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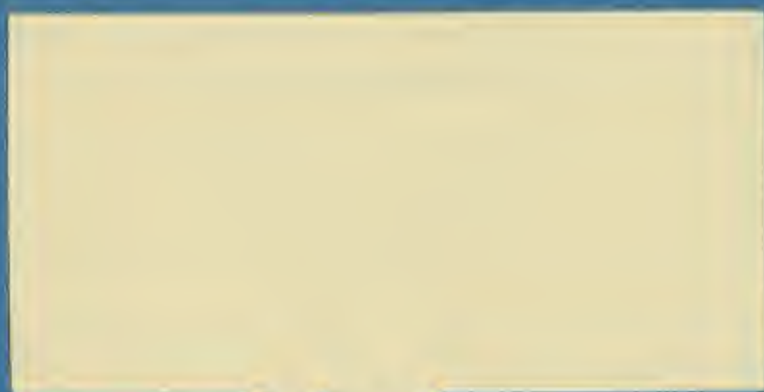
COMPARATIVE ADVANTAGE AND THE
CROSS-SECTION OF BUSINESS CYCLES

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Abstract: Business cycles are both less volatile and more synchronized with the world cycle in rich countries than in poor ones. In this paper, we develop two alternative but non-competing explanations for these facts. Both explanations proceed from the observation that the law of comparative advantage causes rich and poor countries to specialize in the production of different commodities. In particular, rich countries specialize in "high-tech" products produced by skilled workers while poor countries specialize in "low-tech" products produced by unskilled workers. Cross-country differences in business cycles then arise as a result of asymmetries among the industries in which different countries specialize. We focus on two such asymmetries. The first we label the "competition bias" hypothesis, and is based on the idea that cross-country differences in production costs are more prevalent in high-tech industries, sheltering producers from foreign competition and therefore making them large suppliers in the markets for their products. The second asymmetry we label the "cyclical bias" hypothesis, and is based on the idea that production costs in low-tech industries might be more sensitive to the shocks that drive business cycles.

Business cycles are different in rich and poor countries. In the top panel of Figure 1, we have plotted the standard deviation of per capita GDP growth against the log-level of per capita income for a large sample of countries. We refer to this relationship as the Volatility Graph and note that it is downward-sloping, meaning that fluctuations in per capita income growth are smaller in rich countries than in poor ones. In the bottom panel of Figure 1, we have plotted the correlation of per capita income growth rates with world average per capita income growth (excluding the country in question) against the log-level of per capita income for the same set of countries. We refer to this relationship as the Comovement Graph and note that it is upward-sloping, meaning that fluctuations in per capita income growth are more synchronized with the world cycle in rich countries than in poor ones. Table 1, which is self-explanatory, shows that these facts are quite robust.[1]

Here we develop two alternative but non-competing explanations for these facts. Both explanations rely on the notion that the law of comparative advantage causes rich countries to specialize in "high-tech" industries that require sophisticated technologies operated by skilled workers, while poor countries specialize in "low-tech" industries that require traditional technologies operated by unskilled workers. This pattern of specialization opens up the possibility that cross-country differences in business cycles are due to asymmetries between high-tech and low-tech industries. For instance, assume that production in high-tech industries is more sensitive to foreign shocks and less sensitive to domestic shocks than in low-tech ones. It follows immediately that production in high-tech industries, and therefore in rich countries, would be more synchronized with the world cycle than in low-tech ones. Moreover, to the extent that foreign shocks are an average of the domestic shocks of many other countries, it is reasonable to expect that foreign shocks are less volatile than domestic shocks. As a result, production in high-tech industries, and therefore in rich countries, would also be less volatile than in low-tech ones.

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[1] Acemoglu and Zilibotti (1997) also present the Volatility graph. We are unaware of any previous reference to the Comovement graph.

One explanation of why industries react differently to shocks is based on the idea that producers in high-tech industries enjoy more market power than producers in low-tech industries. We refer to this asymmetry among industries as the "competition bias" hypothesis. This bias would occur, for instance, if differences in production costs among firms are more prevalent in high-tech industries. These cost differences shelter technological leaders from their competitors and make them large suppliers in international markets.

