j^{st})^{\frac{1}{1-\sigma^{st}}}. \quad (73)$$

Equation (64) determines  $W_j$ . Eqs. (60), (63), (65), and (66) for  $ik = sn$  yield the relation

$w_j^s n_j^{sn} = (1 - \sigma^{sn}) \alpha_j^{sn} W_j$ , from which we can derive:

$$n_j^{sn} = (1 - \sigma^{sn}) \alpha_j^{sn} \left( \frac{w_j^u}{w_j^s} n_j^u + n_j^s \right). \quad (74)$$

Since  $n_j^{st} = n_j^s - n_j^{sn}$ , it follows that:

$$n_j^{st} = (1 - (1 - \sigma^{sn}) \alpha_j^{sn}) n_j^s - (1 - \sigma^{sn}) \alpha_j^{sn} \frac{w_j^u}{w_j^s} n_j^u. \quad (75)$$

Eqs. (60), (63), (65), and (66) for  $ik = un$  yield the relation  $w_j^u n_j^{un} = (1 - \sigma^{un}) \alpha_j^{un} W_j$ , from which we can derive:

$$n_j^{un} = (1 - \sigma^{un}) \alpha_j^{un} \left( n_j^u + \frac{w_j^s}{w_j^u} n_j^s \right). \quad (76)$$

Since  $n_j^{ut} = n_j^u - n_j^{un}$ , it follows that:

$$n_j^{ut} = (1 - (1 - \sigma^{un}) \alpha_j^{un}) n_j^u - (1 - \sigma^{un}) \alpha_j^{un} \frac{w_j^s}{w_j^u} n_j^s. \quad (77)$$

Equation (63), along with either eq. (72) or (73), determines  $p_j^{sn}$  and  $p_j^{un}$  as

$$p_j^{sn} = \left( \frac{(1 - \sigma^{st})(\sigma^{st})^{\frac{\sigma^{st}}{1 - \sigma^{st}}} (A_j^{st})^{\frac{1}{1 - \sigma^{st}}}}{(1 - \sigma^{sn})(\sigma^{sn})^{\frac{\sigma^{sn}}{1 - \sigma^{sn}}} (A_j^{sn})^{\frac{1}{1 - \sigma^{sn}}}} \right)^{1 - \sigma^{sn}}, \quad (78)$$

$$p_j^{un} = \left( \frac{(1 - \sigma^{ut})(\sigma^{ut})^{\frac{\sigma^{ut}}{1 - \sigma^{ut}}} (A_j^{ut})^{\frac{1}{1 - \sigma^{ut}}}}{(1 - \sigma^{un})(\sigma^{un})^{\frac{\sigma^{un}}{1 - \sigma^{un}}} (A_j^{un})^{\frac{1}{1 - \sigma^{un}}}} \right)^{1 - \sigma^{un}} (p^{ut})^{\frac{1 - \sigma^{un}}{1 - \sigma^{ut}}}. \quad (79)$$

As before, eqs. (60) and (61) determine  $y_j^{ik}$  and  $m_j^{ik}$ . For a given  $p^{ut}$ , the equations just derived completely determine a country's resource allocation and non-traded goods prices in Region II.

Let's now re-write the Good  $ut$  excess supply function in this region. Note that  $w_j^u n_j^{ut} = w_j^u n_j^u - (1 - \sigma^{un}) \alpha_j^{un} W_j$ , so

$$Z_j = \frac{(1 - (1 - \sigma^{ut}) \alpha_j^{ut} - (1 - \sigma^{un}) \alpha_j^{un}) w_j^u n_j^u - ((1 - \sigma^{ut}) \alpha_j^{ut} + (1 - \sigma^{un}) \alpha_j^{un}) w_j^s n_j^s}{1 - \sigma^{ut}} \quad (80)$$

Since a rise in  $p^{ut}$  leads to a rise in  $w_j^u$  and no change in  $w_j^s$ , it follows that the Good  $ut$  excess supply function is a continuous, strictly-increasing function of  $p^{ut}$  in Region II.

As shown in the Appendix, there exists prices  $p_j^{utL}$  and  $p_j^{utH}$ , with  $p_j^{utL} < p_j^{utH}$ , such that if  $p^{ut} < p_j^{utL}$  then Country  $j$  will locate in Region III, if  $p_j^{utL} < p^{ut} < p_j^{utH}$  then Country

$j$  will locate in Region II, and if  $p^{ut} > p_j^{utH}$  then Country  $j$  will locate in Region I. These prices are:

$$p_j^{utH} = \left( \frac{1 - (1 - \sigma^{sn})\alpha_j^{sn}}{(1 - \sigma^{sn})\alpha_j^{sn}} \frac{(1 - \sigma^{st})(\sigma^{st})^{\frac{\sigma^{st}}{1 - \sigma^{st}}} (A_j^{st})^{\frac{1}{1 - \sigma^{st}}} n_j^s}{(1 - \sigma^{ut})(\sigma^{ut})^{\frac{\sigma^{ut}}{1 - \sigma^{ut}}} (A_j^{ut})^{\frac{1}{1 - \sigma^{ut}}} n_j^u} \right)^{1 - \sigma^{ut}} \quad (81)$$

$$p_j^{utL} = \left( \frac{(1 - \sigma^{un})\alpha_j^{un}}{1 - (1 - \sigma^{un})\alpha_j^{un}} \frac{(1 - \sigma^{st})(\sigma^{st})^{\frac{\sigma^{st}}{1 - \sigma^{st}}} (A_j^{st})^{\frac{1}{1 - \sigma^{st}}} n_j^s}{(1 - \sigma^{ut})(\sigma^{ut})^{\frac{\sigma^{ut}}{1 - \sigma^{ut}}} (A_j^{ut})^{\frac{1}{1 - \sigma^{ut}}} n_j^u} \right)^{1 - \sigma^{ut}} \quad (82)$$

The Appendix also shows that the worldwide Good  $ut$  excess supply function  $Z$  is an increasing function of  $p^{ut}$  and that there exists a unique price  $p^{ut}$  that equilibrates the world economy.

### 3.2.2 Some Qualitative Properties

This model generates predictions regarding the pattern of trade and production, the determination of wages, and the allocation of labor within and between the manufacture and service sectors. As above, this section focuses on Region II and leaves for the Appendix a consideration of Regions I and III.

The pattern of trade for Country  $j$  depends on the value of  $p^{ut}$  relative to that country's productivity in producing various goods and its endowment of various labor types. Specifically, the pattern of trade for Country  $j$  can be derived from eq. (80) along with the determination of wage rates as given by eqs. (72) and (73). A country will import Good  $ut$  if  $p^{ut} < \bar{p}_j^{ut}$ , where  $\bar{p}_j^{ut}$  is given by

$$\bar{p}_j^{ut} = \left( \frac{(1 - \sigma^{ut})\alpha_j^{ut} + (1 - \sigma^{un})\alpha_j^{un}}{1 - (1 - \sigma^{ut})\alpha_j^{ut} - (1 - \sigma^{un})\alpha_j^{un}} \frac{(1 - \sigma^{st})(\sigma^{st})^{\frac{\sigma^{st}}{1 - \sigma^{st}}} (A_j^{st})^{\frac{1}{1 - \sigma^{st}}} n_j^s}{(1 - \sigma^{ut})(\sigma^{ut})^{\frac{\sigma^{ut}}{1 - \sigma^{ut}}} (A_j^{ut})^{\frac{1}{1 - \sigma^{ut}}} n_j^u} \right)^{1 - \sigma^{ut}}. \quad (83)$$

Similarly, a country will export Good  $ut$  if  $p^{ut} > \bar{p}_j^{ut}$ . We can now derive the following result: a country with relatively high productivity ratio  $(A_j^{ut})^{\frac{1}{1 - \sigma^{ut}}} / (A_j^{st})^{\frac{1}{1 - \sigma^{st}}}$ , or a country with a relatively high fraction of type  $s$  labor, will tend to import the manufacture good produced with type  $u$  labor and export the manufacture good produced with type  $s$  labor. These results are in line with standard predictions based on comparative advantage.

This model also has rather standard predictions regarding the determination of wages: For a fixed  $p^{ut}$ , a rise in  $A_j^{st}$  will raise  $w_j^s$  and a rise in  $A_j^{ut}$  or a rise in  $p^{ut}$  will raise  $w_j^u$ . A rise in  $A_j^{sn}$  or  $A_j^{un}$  will not affect wages in units of Good  $st$ . These results are straightforward to establish.