This competition bias has implications for how industries react to domestic and foreign shocks. Consider the effects of a favourable domestic shock that reduces unit costs in all industries. Since producers in high-tech industries are large suppliers in international markets, increases in their production lower prices, moderating the effects of the shock. Since producers in low-tech industries are small suppliers in world markets, increases in their production have little or no effect on their prices. To the extent that the competition bias is important, one would therefore expect that high-tech industries are less sensitive to domestic shocks than low-tech industries. Consider next the effects of a foreign shock that raises production and income abroad and, as a result, increases demand in all industries. Since producers in high-tech industries are large suppliers in international markets, this shock is translated into a large shift in their industry demand which leads to large increases in production and prices. Since producers in low-tech industries are small suppliers in international markets, this shock has a negligible effect on their industry demand as most of the increase in world demand is met by increases in production abroad. To the extent that the competition bias is important, one would therefore expect that high-tech industries are more sensitive to foreign shocks than low-tech industries.

Another explanation for why industries react differently to shocks is based on the idea that unit costs in the latter might be more sensitive to the shocks that drive business cycles than in the former. We refer to this asymmetry among industries as the "cyclical bias" hypothesis. If business cycles are driven by productivity shocks, this bias would occur if industry productivity is more volatile in low-tech industries. If

business cycles are driven by monetary shocks, this bias might arise if cash-in-advance constraints are more prevalent for firms in low-tech industries.

This cyclical bias also has implications for how industries react to domestic and foreign shocks. Almost by assumption, the cyclical bias implies that favourable domestic shocks reduce unit costs in low-tech industries more than in high-tech industries, leading to larger increases in production in the former than in the latter. This is how the cyclical bias explains why high-tech industries are less sensitive to domestic shocks than low-tech industries. Less obviously, the cyclical bias also implies that high-tech industries are more sensitive to foreign shocks than low-tech industries. To see this, consider the effects of a favourable shock that raises production and income abroad. The cyclical bias implies that worldwide production of low-tech products increases relative to that of high-tech products, raising the relative price of high-tech products. From the perspective of the domestic economy, this constitutes a favourable shock for producers of high-tech products and an adverse one for low-tech producers. As a result, high-tech industries are more sensitive to foreign shocks than low-tech industries.

To analyze these issues we construct a stylized world equilibrium model of the cross-section of business cycles. Inspired by the work of Davis (1995), we consider a world in which differences in both factor endowments à la Heckscher-Ohlin and industry technologies à la Ricardo combine to determine a country's comparative advantage and, therefore, the patterns of specialization and trade. We subject this world economy to both the sort of productivity fluctuations that have been emphasized by Kydland and Prescott (1982), and also to monetary shocks that have real effects since firms face cash-in-advance constraints. We then characterize the cross-section of business cycles and find conditions under which the competition and cyclical biases can be used to explain the evidence in Figure 1. The model is simple enough that we obtain closed-form solutions for all the expressions of interest. We also find that our results hold even in the presence of trade frictions, modelled here as "iceberg" transport costs, provided that these frictions are not so large as to alter the pattern of trade. Also, we find that reductions in transport costs (globalization?)

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magnify cross-country differences in business cycles. Finally, we show that the two hypotheses under consideration have different implications for the cyclical properties of the terms of trade. In principle, these properties can be used to distinguish between the two hypotheses. In practice, however, a first look at the data yields conflicting evidence.

The research presented here is related to the large literature on open-economy real business cycle models, surveyed by Backus, Kehoe and Kydland (1995) and Baxter (1995), that explores how productivity shocks are transmitted across countries. Our work also relates to recent work by Obstfeld and Rogoff (1995, 1998) and Corsetti and Pesenti (1998) that analyzes the international transmission of monetary shocks. We differ from these lines of research in two ways. Instead of emphasizing the aspects in which business cycles are similar across countries, we focus on those aspects in which they are different. Instead of focusing primarily on the implications of international lending, risk-sharing and factor movements for the transmission of business cycles, we emphasize the role of commodity trade.[2]

The paper is organized as follows. Section 1 develops the basic model. Section 2 explores the properties of a cross-section of business cycles in the basic model. Section 3 extends the model by introducing money. Section 4 further extends the model by introducing transport costs. Section 5 examines some implications of the model for cyclical properties of the terms of trade. Section 6 concludes.

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[2] Previous literature on business cycles in open economies typically assumes that either (a) there is a single commodity, so that there is no commodity trade whatsoever, or (b) that countries are completely specialized in the production of differentiated products. Whether such models provide a good description of observed trade patterns has not been a major concern for this literature. In contrast, the model presented here is empirically consistent with the main features of observed trade patterns: (a) a large volume of trade among rich countries in products with similar factor intensity (intraindustry trade); (b) substantial trade among rich and poor countries in products with different factor intensities (interindustry trade); and (c) little trade among poor countries.

1. A Simple Model of Trade and Business Cycles

We consider a world with a continuum of countries with mass one; two industries, which we refer to as the α- and β-industries; and two factors of production, skilled and unskilled workers. Countries differ in their technologies, their endowments of skilled and unskilled workers and their level of productivity. In particular, each country is defined by a triplet (μ,δ,π), where μ is a measure of how advanced the technology of the country is, δ is the fraction of the population that is skilled, and π is an index of productivity. We assume that workers cannot migrate and that cross-country differences in technology are stable, so that μ and δ are constant. We generate business cycles by allowing the productivity index π to fluctuate randomly.

The α- and β-industries each contain a continuum of differentiated products of measure one which can be traded at zero cost. Firms in the α-industry use sophisticated technologies that require skilled labour, while firms in the β-industry use traditional technologies that can be operated by both skilled and unskilled workers. Not surprisingly, we shall find that rich countries that have better technologies and a high proportion of skilled workers export mainly α-products, while poor countries that have worse technologies and a high proportion of unskilled workers export mainly β-products. To emphasize the role of commodity trade, we rule out trade in financial instruments. To simplify the problem further, we also rule out investment. Jointly, these assumptions imply that countries do not save.[3]

Preferences

Each country is populated by a continuum of consumers who differ in their level of skills and their personal opportunity cost of work, or reservation wage. We

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[3] The model presented here is related to Kraay and Ventura (1997).

index consumers by $i \in [1/\gamma, \infty)$ and assume that this index is distributed according to this Pareto distribution: $P(i) = 1 - (\gamma \cdot i)^{-\lambda}$, with $\lambda > 0$, $\gamma > 0$. A consumer with index i maximizes the following expected utility:

$$E \int_0^\infty U\left(\left[\frac{c_\alpha(z,i)}{v} \right]^v \cdot \left[\frac{c_\beta(i)}{1-v} \right]^{1-v} - \frac{I(i)}{i} \right) \cdot e^{-\rho \cdot t} \cdot dt \tag{1}$$

where U(.) is any well-behaved function; I(i) is an indicator function that takes value 1 if the consumer works and 0 otherwise; and $c_\alpha(i)$ and $c_\beta(i)$ are the following consumption indices of α- and β-products:

$$c_\alpha(i) = \left[\int_0^1 c_\alpha(z,i)^{\frac{\theta-1}{\theta}} \cdot dz \right]^{\frac{\theta}{\theta-1}} \qquad c_\beta(i) = \left[\int_0^1 c_\beta(z,i)^{\frac{\theta-1}{\theta}} \cdot dz \right]^{\frac{\theta}{\theta-1}} \tag{2}$$

where $c_\alpha(z,i)$ and $c_\beta(z,i)$ are consumer i's consumption of variety z of the α- and β-industries, respectively. The elasticity of substitution between industries is one, while the elasticity of substitution between any two varieties within an industry is θ, with $\theta > 1$.

The solution to the consumer's problem is quite straightforward. Consumers spend a fraction v of their income on α-products and a fraction 1-v on β-products. Moreover, the ratio of spending on any two α-products z and z' is given by

$$\left[\frac{p_\alpha(z)}{p_\alpha(z')} \right]^{1-\theta}$$; and the ratio of spending on any two β-products z and z' is $\left[\frac{p_\beta(z)}{p_\beta(z')} \right]^{1-\theta}$,

where $p_\alpha(z)$ and $p_\beta(z)$ denote the price of variety z of the α- and β-products, respectively. Finally, consumers work if and only if the applicable wage (skilled or unskilled) exceeds a reservation wage of i^{-1}.