Any shock that shifts up the Good  $ut$  world excess supply curve will lead to a lower price  $p^{ut}$ . This is, of course, the channel by which an emerging giant affects other countries. The following result follows trivially from how  $Z_j$  depends on wages and labor supplies in eq. (80): a rise in the productivity of producing Good  $ut$ , or a rise in the supply of type  $u$  labor, will lower  $p^{ut}$  in equilibrium; a rise in the productivity of producing Good  $st$ , or a rise in the supply of type  $s$  labor, will raise  $p^{ut}$  in equilibrium. As before, for an emerging giant with a large  $n_j^u$  relative to the rest of the world and a very small  $n_j^s/n_j^u$ , a rise in both  $A_j^{ut}$  and  $A_j^{st}$  would tend to be associated with a fall in  $p^{ut}$ . Note that a rise in  $p^{ut}$  will lead to a rise in the terms of trade for all countries that export Good  $ut$  and will lead to a fall in the terms of trade for all countries that import Good  $ut$ .

The behavior of employment within the manufacture sector is also fairly straightforward to derive. Essentially, as derived from eqs. (72)-(77), due either to a rise in  $p^{ut}$  or a rise in  $(A_j^{ut})^{\frac{1}{1-\sigma^{ut}}}/(A_j^{st})^{\frac{1}{1-\sigma^{st}}}$ , type  $u$  labor shifts towards producing Good  $ut$  and away from producing Good  $un$  (out of service and into manufacturing). Consequently, more of Good  $ut$  is exported (or less is imported) and hence, to balance out trade, more of Good  $st$  is imported (or less is exported). There must thus be a corresponding shift of type  $s$  labor away from producing Good  $st$  and towards producing Good  $sn$  (out of manufacturing and into service). In summary, a rise in the relative value or relative productivity of producing Good  $ut$  will lead to an allocation of employment towards the production of this set of manufacture goods and away from the set of manufacture Goods  $st$  whose relative price has fallen.

A central reason for developing this extension of the model is to study its predictions regarding the allocation of labor between the manufacture and service sectors, which are: for a sufficiently high fraction of type  $u$  workers (to be made precise below), a rise in  $(A_j^{st})^{\frac{1}{1-\sigma^{st}}}/(A_j^{ut})^{\frac{1}{1-\sigma^{ut}}}$  for a fixed  $p^{ut}$ , or a fall in  $p^{ut}$ , will lead on average to a rise in service sector employment relative to manufacture sector employment. To derive this result, first note that the fraction of service sector employment is given by

$$\frac{n_j^{sn} + n_j^{un}}{n_j}, \quad (84)$$

where  $n_j = n_j^s + n_j^u$  equals total employment. What will first be shown is that the fraction of service sector employment on average rises as  $p^{ut}$  falls. Recall, first, that the boundary between Regions I and II is associated with a higher value of  $p^{ut}$  than that for the boundary between Regions II and III. What will be shown is that the fraction of service sector employment is lower at the boundary between Regions I and II than at the boundary between Regions II and III. To see this, use eqs. (72)-(77) as well as eqs. (81)-(82) to show that on

the boundary between Regions I and II:

$$\left(\frac{n_j^{sn} + n_j^{un}}{n_j}\right)_{I-II} = \frac{n_j^s}{n_j} + \frac{(1 - \sigma^{un})\alpha_j^{un}}{1 - (1 - \sigma^{sn})\alpha_j^{sn}} \frac{n_j^u}{n_j}, \quad (85)$$

and on the boundary between Regions II and III:

$$\left(\frac{n_j^{sn} + n_j^{un}}{n_j}\right)_{II-III} = \frac{(1 - \sigma^{sn})\alpha_j^{sn}}{1 - (1 - \sigma^{un})\alpha_j^{un}} \frac{n_j^s}{n_j} + \frac{n_j^u}{n_j}. \quad (86)$$

From these results it follows that service sector employment is lower on the boundary between Regions I and II than between Regions II and III if:

$$\frac{n_j^s}{n_j^u} \leq \frac{1 - (1 - \sigma^{un})\alpha^{un}}{1 - (1 - \sigma^{sn})\alpha^{sn}}. \quad (87)$$

Hence, as long as the relative supply of type  $u$  workers is sufficiently high, a rise in  $p^{ut}$  will tend to lower the fraction of workers in the service sector. Evidently, if type  $u$  labor is large relative to type  $s$  labor, then the shift in type  $u$  labor out of producing service goods and into producing manufacture goods will dominate the effect on overall employment.

Under a stronger set of conditions it can be shown that the fraction of service sector employment rises as  $p^{ut}$  falls, not just on average but for every value of  $p^{ut}$ . Since  $w_j^u/w_j^s$  depends positively on  $p^{ut}$  it suffices to establish conditions for which

$$\frac{d(n_j^{sn} + n_j^{un})/n_j}{d(w_j^u/w_j^s)} \leq 0. \quad (88)$$

From eqs. (74) and (76) it follows that

$$\frac{d(n_j^{sn} + n_j^{un})/n_j}{d(w_j^u/w_j^s)} = \frac{(1 - \sigma^{sn})\alpha^{sn}n_j^u}{n_j} - \frac{(1 - \sigma^{un})\alpha^{un}n_j^s}{(w_j^u/w_j^s)^2 n_j}, \quad (89)$$

hence the above inequality holds as long as

$$\left(\frac{w_j^u}{w_j^s}\right)^2 \leq \frac{(1 - \sigma^{un})\alpha^{un}}{(1 - \sigma^{sn})\alpha^{sn}} \frac{n_j^s}{n_j^u}. \quad (90)$$

Note that within Region II this wage ratio will be highest at the boundary between Regions I and II, and it is straightforward to show that the value at this boundary is given by

$$\left(\frac{w_j^u}{w_j^s}\right)_{I-II} = \frac{1 - (1 - \sigma^{sn})\alpha^{sn}}{(1 - \sigma^{sn})\alpha^{sn}} \frac{n_j^s}{n_j^u}. \quad (91)$$

Hence, the appropriate condition is given by

$$\left( \frac{1 - (1 - \sigma^{sn})\alpha^{sn}}{(1 - \sigma^{sn})\alpha^{sn}} \frac{n_j^s}{n_j^u} \right)^2 \leq \frac{(1 - \sigma^{un})\alpha^{un}}{(1 - \sigma^{sn})\alpha^{sn}} \frac{n_j^s}{n_j^u}, \quad (92)$$

which can be rewritten as

$$\frac{n_j^s}{n_j^u} \leq \frac{1 - (1 - \sigma^{un})\alpha^{un}}{1 - (1 - \sigma^{sn})\alpha^{sn}} \frac{(1 - \sigma^{un})\alpha^{un}(1 - \sigma^{sn})\alpha^{sn}}{1 - (1 - \sigma^{un})\alpha^{un} - (1 - \sigma^{sn})\alpha^{sn} + (1 - \sigma^{un})\alpha^{un}(1 - \sigma^{sn})\alpha^{sn}}. \quad (93)$$

Since the last ratio is less than one, this inequality is tighter than that given by eq. (87).

Using the results just established, it is also straightforward to derive the dependence of the fraction of service sector employment on productivity. For a fixed  $p^{ut}$ , a country is at the boundary between Regions I and II for a low level of  $(A_j^{st})^{\frac{1}{1-\sigma^{st}}}/(A_j^{ut})^{\frac{1}{1-\sigma^{ut}}}$ , and is at the boundary between Regions II and III for a high level of  $(A_j^{st})^{\frac{1}{1-\sigma^{st}}}/(A_j^{ut})^{\frac{1}{1-\sigma^{ut}}}$  (see eqs. (81)-(82)). Hence, in this sense a fall in  $(A_j^{st})^{\frac{1}{1-\sigma^{st}}}/(A_j^{ut})^{\frac{1}{1-\sigma^{ut}}}$  will lead to a fall in service sector employment. The explanation is the same as for the the rise in  $p^{ut}$  as both lead to a shift of employment towards Good  $ut$  and away from Good  $st$ .

The principal purpose of developing this extension of the model is to consider how employment in various sectors responds to an emerging giant, which is an issue that we just examined. The model will have implications for aggregate growth as well, so it will be important to see if this extension reinforces our understanding of the growth implications of an emerging giant, or if this extension broadens the set of possibilities. It turns out to largely reinforce our understanding, so in this sense the main result will be that the implications for growth developed in the previous section seem robust to at least this extension. To see this connection it will help to simplify the analysis and impose the restriction that  $\sigma^{ut} = \sigma^{un}$ . With this restriction, a reallocation of labor between Goods  $ut$  and  $un$  for fixed prices, along with an optimal reallocation of intermediate inputs, will not change aggregate real-value added. In terms of the effect on aggregate real-value added from a change in  $p^{ut}$ , the main result of this section can be summarized as follows: if Good  $ut$  is produced and if  $\sigma^{ut} = \sigma^{un}$ , for fixed levels of productivity a rise in  $p^{ut}$  leads to a rise in aggregate real-value added measured in base year prices. To prove this result, note that the value added in units of Good  $st$  from producing good  $ik$  is again given by:

$$w_j^{ik} n_j^{ik} = p_j^{ik} y_j^{ik} - m_j^{ik}. \quad (94)$$

Hence, aggregate real-value added using base year prices denoted by  $p_j^{ikb}$  can be written as:

$$W_j^b = p^{utb} \frac{w_j^u n_j^{ut}}{p^{ut}} + p_j^{unb} \frac{w_j^u n_j^{un}}{p_j^{un}} + w_j^s n_j^{st} + p_j^{snb} \frac{w_j^s n_j^{sn}}{p_j^{sn}}. \quad (95)$$

Consider, now, a rise in  $p^{ut}$  keeping levels of productivity constant at the base year levels. If  $\sigma^{ut} = \sigma^{un}$  then  $p^{utb}/p^{ut} = p_j^{unb}/p_j^{un}$ , so the sum of the first two terms can be written as

$$p^{utb} \frac{w_j^u n_j^{ut}}{p^{ut}} + p_j^{unb} \frac{w_j^u n_j^{un}}{p_j^{un}} = p^{utb} (1 - \sigma^{ut}) (\sigma^{ut})^{\frac{\sigma^{ut}}{1-\sigma^{ut}}} (A_j^{ut})^{\frac{1}{1-\sigma^{ut}}} (p^{ut})^{\frac{\sigma^{ut}}{1-\sigma^{ut}}} n_j^u. \quad (96)$$

This term rises as  $p^{ut}$  rises. Consider now the second two terms. In Region II  $p_j^{snb}/p_j^{sn} = 1$ , so

$$w_j^s n_j^{st} + p_j^{snb} \frac{w_j^s n_j^{sn}}{p_j^{sn}} = w_j^s n_j^s. \quad (97)$$

Since  $w_j^s$  is unaffected by  $p^{ut}$  in Region II, this term is unaffected by  $p^{ut}$ . Hence the result follows that if Good  $ut$  is produced and if  $\sigma^{ut} = \sigma^{un}$ , then a rise in  $p^{ut}$  leads to a rise in aggregate real-value added.

Note that the elasticity of aggregate real-value added with respect to  $p^{ut}$  is given by

$$\frac{p^{ut}}{W_j^b} \frac{dW_j^b}{dp^{ut}} = \frac{\sigma^u}{1 - \sigma^u} \frac{w_j^u n_j^u}{W_j}. \quad (98)$$

This is the same expression as in the base model (recall that all goods were traded in the base model). The reason is that, since labor of each type can freely shift between the traded and non-traded sectors, and hence wages are equalized across these sectors for each labor type, for every change in  $p^{ut}$  there is a proportional change in  $p^{un}$ . So, all of labor of type  $u$  is affected, either directly or indirectly, by a fall in  $p^{ut}$  due, say, to the emergence of a giant economy.

In terms of the effect on welfare, the previous discussion on this issue carries over to this model as well: if Good  $ut$  is imported, a rise in  $p^{ut}$  leads to a fall in welfare; conversely, if Good  $ut$  is exported, a rise in  $p^{ut}$  leads to a rise in welfare. As before, the sign of the effect on welfare is the same as the sign of the effect on the terms of trade.

## 4 Understanding Some Data During China's Emergence

Do the models just developed help explain how the world seems to accommodate emerging giants? This section summarizes various empirical facts for China and the following eleven countries (or regions), mostly in East and South East Asia, during the time that China began emerging: Japan, Hong Kong, Singapore, South Korea, Malaysia, Thailand, Philippines,



Indonesia, Australia, India,<sup>5</sup> and Taiwan (other countries in East and South East Asia were not included due to data availability problems). As a group these eleven countries will be referred to as the E&SEAsia countries. Due to their proximity to China one would expect them to be most affected by China's emergence, and due to their diverse stages of development they should allow for a good test of the model's predictions. The models just developed provide a clear sense of what to look for in the data regarding the effects of an emerging giant, as well as how to interpret these observations.

Figure 1 graphs China's labor productivity in secondary industry<sup>6</sup> from 1970 until 2003 and China's share of world exports. Labor productivity is simply real-value added in secondary industry divided by the number of employees in secondary industry, both obtained from the China Statistical Yearbook. Data on exports from China as well as the world were taken from WDI-Online. Based on Fig. 1 it seems that in the late 1980s/early 1990s China accelerated its growth of labor productivity, which is also reflected in an acceleration of its rising world export share beginning around that time.

Documenting the extent to which the emergence of China may have affected the world price of some goods requires the construction of world prices. Using Alessandro and Olarreaga's Trade, Production, and Protection Database, which reports the value (in US dollars) and quantity of exports at the three digit ISIC level<sup>7</sup> from all countries, the world price of each good was constructed by dividing the sum of each country's value of exports of a particular good by the sum of each country's quantity of exports of the same good;<sup>8</sup> for each good this price series was normalized to one in 1990. All goods were then separated into one of two subsets. One subset, labeled "China High-Growth Export Goods," or CHEG for short, are those goods for which China's world export share rose by more than 7 percent from 1990 to 2003 (with this cutoff, half of all goods are CHEG goods). The other set is the complement of this set. Table 1 lists all the goods along with China's world export share in 1990 and 2003; note that goods labeled "Glass and products" and above are CHEG goods. The world price of CHEG goods is the chain-weighted price index of goods in the CHEG

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<sup>5</sup>India itself is an emerging giant economy, so the model developed in this paper could be applied to India as well.

<sup>6</sup>Secondary industry is manufacturing plus construction. I would rather have reported data on only manufacturing, which is the source of most exports, but the Chinese Statistical Yearbook did not separate out construction from manufacturing for both real-value added and employment.

<sup>7</sup>More disaggregated data is available directly from the United Nations Commodity Trade Statistics Database, but it is difficult to obtain related production data at a finer level of disaggregation.

<sup>8</sup>Mirrored export data was used.

set divided by the chain-weighted price index of goods not in CHEG. In constructing the chain-weighted indices, the real value of exports was constructed as the dollar value divided by the world prices computed as described above. The log of this time series is graphed in Fig. 2 with the label World Price CHEG. As can be seen from Fig. 2, the relative world price of goods that China exports (in the sense above) fell dramatically beginning in the late 1980s. Fig. 2 also graphs the chain-weighted quantity index of CHEG goods relative to the chain-weighted quantity index of non-CHEG goods. The negative association between the price and quantity indices (the correlation is  $-.31$ ) suggests that the relative quantity of CHEG goods is a key supply-driven determinant of World Price CHEG.

To provide evidence that China is a key driver for the rise in quantity that is associated with a fall in World Price CHEG from the late 1980s to early 2000s, Fig. 3 graphs the chain-weighted quantity index excluding China. Comparing Figs. 2 and 3 reveals that the entire increase in relative supply of CHEG goods during this period was due to the emergence of China. Fig. 3 also graphs China's contribution to the world relative supply of CHEG goods, which is measured as simply the world relative supply of CHEG goods minus (in logs) the world relative supply of CHEG goods excluding China. Here we see the dramatic rise in China's relative supply of CHEG goods. Figs. 2 and 3 taken together provide a clear picture that China's emergence is associated with a rise in the world quantity and a fall in the world price of goods that China exports to the rest of the world.

Table 2 reports results from regressing a Country's real per-capita GDP on World Price CHEG (in logs), as well as a linear time trend. Real per-capita GDP was taken from the Heston, Summers, and Aten's Penn World Tables (PWT).<sup>9</sup> Recall that the model is consistent with either a positive, zero, or negative dependence of a country's real per-capita GDP on World Price CHEG. Rather, the model predicts that this elasticity should be positively related to the share of wages in producing CHEG goods. Table 2 also reports the wage bill in producing CHEG as a fraction of the total wage bill in producing all manufacture goods (for 1990).<sup>10</sup> The wage bill in producing CHEG goods was constructed by summing the wage bill (as reported in Trade, Production, and Protection Database) for each CHEG industry,

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<sup>9</sup>Throughout this paper real per-capita GDP corresponds to the constant-price chain-weighted series.