We express all prices in terms of the ideal consumer price index, i.e.

$$\left[\int_0^1 p_\alpha(z)^{1-\theta}\cdot dz\right]^{\frac{\nu}{1-\theta}}\cdot\left[\int_0^1 p_\beta(z)^{1-\theta}\cdot dz\right]^{\frac{1-\nu}{1-\theta}} = 1.$$ Let $r(\mu,\delta,\pi)$ and $w(\mu,\delta,\pi)$ be the wages

of skilled and unskilled workers in a (μ,δ,π)-country. Also, define $s(\mu,\delta,\pi)$ and $u(\mu,\delta,\pi)$
to be the measure of skilled and unskilled workers that are employed. Under the
assumption that the distribution of skills and reservation wages are independent, we
have that

$$s = \delta\cdot\left(\frac{r}{\gamma}\right)^\lambda \tag{3}$$

$$u = (1-\delta)\cdot\left(\frac{w}{\gamma}\right)^\lambda \tag{4}$$

Equations (3)-(4) show that the fraction of skilled and unskilled workers that are

employed are $\left(\frac{r}{\gamma}\right)^\lambda$ and $\left(\frac{w}{\gamma}\right)^\lambda$, respectively. If the wage of any type of worker

reaches γ, the entire labour force of that type is employed and the labour supply for
that type of workers becomes vertical. Throughout, we shall assume that γ is large
enough so that this never happens. Finally, we note that the wage-elasticity of the
labour supplies, λ, is the same for both types of workers since it only depends on the
dispersion of reservation wages.

Firms and Technology

The α-industry uses sophisticated production processes that are not available
to all countries and that require skilled workers. Let $e^{-\varepsilon_\alpha\cdot\pi}\cdot dz$ ($\varepsilon_\alpha>0$) be the "best-
practice" unit labour requirements to produce one unit of a given small set of α-
products of measure dz. Let $(1+\eta)\cdot e^{-\varepsilon_\alpha\cdot\pi}\cdot dz$ ($\eta>0$) be the "second-best"

technology available to produce one unit of a given small set of α-products of measure dz. Let μ be the measure of α-products in which a firm located in a (μ,δ,π)-country owns the best-practice technology. We can interpret μ a natural indicator of how advanced the technology of a country is. Assume further that the set of α-products in which two or more firms share best-practice technology has measure zero. Jointly, these assumptions imply that $1 = \int_0^1 \int_0^1 \mu \cdot dF(\mu,\delta)$, where $F(\mu,\delta)$ is the time-invariant joint distribution function of μ and δ. We shall assume throughout that η is large enough so that the firms that have the best-practice technology are 'de facto' monopolists in the market for their products. Therefore, their optimal pricing policy is to set a markup over their unit cost. Symmetry ensures that that all firms in the α-industry of a (μ,δ,π)-country set the same price, $p_\alpha(\mu,\delta,\pi)$:

$$p_\alpha = \frac{\theta}{\theta - 1} \cdot r \cdot e^{-\varepsilon_\alpha \cdot \pi} \tag{5}$$

The β-industry uses traditional technologies that are available in all countries and can be operated by both skilled and unskilled workers. In particular, $e^{-\varepsilon_\beta \cdot \pi} \cdot dz$ ($\varepsilon_\beta > 0$) workers of any kind are required to produce one unit of a given "small" set of β-products of measure dz. Since all firms have access to the same technologies, the β-industry is competitive and prices are equal to costs. We shall assume throughout that in equilibrium skilled wages are high enough that only unskilled workers produce β-products.[4] Symmetry ensures that all firms in the β-industry of a (μ,δ,π)-country set the same price, $p_\beta(\mu,\delta,\pi)$:

$$p_\beta = w \cdot e^{-\varepsilon_\beta \cdot \pi} \tag{6}$$

Two features of this representation of technology play an important role throughout the paper. First, the elasticity of substitution among varieties θ regulates