<sup>10</sup>It is important to note that the model with non-traded goods suggests that the GDP elasticity with respect World Price CHEG is related to the share of the total wage bill of the wage bill in producing CHEG goods plus the wage bill in producing all non-traded goods that require similar type labor. This data is not readily available. The two approaches are the same under the assumption that the ratio of various types of labor in producing the two types of manufacture goods equal the ratio of various types of labor in producing the two types of service goods.

and dividing it by the entire wage bill for all manufacturing industries. The relationship between the GDP elasticity and this wage share is depicted in Fig. 4. This relationship is very much in line with the predictions of the model (except for Indonesia, which seems to be an outlier). As the wage share in CHEG rises, so too does the dependence of a country's real per-capita GDP on World Price CHEG.

Table 3, panel A reports results from regressing the estimated elasticity of a country's real per-capita GDP with respect to World Price CHEG on that country's wage share in CHEG (the regression line for Fig. 4.). As derived from Table 3A, amongst the set of E&SEAsia countries, a country's real per-capita GDP falls in response to a fall in World Price CHEG only if it has a wage share in CHEG that is more than .54 (which equals  $3.77/7.02$ ). Table 3, panel B, reports similar regression results, but based on all countries in the Trade, Production, and Protection dataset (74 countries). Here as well the elasticity of real GDP on World Price CHEG is estimated to depend positively on the wage share in producing CHEG goods. Here, though, given the further distance from China, this dependence is somewhat lower. Based on these results a country's real GDP falls in response to a fall in World Price CHEG only if it has a wage share in CHEG that is more than .63 (which equals  $2.10/3.32$ ). In the United States the wage share is .53 and its GDP elasticity with respect to World Price CHEG is estimated to be .01, both of which suggest that in terms of aggregate growth the positive and negative effects of China's emergence just about cancel out.

The relationship between the regression coefficients in Table 3 and the structural parameters in the model is given in eq. (52). Since there are more structural parameters in eq. (52) than regression coefficients, it is not possible to infer the value of the structural parameters from the regression results alone. It is insightful, though, to check how close a reasonably calibrated model matches these regression coefficient estimates. Performing this exercise requires estimates of  $\gamma^s$ ,  $\gamma^u$ ,  $\sigma^s$ , and  $\sigma^u$ . Consider parameter values such that  $\gamma^s = 0$  and  $\gamma^u = 1$ . That is, the input-output structure is such that only Good  $u$  goods are used as intermediate inputs to produce Good  $s$  goods, and only Good  $s$  goods are used as intermediate inputs to produce Good  $u$  goods. Regarding  $\sigma^s$  and  $\sigma^u$ , assume that  $\sigma^s = \sigma^u$ , so that the share of production accounted for by intermediate inputs is the same for both types of goods. Under these assumptions it is possible to infer regression coefficients using aggregate data on the value of intermediate inputs as a share of gross output. In the U.S., for the manufacturing industry this share has been reasonably stable at roughly 66 percent

from 1987 to 2005.<sup>11</sup> Using these estimates, the intercept should be -1.94 (in Table 3, panel A it is -3.77 and in panel B it is -2.10) and the slope should be 3.88 (in Table 3, panel A it is 7.02 and in panel B it is 3.32). Although the implied coefficients based on calibrated parameter values are a bit closer to zero than those in panel A, they seem reasonably close to those in panel B.

Figure 5 compares the model's predictions regarding how growth in the E&SEAsian countries were affected by the emergence of China to the actual growth experience of these countries during the emergence of China. The actual growth experience is summarized by comparing the level of real per-capita GDP in 2003 to the level of real per-capita GDP predicted in 2003 based on a linear time trend fitted to the log of per-capita GDP using data from 1976 to 1990. To compute the model's prediction regarding this growth experience, the following steps were taken. First, the difference was computed between the World Price CHEG in 2003 and the value predicted based on a linear time trend fitted to the log of World Price CHEG from 1976 to 1990. The log difference was computed to be -.23. Next, each country's Wage Share CHEG was then used as the explanatory variable in the regression equation reported in Table 3, panel A. Figure 5 compares the relationship between this model prediction and Wage Share CHEG to the relationship between the actual growth experience (as summarized above) and Wage Share CHEG. For instance, real per capita GDP in Hong Kong is about 50 percent below trend (computed as 100 times the difference in logs) in 2003, and this is almost exactly what is predicted based on the regression motivated by the model. As exhibited in Fig. 5, the model seems to do a remarkable job of accounting for the various growth experiences of the E&SEAsian countries following 1990.

Figures 6 and 7 report how employment has shifted during the time that China began to emerge. Fig. 6 is based on the deviation from a linear trend of the log of the ratio of employment in the CHEG industries to the non-CHEG industries (but still manufacture goods). Fig. 6 averages this de-trended series across the E&SEAsia countries listed above (excluding Thailand and the Philippines due to data availability problems). This figure clearly shows a fall in employment in the CHEG industries following the late 1980s. Fig. 7 is based on the deviation from a linear trend of the log of the ratio of employment overall in industry to that in the service sector. Here the data is obtained from WDI Online. As before, Fig. 7 averages this de-trended series across the E&SEAsia countries listed above (excluding Indonesia and Taiwan due to data availability problems). This figure clearly shows a fall in

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<sup>11</sup>Source: U.S. Bureau of Economic Analysis Gross-Domestic-Product-by-Industry Accounts.

employment in industry relative to that in the service sector. The fall in employment in the CHEG industries and the fall in employment overall in manufacturing are both consistent with the predictions of the model.

As a final issue, Fig. 5 suggests that the emergence of China may have played a significant role in Japan's growth slowdown beginning in the early 1990s. It seems reasonable to question if China competes with Japan to a degree that is sufficient to cause such a significant growth slowdown. Japan has established various brands that are well recognized around the world, such as Sony, Toyota, and Honda. China has not established a significant collection of brands that it markets to the rest of the world, so in this sense China does not compete with Japan. To explain the trends just documented, it seems more appropriate to envision that a larger and larger fraction of the value of goods sold around the world is made of parts made in China, and that these parts were previously made in Japan. Indeed, some of these goods are likely sold under Japanese brands. This is the type of competition guiding the allocation of resources that has been modeled in this paper. As an example, as shown in Table 4, in 1990 Japan produced \$28,889 million (value-added in 1997 US dollars) of "Office and computing machinery," whereas China produced \$398 million.<sup>12</sup> By 2003 Japan's value added fell to \$13,136 million, whereas China's value-added rose to \$46,689 million. Japan's value added began at 73.66 times that of China in 1990 and ended up at .28 times that of China in 2003. Table 4 also shows similar trends for other manufacture goods, although the magnitudes are not as dramatic as for this example. To further document that China may be competing more and more with countries that are much richer than itself, Schott (2006) examined how similar the composition of China's exports are to those of other countries. In particular, he computed an OECD Export Similarity Index, which measures how similar the composition of a country's exports are to the composition of exports from the OECD countries. He has shown that prior to the 1980s China's exports were very dissimilar to those of the OECD countries, but by the early 2000s China's exports are among the most similar to the OECD countries of any non-OECD country.

## 5 Conclusions

To explain the data regarding how countries seem to accommodate an emerging giant, this paper develops a tractable model with the following features. An emerging giant by as-

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<sup>12</sup>Source: National Science Board. 2006. *Science and Engineering Indicators 2006*. Volume 2.

sumption is sufficiently large to either directly or indirectly change prices around the world. For rather obvious reasons, goods that the emerging giant produces in relative abundance, and thereby tends to export, become relatively cheaper. Such a change in relative prices leads some industries in other countries around the world to expand and others to contract, and this effect has important implications for the reallocation of resources across sectors and aggregate growth. In particular, the reallocation of resources is reflected in a shift of employment within the manufacture sector as well as between the manufacture and service sectors. The overall effect on growth depends on the mix of industries in which a country has invested. A country that is heavily invested in the production of goods whose price has fallen due to the emerging giant will tend to experience a growth slowdown, whereas a country that is heavily invested in goods whose production requires inputs whose price has fallen will tend to experience a growth acceleration. The contribution of this paper is to construct a tradeable, general equilibrium model in which all these effects operate simultaneously, and to compare the predictions of such a model to the data.

This view of the world seems to accord well with the data documented in this paper. During China's recent emergence prices tended to fall for the goods for which China's world export share rose the most. As a whole Japan, Hong Kong, Singapore, South Korea, Malaysia, Thailand, Philippines, Indonesia, Australia, India, and Taiwan reallocated employment away from producing manufacture goods for which China's world export share rose the most, and generally away from manufacture goods and towards service goods. Moreover, the models constructed in this paper predict that the elasticity of a country's real GDP on the world price of goods that China exports (the time series labeled World Price China High-Growth Export Goods that was constructed for this paper) is monotonically related to a country's wage share in producing goods that China exports. This relationship seems consistent with the data.