the extent to which the competition bias is important. If θ is low (high), α-products are perceived as different (similar) by consumers and, as a result, firms in the α-industry face weak (strong) competition from producers of other varieties of α-products. As $\theta \rightarrow \infty$, the degree of competition in the α-industry increases and the competition bias disappears. Second, the parameters ε_α and ε_β regulate the importance of the cyclical bias. If $\varepsilon_\alpha < \varepsilon_\beta$ ($\varepsilon_\alpha > \varepsilon_\beta$), unit costs in the β-industry (α-industry) are more sensitive to fluctuations in productivity. As $\varepsilon_\alpha \rightarrow \varepsilon_\beta$, the cyclical bias disappears.

Productivity Fluctuations

We generate business cycles by assuming that the productivity index fluctuates randomly. In particular, we assume that π consists of the sum of a global component, Π, and a country-specific component, π-Π. We assume that the global and country-specific components are independent, and moreover that the country-specific components are independent across countries. Both the global and country-specific components of productivity are reflected Brownian motions on the interval $\left[-\dfrac{\overline{\pi}}{2}, \dfrac{\overline{\pi}}{2} \right]$, with zero drift and instantaneous variances $\sigma \cdot dt$ and $(1-\sigma) \cdot dt$ respectively, where $\overline{\pi}$ is a positive constant and $0 < \sigma < 1$. These assumptions imply that the productivity index π follows a Brownian motion with zero drift and unit variance reflected on the interval $\left[\Pi - \dfrac{\overline{\pi}}{2}, \Pi + \dfrac{\overline{\pi}}{2} \right]$. This interval itself fluctuates over time as the global component of productivity changes. Finally, it is a well-known result of the theory of reflected Brownian motion that the invariant distributions of the global and country-specific components of productivity, $G(\Pi)$ and $G(\pi$-$\Pi)$, are uniform on the interval $\left[-\dfrac{\overline{\pi}}{2}, \dfrac{\overline{\pi}}{2} \right]$.[5] We assume that the initial cross-sectional distribution of

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[4] This is the case if the share of spending on α-products not too small, i.e. $v >> 0$.
[5] See, for instance, Harrison (1990), Chapter 5.

the country-specific component of productivity is equal to the invariant distribution and hence does not change over time.

From the perspective of a (μ,δ,π)-country, we can refer to changes in π and Π as as domestic and foreign productivity shocks. It is straightforward to show that the instantaneous correlation between these shocks is $\sqrt{\sigma}$.[6] That is, the parameter σ regulates the extent to which the variation in domestic productivity is due to the global or country-specific components, i.e. whether it comes from $d\Pi$ or $d(\pi-\Pi)$. Figure 2 shows possible sample paths of π under three different assumptions regarding σ. In the first panel, we assume that $\sigma=0$, so that Π is constant and all the variation in π is country-specific. The second panel shows the case in which $\sigma=1$. Then, $d\pi=d\Pi$ and all the variation in π is global, i.e. changes in π are perfectly correlated with changes in global productivity, Π. The third panel shows the case in which $0<\sigma<1$. Then, the variation in π is has both country-specific and global components.

Equilibrium Prices and Trade Flows

Let p be the average price of an α-product (or the ideal price index of the α-industry) relative to the average price of a β-product product (or the ideal price index of the β-industry). Then, our normalization rule implies that

$$\left[\int_0^1 p_\alpha(z)^{1-\theta}\cdot dz\right]^{\frac{1}{1-\theta}} = p^{1-v} \text{ and } \left[\int_0^1 p_\beta(z)^{1-\theta}\cdot dz\right]^{\frac{1}{1-\theta}} = p^{-v}.$$ Using this notation, the

equilibrium prices of any α-product and β-product produced in a (μ,δ,π)-country are:

$$p_\alpha = \chi\cdot p^{1-v}\cdot\left(\frac{\mu}{\delta}\right)^{\frac{1}{\theta+\lambda}}\cdot e^{-\frac{1+\lambda}{\theta+\lambda}\cdot\varepsilon_\alpha\cdot(\pi-\Pi)} \tag{7}$$