Although this paper focused on China as an important source of global shocks to world prices, it is quite consistent with this paper to think of China as representing one of many countries that altered world prices in the way that was documented here. Ideally, to test the full implications of the model developed in this paper, one would like to have data on supplies of labor of various types (and perhaps even to explain these different supplies) along with data on the productivity of producing various goods (and perhaps even to explain these different levels of productivity) for all countries around the world. However, as long as these events in most countries around the world are reasonably independent of those in China, then it would seem that the tests in this paper are both valid and in some sense a

tougher test by which to uncover the empirical significance of the mechanism highlighted in the model.

It is surely not the case that China will be the last emerging giant economy (and the emergence of China is likely to still persist for some time). Most of the world's population is poor and has yet to enjoy the benefits of industrialization. Policy reforms can lead to abrupt changes in economic conditions, which will likely have important consequences for other countries in the world. In this sense, the lessons learned by the experiences documented in this paper may be important for understanding an effect that has perhaps played a significant role in the development of some countries, and that has the potential to play an even greater role in shaping the world economy.

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## 7 Appendix: Additional Discussion of the Model with Non-Traded Goods

For the extension of the model with non-traded goods, this appendix discusses properties of Regions I and III (recall that Region II was dealt with in the text), characterizes the solution to the world equilibrium in which countries can be located in any of the three regions, and provides a general discussion of some qualitative properties of the model.

### 7.1 Discussion of Regions I and III and the Worldwide Equilibrium

#### 7.1.1 Region I: Country $j$ produces Goods $sn$ , $ut$ , and $un$

Suppose Country  $j$  locates in Region I. Since Good  $ut$  is produced, the unskilled wage rate is given by eq. (63) with equality for  $ik = ut$  and  $p_j^{ut}$  replaced by  $p^{ut}$ :

$$w_j^u = (1 - \sigma^{ut})(\sigma^{ut})^{\frac{\sigma^{ut}}{1-\sigma^{ut}}} (p^{ut} A_j^{ut})^{\frac{1}{1-\sigma^{ut}}}. \quad (99)$$

Since  $n_j^{sn} = n_j^s$  and  $n_j^{st} = 0$  (recall that Good  $st$  is not produced), it follows from eqs. (60), (63), (65) and (66) that the skilled wage rate is given by:

$$w_j^s = \frac{(1 - \sigma^{sn})\alpha_j^{sn}}{1 - (1 - \sigma^{sn})\alpha_j^{sn}} \frac{n_j^u}{n_j^s} w_j^u. \quad (100)$$

We have thereby determined  $w_j^u$  and  $w_j^s$ , and hence also  $W_j$ , which can be written as:

$$W_j = \frac{1}{1 - (1 - \sigma^{sn})\alpha_j^{sn}} w_j^u n_j^u. \quad (101)$$

Again using eqs. eqs. (60), (63), (65) and (66) for  $ik = un$ , it follows that  $n_j^{un}$  is determined by  $w_j^u n_j^{un} = (1 - \sigma^{un})\alpha_j^{un} W_j$ , or:

$$n_j^{un} = \frac{(1 - \sigma^{un})\alpha_j^{un}}{1 - (1 - \sigma^{sn})\alpha_j^{sn}} n_j^u. \quad (102)$$

This in turn determines  $n_j^{ut} = n_j^u - n_j^{un}$ , which can be written as:

$$n_j^{ut} = \frac{1 - (1 - \sigma^{sn})\alpha_j^{sn} - (1 - \sigma^{un})\alpha_j^{un}}{1 - (1 - \sigma^{sn})\alpha_j^{sn}} n_j^u. \quad (103)$$

The prices  $p_j^{sn}$  and  $p_j^{un}$  are given by

$$p_j^{sn} = \left( \frac{w_j^s}{(1 - \sigma_2)(\sigma^{sn})^{\frac{\sigma^{sn}}{1-\sigma^{sn}}} (A_j^{sn})^{\frac{1}{1-\sigma^{sn}}}} \right)^{1-\sigma^{sn}}, \quad (104)$$

$$p_j^{un} = \left( \frac{(1 - \sigma^{ut})(\sigma^{ut})^{\frac{\sigma^{ut}}{1 - \sigma^{ut}}} (A_j^{ut})^{\frac{1}{1 - \sigma^{ut}}}}{(1 - \sigma_4)(\sigma^{un})^{\frac{\sigma^{un}}{1 - \sigma^{un}}} (A_j^{un})^{\frac{1}{1 - \sigma^{un}}}} \right)^{1 - \sigma^{un}} (p^{ut})^{\frac{1 - \sigma^{un}}{1 - \sigma^{ut}}}. \quad (105)$$

The remaining variables  $m_j^{ik}$  and  $y_j^{ik}$  are determined in a straightforward manner from eqs. (60) and (61).

To re-write the Good  $ut$  excess supply function for Country  $j$  in a way that more readily reveals how it is affected by various exogenous forces, note first that

$$Z_j = \frac{w_j^u n_j^{ut}}{(1 - \sigma^{ut})} - \alpha_j^{ut} (w_j^u n_j^u + w_j^s n_j^s). \quad (106)$$

Using the results just derived, we can write this as:

$$Z_j = \frac{1 - (1 - \sigma^{sn})\alpha_j^{sn} - (1 - \sigma^{ut})\alpha_j^{ut} - (1 - \sigma^{un})\alpha_j^{un}}{(1 - \sigma^{ut})(1 - (1 - \sigma^{sn})\alpha_j^{sn})} w_j^u n_j^u. \quad (107)$$

Since  $\Sigma_{ik}(1 - \sigma^{ik})\alpha_j^{ik} \leq \max_i \{1 - \sigma^{ik}\} \Sigma_{ik} \alpha_j^{ik} < 1$ , it follows that the Good  $ut$  excess supply function in Region I is strictly positive. Recall that a rise in  $p^{ut}$  leads to a rise in  $w_j^u$ . Consequently, the Good  $ut$  excess supply function is a continuous, strictly-positive, and strictly-increasing function of  $p^{ut}$  in Region I.

### 7.1.2 Region III: Country $j$ produces Goods $st$ , $sn$ , and $un$

Suppose Country  $j$  locates in Region III. Since Good  $st$  is produced, the skilled wage rate is given eq. (73). Since  $n_j^{un} = n_j^u$  and  $n_j^{ut} = 0$  (recall that Good  $ut$  is not produced), it follows that the unskilled wage rate is given by:

$$w_j^u = \frac{(1 - \sigma^{un})\alpha_j^{un}}{1 - (1 - \sigma^{un})\alpha_j^{un}} \frac{n_j^s}{n_j^u} w_j^s. \quad (108)$$

We have thereby determined  $w_j^u$  and  $w_j^s$ , and hence also  $W_j$ , which can be written as:

$$W_j = \frac{1}{1 - (1 - \sigma^{un})\alpha_j^{un}} w_j^s n_j^s. \quad (109)$$

Since  $w_j^s n_j^{sn} = (1 - \sigma^{sn})\alpha_j^{sn} W_j$ , it follows that

$$n_j^{sn} = \frac{(1 - \sigma^{sn})\alpha_j^{sn}}{1 - (1 - \sigma^{un})\alpha_j^{un}} n_j^s. \quad (110)$$

This in turn determines  $n_j^{st} = n_j^s - n_j^{sn}$ , which can be written as:

$$n_j^{st} = \frac{1 - (1 - \sigma^{sn})\alpha_j^{sn} - (1 - \sigma^{un})\alpha_j^{un}}{1 - (1 - \sigma^{un})\alpha_j^{un}} n_j^s. \quad (111)$$

The price  $p_j^{sn}$  is given by eq. (78) and  $p_j^{un}$  is then given by

$$p_j^{un} = \left( \frac{w_j^u}{(1 - \sigma^{un})(\sigma^{un})^{\frac{\sigma^{un}}{1-\sigma^{un}}}(A_j^{un})^{\frac{1}{1-\sigma^{un}}}} \right)^{1-\sigma^{un}}. \quad (112)$$

The remaining variables  $m_j^{ik}$  and  $y_j^{ik}$  are again determined in a straightforward manner.