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[6] This will be true except when either π or Π are reflected at their respective boundaries. These are rare events since the dates at which they occur constitute a set of measure zero in the time line.

$$p_\beta = p^{-\nu} \tag{8}$$

where χ is a positive constant.[7] Since each country is a "large" producer of its own varieties of α-products, the price of these varieties depends negatively on the quantity produced. Countries with many skilled workers (high δ) with relatively high productivity (high π-Π) producing a small number of varieties (low μ) produce large quantities of each variety of the α-products and as a result, face low prices. As $\theta \to \infty$, the dispersion in their prices disappears and $p_\alpha \to p^{1-\nu}$. In the β-industry all products must command the same price. Otherwise, low-price varieties of β-products would not be produced in equilibrium. Finally, we find that the equilibrium value for p is:

$$p = \psi \cdot e^{(\varepsilon_\beta - \varepsilon_\alpha) \cdot \Pi} \tag{9}$$

where ψ is another positive constant.[8] In the presence of a cyclical bias, $\varepsilon_\alpha < \varepsilon_\beta$ ($\varepsilon_\alpha > \varepsilon_\beta$), high productivity is associated with high (low) relative prices for α-products as the world supply of β-products is high (low) relative to that of α-products. As $\varepsilon_\alpha \to \varepsilon_\beta$, the cyclical bias disappears and the relative prices of both industries are unaffected by the level of productivity.

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[7] In particular, $\chi^{\theta-1} = \int_{-\infty}^{\infty} \int_0^1 \int_0^1 \mu \cdot \left(\frac{\mu}{\delta}\right)^{-\frac{\theta-1}{\theta+\lambda}} \cdot e^{\frac{\theta-1}{\theta+\lambda} \cdot (1+\lambda) \cdot \varepsilon_\alpha \cdot (\pi-\Pi)} \cdot dF(\mu, \delta) \cdot dG(\pi - \Pi)$, which is constant given that the distributions F and G are time-invariant. To derive Equation (7), equate the ratio of world expenditure on the (sum of all) α-products of a (μ, δ, π)-country and a (μ', δ', π')-country to the ratio of the value of productions. Second, use Equations (3)-(6) to find that:

$p_{\alpha'} = p_\alpha \cdot \left(\frac{\mu' \cdot \delta}{\mu \cdot \delta'}\right)^{\frac{1}{\theta+\lambda}} \cdot e^{\frac{1+\lambda}{\theta+\lambda} \cdot \varepsilon_\alpha \cdot (\pi - \pi')}$. Finally, substitute this expression in the ideal price index of the α-industry and solve for p_α. Equation (8) is simply a consequence of our normalization rule and the observation that all β-products command the same price in equilibrium.

[8] In particular, $\psi^{1+\lambda} \cdot \chi^{\theta+\lambda} = \frac{\nu}{1-\nu} \cdot \left(\frac{\theta}{\theta-1}\right)^\lambda \cdot \int_{-\infty}^{\infty} \int_0^1 \int_0^1 (1-\delta) \cdot e^{(1+\lambda) \cdot \varepsilon_\beta \cdot (\pi-\Pi)} \cdot dF(\mu, \delta) \cdot dG(\pi - \Pi)$.

To derive Equation (8), we equate the ratio of spending in both industries to the ratio of worldwide production of both industries and then use Equations (3)-(7) to solve for p.

Let $y(\mu,\delta,\pi)$ and $x(\mu,\delta,\pi)$ be the income and the share in production of the α-industry, i.e. $y=r{\cdot}s+w{\cdot}u$ and $x=\dfrac{r{\cdot}s}{y}$. Not surprisingly, countries with good technologies (high μ) and a high proportion of skilled workers (high δ) have high values for both y and x. We therefore refer to countries with high values of x as rich countries. Since each country produces an infinitesimal number of varieties of α-products and consumes all of them, all countries export almost all of their production of α-products and import almost all of their consumption of α-products. As a share of income, these exports and imports are x and v, respectively. This kind of trade is usually referred to as intraindustry trade, since it involves two-way trade in products with similar factor intensities. To balance their trade, countries with x<v export β-products and countries with x>v import them. As a share of income, these exports and imports are v-x and x-v, respectively. This kind of trade is usually referred to as interindustry trade or factor-proportions trade. As a result, the model captures in a stylized manner three broad empirical regularities regarding the patterns of trade: (a) a large volume of intraindustry trade among rich countries, (b) substantial inter-industry trade between rich and poor countries, and (c) little trade among poor countries.