Since Good  $ut$  is not produced, the excess supply function is just the negative of consumption (recall, in units of Good  $st$ ), which is just  $Z_j = -\alpha_j^{ut}W_j$ . The Good  $ut$  excess supply function in Region III can thus be written as

$$Z_j = \frac{-\alpha_j^{ut}}{1 - (1 - \sigma^{un})\alpha_j^{un}} w_j^s n_j^s. \quad (113)$$

In this region production and income do not depend on  $p^{ut}$ , so the Good  $ut$  excess supply function is constant and negative in Region III (in units of Good  $ut$  this excess supply function is a strictly-increasing function of  $p^{ut}$ ).

### 7.1.3 Determination of Regions of Production

Here it will be determined in which region the economy will operate. Specifically, it will be shown that there exists a  $p_j^{utL}$  and  $p_j^{utH}$ , with  $p_j^{utL} < p_j^{utH}$ , such that if  $p^{ut} < p_j^{utL}$  then Country  $j$  will locate in Region III, if  $p_j^{utL} < p^{ut} < p_j^{utH}$  then Country  $j$  will locate in Region II, and if  $p^{ut} > p_j^{utH}$  then Country  $j$  will locate in Region I.

Consider, first, Region I. Recall that in Region I firms find it unprofitable to produce Good  $st$ . If  $p^{ut}$  is such that

$$w_j^s > (1 - \sigma^{st})(\sigma^{st})^{\frac{\sigma^{st}}{1-\sigma^{st}}}(A_j^{st})^{\frac{1}{1-\sigma^{st}}} \quad (114)$$

then the skilled wage rate is higher than the marginal productivity of labor in producing Good  $st$ , which is the manufacture good produced with skilled labor. Consequently, if the strict inequality (114) holds, then firms will choose to continue to not produce Good  $st$ . Recall that in Region I  $w_j^s$  is an increasing function of  $p^{ut}$ , so for some  $p_j^{utH}$  firms will choose to not produce Good  $st$  as long as  $p^{ut} > p_j^{utH}$ . To find  $p_j^{utH}$  note that it is such that when  $p^{ut} = p_j^{utH}$  then eq. (114) holds with equality, and all the other conditions in Region I hold. It is straightforward to show that such a  $p_j^{utH}$  is given by eq. (81). Note that this solution is nothing other than the solution for Region II, but where in addition there is just enough skilled labor to satisfy the demand for skilled labor stemming from the production of Good  $sn$  (the service good produced with skilled labor).

Similarly, in Region III firms will continue to not produce the unskilled manufacture good at a price  $p^{ut} < p_j^{utL}$  if  $p^{ut}$  is such that

$$w_j^u > (1 - \sigma^{ut})(\sigma^{ut})^{\frac{\sigma^{ut}}{1-\sigma^{ut}}}(p^{ut} A_j^{ut})^{\frac{1}{1-\sigma^{ut}}}. \quad (115)$$

It is straightforward to show that this inequality holds for any  $p^{ut} < p_j^{utL}$ , where  $p_j^{utL}$  is given by eq. (82). Note that this solution is nothing other than the solution for Region II, but where there is just enough unskilled labor to satisfy the demand for unskilled labor stemming from the production of Good  $un$  (the service good produced with unskilled labor).

In Region II all goods are produced and by construction no firm wishes to not produce any of the goods. Also, as just shown, if  $p_j^{utL} < p^{ut} < p_j^{utH}$ , then there will be sufficient labor to produce some of each of the four goods.

Lastly, though, it must be shown that  $p_j^{utL} < p_j^{utH}$ . By comparing eqs. (81) and (82), it follows that  $p_j^{utL} < p_j^{utH}$  if

$$\frac{(1 - \sigma^{un})\alpha_j^{un}}{1 - (1 - \sigma^{un})\alpha_j^{un}} < \frac{1 - (1 - \sigma^{sn})\alpha_j^{sn}}{(1 - \sigma^{sn})\alpha_j^{sn}}. \quad (116)$$

Cross multiplying we find that this inequality holds if

$$(1 - \sigma^{sn})\alpha_j^{sn} + (1 - \sigma^{un})\alpha_j^{un} < 1, \quad (117)$$

which follows from the assumptions on  $\sigma^{ik}$  and  $\alpha_j^{ik}$ .

#### 7.1.4 The Worldwide Equilibrium

From the results just proven it follows that the Good  $ut$  excess supply function for Country  $j$  is a continuous function that is constant and negative for  $p^{ut} \leq p_j^{utL}$  (Region III), a strictly-increasing function for  $p^{ut} \geq p_j^{utL}$  (Regions II and I), and strictly-positive for  $p^{ut} \geq p_j^{utH}$  (Region I). The worldwide Good  $ut$  excess supply function, defined as

$$Z = \sum_{j=1}^n Z_j, \quad (118)$$

is thus a continuous function that is negative and constant for  $p^{ut} \leq \min_j\{p_j^{utL}\}$ , a strictly-increasing function for  $p^{ut} \geq \min_j\{p_j^{utL}\}$ , and a strictly-positive function for  $p^{ut} \geq \max_j\{p_j^{utH}\}$ . The equilibrium price  $p^{ut}$  is one such that the Good  $ut$  worldwide excess supply function equals zero:

$$Z = 0. \quad (119)$$

The properties just established are sufficient to use monotonicity and continuity arguments to prove the existence of an equilibrium price  $p^{ut}$  that clears the market for Good  $ut$  (and by Walras Law the market for Good  $st$  as well). These properties are also sufficient to prove that this price is unique. The monotonicity properties just established will be useful in the next section for deriving various qualitative features of this example.

## 7.2 Qualitative Properties

This section studies the model's predictions regarding the pattern of trade and production, the determination of wages for unskilled and skilled labor, and the allocation of labor between manufacture and service employment.

### 7.2.1 The World Price $p^{ut}$

Any shock that shifts up the Good  $ut$  world excess supply curve will lead to a lower price  $p^{ut}$ . The results of this section can be summarized as

*Result 1: If a country produces Good  $ut$ , then a rise in the productivity of producing Good  $ut$ , or a rise in the supply of type  $u$  labor, will lower  $p^{ut}$  in equilibrium. If a country produces Good  $st$ , then a rise in the productivity of producing Good  $st$ , or a rise in the supply of type  $s$  labor, will raise  $p^{ut}$  in equilibrium.*

These results follow trivially from how  $Z_j$  depends on wages and labor supplies in eqs. (80), (107), and (113).

### 7.2.2 Wages and the Allocation of Labor

This model has interesting predictions regarding wages and the allocation of labor between the manufacture and service sectors. These results were already derived for Region II, and since they are straightforward to derive for Regions I and III they will be stated here without derivation.

The results for the effect on wages can be summarized as follows:

*Result 2a: For a fixed  $p^{ut}$ , if Country  $j$  produces Good  $st$ , then a rise in  $A_j^{st}$  will raise the  $w_j^s$ , and it will also raise  $w_j^u$  if Good  $ut$  is not produced. If Country  $j$  produces Good  $ut$ , then a rise in  $A_j^{ut}$  or a rise in  $p^{ut}$  will raise  $w_j^u$ , and will also raise  $w_j^s$  if Good  $st$  is not produced. A rise in  $A_j^{sn}$  or  $A_j^{un}$  will not affect wages in units of Good  $st$ .*

The results for the effect on the allocation of labor between service and manufacture employment can be summarized as follows:

*Result 2b: For a sufficiently high fraction of type  $u$  (e.g., eq. (87) holds), the following statements are true. A rise in  $A_j^{st}$  will have no effect on the allocation of labor in Region I, will lead on average to a rise in service sector employment in Region II, and will have no effect on the allocation of labor in Region III. A rise in  $A_j^{ut}$ , as well as a rise in  $p^{ut}$ , has no effect on the allocation of labor in Region I, on average leads to a fall in service sector employment in Region II, and has no effect on the allocation of employment in Region III.*



### 7.2.3 Aggregate Output and Welfare

In terms of the effect on aggregate real-value added, the main result of this section can be summarized as:

*Result 3: If Good  $ut$  is produced and if  $\sigma^{ut} = \sigma^{un}$ , for fixed levels of productivity a rise in  $p^{ut}$  leads to a rise in aggregate real-value added measured in base year prices.*

As before, aggregate real-value added is given by eq. (95). Consider, now, a rise in  $p^{ut}$  keeping levels of productivity constant at the base year levels. Region II was already considered and since Good  $ut$  is not produced in Region III, only Region I needs to be considered here. In Region I, if  $\sigma^{ut} = \sigma^{un}$  then the sum of the first two terms in eq. (95) is again given by eq (96), which rises as  $p^{ut}$  rises. Consider now the second two terms in eq. (95). In Region I  $n_j^{st} = 0$  and

$$p_j^{utb} \frac{w_j^s n_j^{sn}}{p_j^{sn}} = (p^{utb})^{\frac{1-\sigma^{sn}}{1-\sigma^{ut}}} (1 - \sigma^{ut}) (\sigma^{ut})^{\frac{\sigma^{ut}}{1-\sigma^{ut}}} (A_j^{ut})^{\frac{1}{1-\sigma^{ut}}} \frac{(1 - \sigma^{sn}) \alpha_j^{sn}}{1 - (1 - \sigma^{sn}) \alpha_j^{sn}} (p^{ut})^{\frac{\sigma^{sn}}{1-\sigma^{ut}}} n_j^u. \quad (120)$$

This term rises as  $p^{ut}$  does. Hence the result follows. As before, the sign of the effect on welfare due to a change in  $p^{ut}$  is given by the sign of the effect on the terms of trade.

Table 1: China's World Export Share of 3 Digit ISIC Goods

Description	1990 World Export Share	2003 World Export Share	Change World Export Share
Footwear except rubber or plastic	9.46	42.71	33.25
Leather products	14.05	36.44	22.39
Furniture except metal	2.47	23.56	21.08
Pottery china earthenware	9.43	29.46	20.02
Other manufactured products	8.81	25.84	17.03
Fabricated metal products	3.02	17.85	14.83
Plastic products	10.79	25.03	14.24
Wearing apparel except footwear	18.06	31.27	13.21
Machinery except electrical	0.57	13.24	12.67
Machinery electrical	3.45	15.20	11.76
Other non-metallic mineral products	1.61	11.05	9.44
Printing and publishing	0.98	9.53	8.55
Textiles	8.37	16.26	7.89
Glass and products	1.57	9.14	7.58
Wood products except furniture	1.15	7.50	6.34
Professional and scientific equipment	2.41	7.95	5.54
Rubber products	0.42	5.25	4.83
Iron and steel	1.39	4.87	3.48
Non-ferrous metals	0.80	3.88	3.08
Industrial chemicals	1.21	3.23	2.02
Paper and products	0.46	2.32	1.86
Food products	2.16	3.45	1.29
Transport equipment	0.18	1.27	1.09
Misc petroleum and coal products	0.42	1.49	1.07
Other chemicals	1.40	1.86	0.45
Beverages	0.94	1.27	0.33
Tobacco	1.35	1.28	-0.07
Petroleum refineries	1.59	1.39	-0.20

Source: Allesandro Nicita and Marcelo Olarreaga, "Trade, Production, and Protection Database, 1976-2004," The World Bank Economic Review, 2007.

Table 2: GDP and World Price of China High-Growth Export Goods

country	year	std. err.	price	std. err.	$R^2$	wage share CHEG, 1990
Japan	.0029	.0027	1.0027	.1309	.9784	.6220
Hong Kong	-.0008	.0047	1.9774	.2288	.9772	.8323
Singapore	.0234	.0056	.9231	.2714	.9711	.7476
South Korea	.0383	.0047	1.1460	.2270	.9903	.6016
Malaysia	.0477	.0043	-.2787	.2082	.9828	.5750
Thailand	.0189	.0067	1.4121	.3227	.9682	.7053
Philippines	.0201	.0035	-.7606	.1698	.6607	.4840
Indonesia	.0195	.0060	.6547	.2902	.9466	.4311
Australia	.0403	.0025	-.4035	.1220	.9899	.5022
India	.0267	.0017	-.3497	.0821	.9878	.4644
Taiwan	.0359	.0025	1.1229	.1215	.9969	.6666

Legend. Regression of log real per-capita GDP on a time trend and log World Price of China High-Growth Export Goods (CHEG) from 1976 to 2004.

Table 3: GDP-World Price CHEG elasticity and Wage Share CHEG

Panel A: E&SEAsia Countries		
variable	coef.	std. err.
constant	-3.7734	.7658
wage share CHEG	7.0192	1.2146
no. of obs.	10	
$R^2$	.8067	

Panel B: All Countries		
variable	coef.	std. err.
constant	-2.1046	.4331
wage share CHEG	3.3171	.7887
no. of obs.	74	
$R^2$	.1972	

Legend. Panel A: Regression of log real per-capita GDP-World Price CHEG elasticity on Wage Share CHEG for E&SEAsia countries (excluding the outlier Indonesia); Panel B: Regression of log real pre-capita GDP-World Price CHEG elasticity on Wage Share CHEG for all countries in the Trade and Production dataset.

Table 4: Japan and China: Industry value added, 1980 to 2003

(Millions of 1997 U.S. dollars)

Industry Value Added	1980	1985	1990	1995	2000	2003
All manufacturing industries						
Japan	524,366.1	698,687.7	935,206.2	937,181.5	980,996.6	923,507.7
China	65,535.7	98,045.7	121,068.7	234,071.1	409,740.2	590,609.8
Aircraft						
Japan	731.1	1,357.6	1,510.3	2,439.4	3,327.7	6,140.0
China	360.1	616.6	714.0	2,250.9	6,289.1	10,211.3
Pharmaceuticals						
Japan	11,790.1	14,893.4	23,095.2	27,004.1	28,926.0	25,521.0
China	1,096.7	1,028.7	1,774.5	3,313.8	8,515.1	14,064.1
Office and computing mach.						
Japan	7,826.1	18,531.7	28,888.7	24,935.9	21,535.8	13,135.3
China	355.9	294.9	397.6	1,645.1	20,027.2	46,688.6
Communication equipment						
Japan	19,759.6	50,981.2	77,414.0	78,708.6	102,636.0	88,569.4
China	991.4	2,869.4	3,859.1	7,965.8	19,384.4	36,710.5
Medical, precision, and opt. instr.						
Japan	8,201.4	13,612.3	17,442.0	13,286.6	14,567.6	11,842.5
China	342.8	762.2	716.0	1,417.4	2,900.2	4,474.4
Other manufacturing industries						
Japan	476,057.7	599,311.4	786,855.9	790,806.7	810,003.4	778,299.6
China	62,388.8	92,473.8	113,607.4	217,478.1	352,624.2	478,461.0

SOURCE: National Science Board. 2006. Science and Engineering Indicators 2006.