2. The Cross-section of Business Cycles

In the world economy described in the previous section, countries are subject to two kinds of shocks. On the one hand, domestic productivity shocks shift industry supplies. On the other hand, foreign productivity shocks shift industry demands. In the presence of the competition bias or the cyclical bias, these shocks have different effects in high-tech and low-tech industries. As a result, the aggregate response to similar shocks differs across economies with different industrial structures. In other words, the properties of the business cycles that countries experience depend on the determinants of their industrial structure, that is, on their factor endowments and technology.

Domestic and Foreign Shocks as a Source of Business Cycles

The (demeaned) growth rate of income in a (μ,δ,π)-country can be written as a linear combination of domestic and foreign shocks:[9]

$$d\ln y - E[d\ln y] = \xi_\pi \cdot d\pi + \xi_\Pi \cdot d\Pi \tag{10}$$

The functions $\xi_\pi(\mu,\delta,\pi)$ and $\xi_\Pi(\mu,\delta,\pi)$ measure the sensitivity of a country's growth rate to domestic and foreign shocks, and are given by:

$$\xi_\pi = (1+\lambda)\cdot\left[x\cdot\varepsilon_\alpha\cdot\frac{\theta-1}{\theta+\lambda}+(1-x)\cdot\varepsilon_\beta\right] \tag{11}$$

$$\xi_\Pi = (1+\lambda)\cdot\left[x\cdot\varepsilon_\alpha\cdot\frac{1+\lambda}{\theta+\lambda}+(x-v)\cdot(\varepsilon_\alpha-\varepsilon_\beta)\right] \tag{12}$$

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[9] To see this, apply Ito's lemma to the definition of income and use the expressions for equilibrium factor prices and supplies in Equations (3)-(9).

Equations (10)-(12) provide a complete characterization of the business cycles experienced by a (μ,δ,π)-country. Moreover, they show how business cycles differ across countries, since the sensitivity of growth rates to domestic and foreign shocks depends on the share in production of high-tech products, x. Finally, we note the the detrended growth rate of world average income, Y, is given by

$$d\ln Y - E[d\ln Y] = \omega_\Pi \cdot d\Pi \tag{13}$$

where the sensitivity of the world growth rate to innovations in the global component of productivity is given by:

$$\omega_\Pi = (1+\lambda)\cdot(\nu\cdot\varepsilon_\alpha + (1-\nu)\cdot\varepsilon_\beta) \tag{14}$$

Let $V(\mu,\delta,\pi)$ denote the standard deviation of the growth rate of a (μ,δ,π)-country, and let $C(\mu,\delta,\pi)$ denote the correlation of its growth rate with world average income growth. These are the theoretical analogs to the Volatility and Comovement graphs in Figure 1. Using the Equations (10)-(14) and the properties of the shocks, we derive the following result:[10]

PROPOSITION 1: The functions C and V depend, at most, on x. Moreover:

(i) If $\varepsilon_\beta = \varepsilon_\alpha \cdot \dfrac{\theta-1}{\theta+\lambda}$, then $\dfrac{\partial V}{\partial x} = \dfrac{\partial C}{\partial x} = 0$ for all x;

(ii) If $\varepsilon_\beta > \varepsilon_\alpha \cdot \dfrac{\theta-1}{\theta+\lambda}$, then $\dfrac{\partial V}{\partial x} < 0$ and $\dfrac{\partial C}{\partial x} > 0$ for all x; and

(iii) If $\varepsilon_\beta < \varepsilon_\alpha \cdot \dfrac{\theta-1}{\theta+\lambda}$, then $\dfrac{\partial V}{\partial x} > 0$ and $\dfrac{\partial C}{\partial x} < 0$ for all x.