Fig 1. China: Labor Productivity and World Export Share

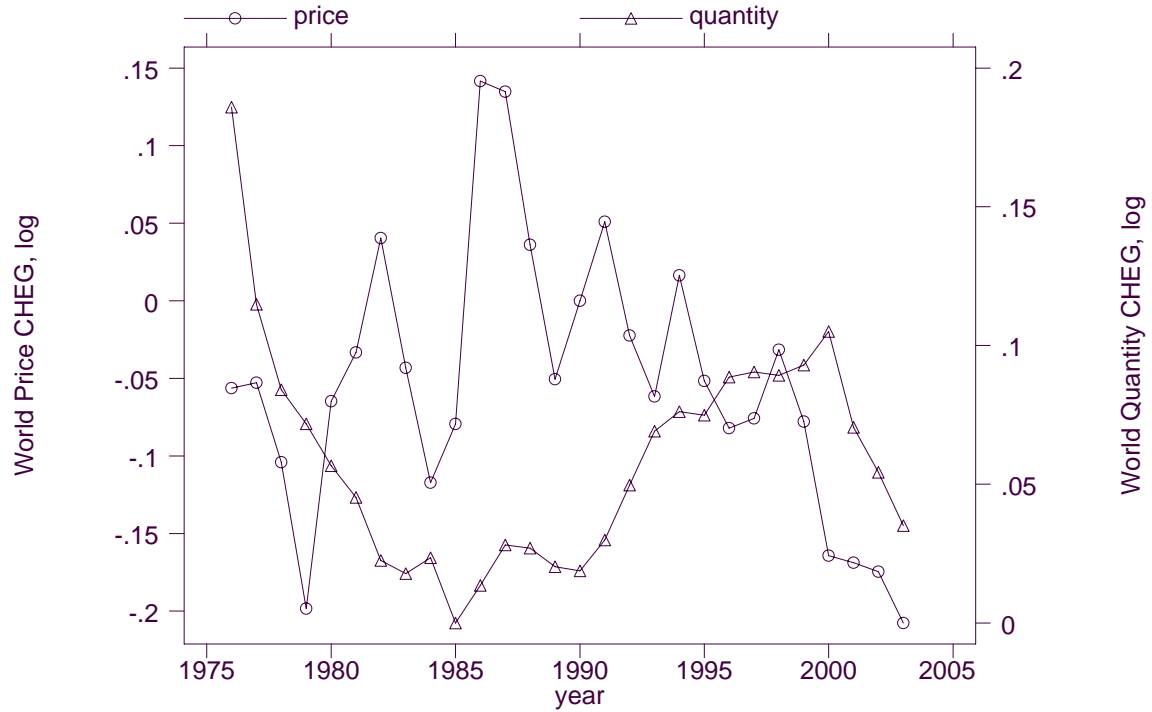


Fig 2. China High Export Goods: World Price and Quantity

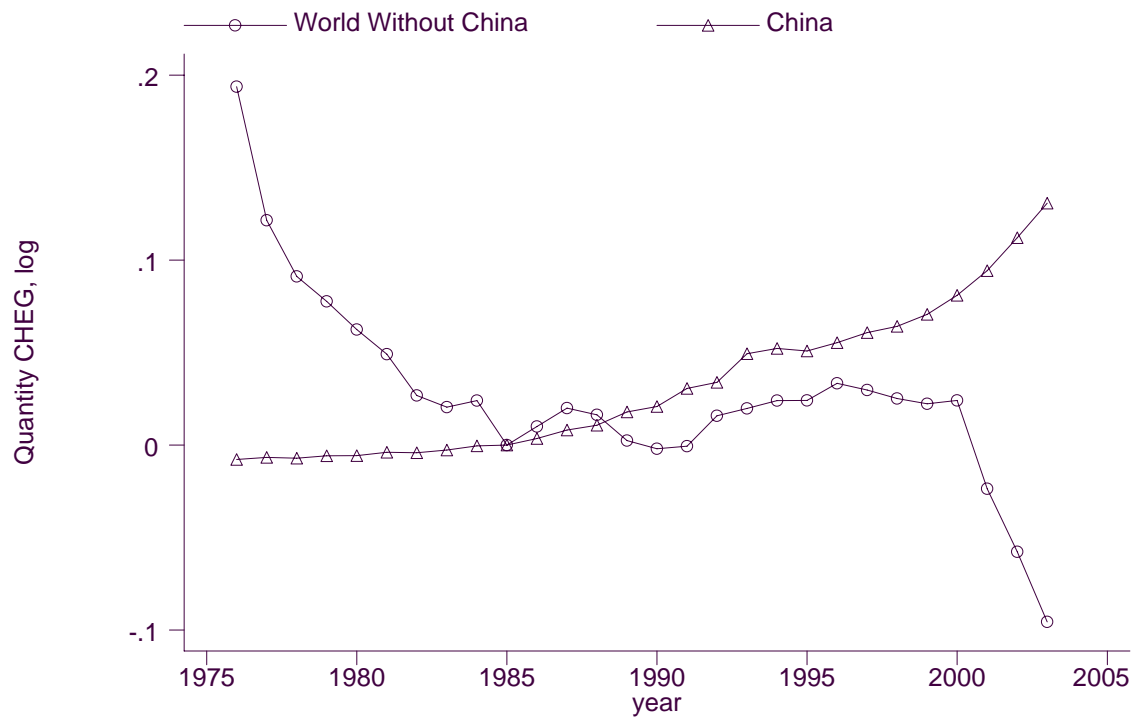


Fig 3. China High Export Goods: World Quantity With and Without China





Fig 4. Dependence of E&SEAsia GDP on China's Emergence

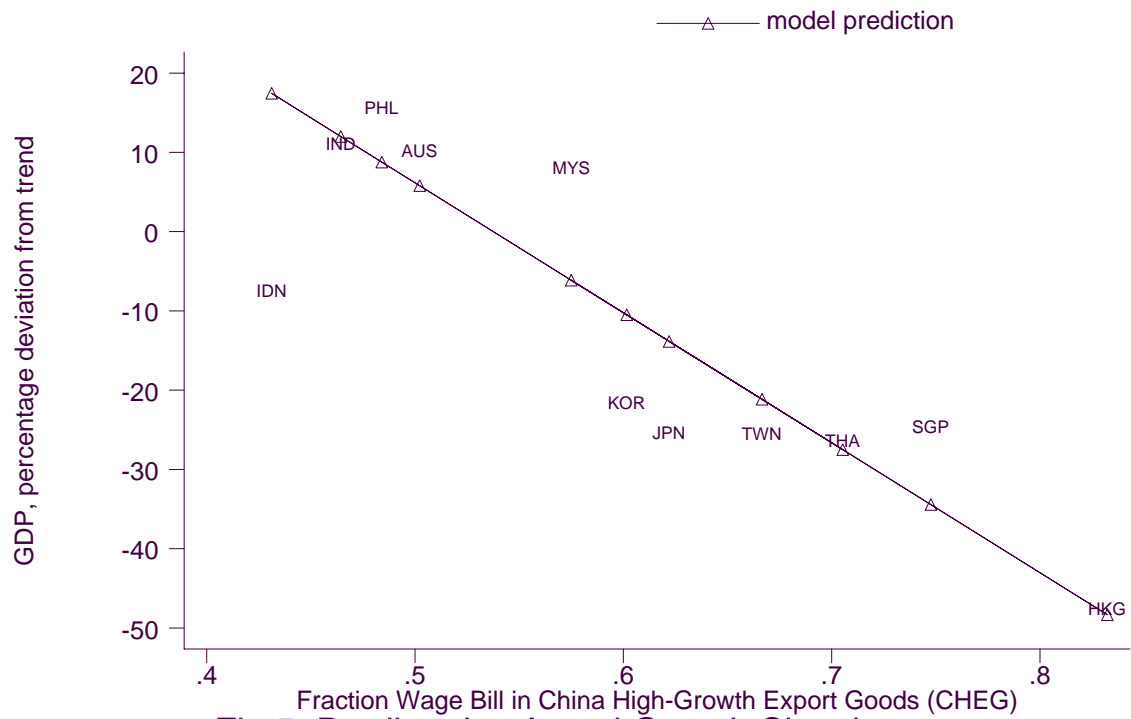


Fig 5. Predicted v. Actual Growth Slowdowns

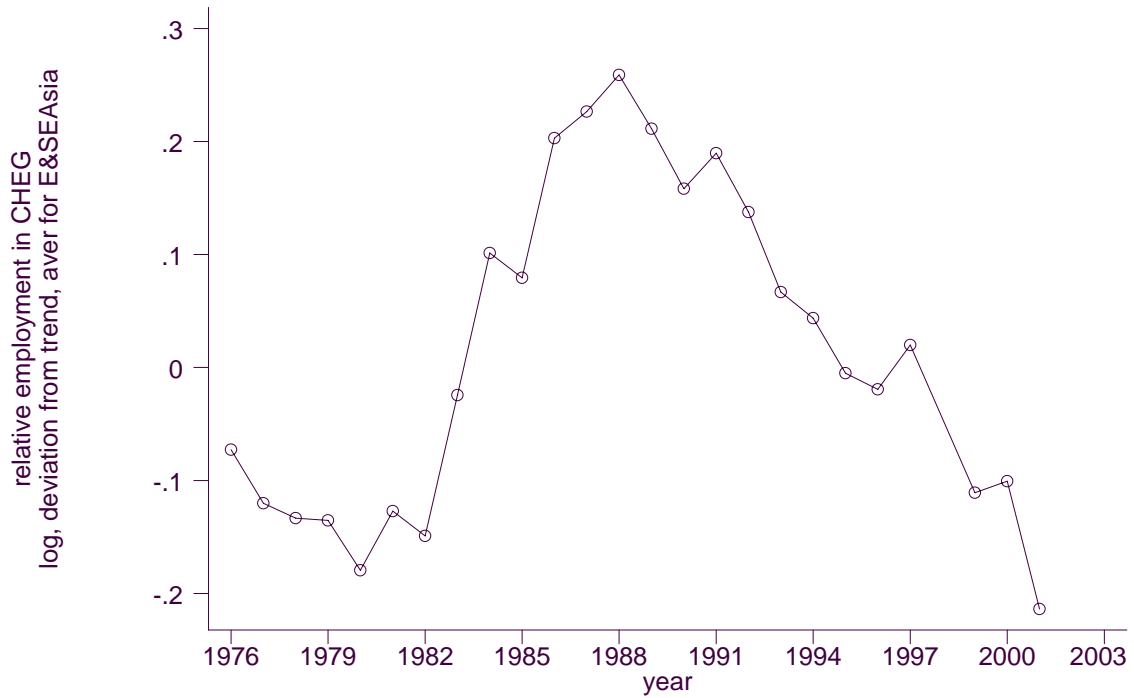


Fig 6. E&SEAsia Employment Re-Allocation and China's Emergence



Fig 7. E&SEAsia Industry/Service Employment Ratio