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[10] The proof is simple, since we have closed-form solutions for both the volatility and comovement statistics: $V = \sqrt{(1-\sigma)\cdot\xi_\pi^2 + \sigma\cdot(\xi_\pi + \xi_\Pi)^2}$ and $C = \dfrac{(\xi_\pi + \xi_\Pi)\cdot\sqrt{\sigma}}{\sqrt{(1-\sigma)\cdot\xi_\pi^2 + \sigma\cdot(\xi_\pi + \xi_\Pi)^2}}$. Since $\xi_\pi + \xi_\Pi$ does not depend on x, V (C) will be downward (upward) sloping if and only if ξ_π is decreasing in x. The proposition describes the sign of $\dfrac{\partial\xi_\pi}{\partial x}$ for different parameter values.

This is the first of a series of results that relate a country's industrial structure, as measured by x, to the properties of its business cycles. Proposition 1 says that the theoretical Volatility and Comovement graphs have the same slopes as their empirical counterparts if the competition bias (low θ) and/or the cyclical bias ($\varepsilon_\beta > \varepsilon_\alpha$) are strong enough. Equations (11)-(12) show that this same parameter restriction implies that rich countries are less sensitive to domestic shocks (i.e. ξ_π is decreasing with x), but more sensitive to foreign shocks (i.e. ξ_Π is increasing with x). In the remainder of this section we provide intuition for this result.

Why Are Rich Countries Less Sensitive To Domestic Shocks?

Domestic shocks shift industry supplies. When these shocks are positive, they raise production, wages and employment in both industries. When negative, they lower production, wages and employment. However, to the extent that the competition bias and the cyclical bias are important, these effects are larger in the β-industry than the α-industry.

It is useful to start with a benchmark case in which $\theta \to \infty$ and $\varepsilon_\alpha = \varepsilon_\beta = \varepsilon$, so that neither the competition bias nor the cyclical bias are present. A favourable productivity shock results in an increase in productivity of magnitude $\varepsilon \cdot d\pi$ in both industries, and has two familiar effects. Holding constant employment, increased productivity directly raises production and hence income. This is nothing but the celebrated Solow residual and consists of the sum of the growth rates of productivity of both sectors, weighted by their shares in production, i.e. $\varepsilon \cdot d\pi$. Increased factor productivity also raises the wages of skilled and unskilled workers and, as a result, employment, output and income rise further. This contribution of employment growth to the growth rate of income is measured by $\lambda \cdot \varepsilon \cdot d\pi$, and its strength depends on the elasticity of the labour supply to changes in wages, λ. Favourable domestic shocks therefore raise growth rates in all countries by the same magnitude, i.e. $(1+\lambda) \cdot \varepsilon \cdot d\pi$.

To see how the competition bias determines how a country reacts to domestic shocks, assume that θ is finite and $\varepsilon_\alpha=\varepsilon_\beta=\varepsilon$. As in the benchmark case, favourable domestic shocks raise productivity equally in the α- and β-industries, raising wages, employment and output. This is captured by the term $(1+\lambda)\cdot\varepsilon\cdot d\pi$ as before. However, since the country is large in the markets for its α-products, increases in the supply of α-products are met with reductions in prices that lower production and income. This stabilizing effect of prices is measured by the term $-x\cdot\dfrac{(1+\lambda)^2}{\theta+\lambda}\cdot\varepsilon\cdot d\pi$. The more inelastic is the demand faced by each α-product (the lower is θ) and the larger is the share of the α-industry (the larger is x), the more important is this stabilizing role of prices. Since rich countries have larger α-industries, domestic shocks have smaller effects on their growth rates, i.e. $(1+\lambda)\cdot\left(1-x\cdot\dfrac{1+\lambda}{\theta+\lambda}\right)\cdot\varepsilon\cdot d\pi$.

To see how the cyclical bias determines how a country responds to domestic shocks, assume that $\theta\to\infty$ and $\varepsilon_\alpha<\varepsilon_\beta$. Now domestic shocks raise productivity in the α-industry by $\varepsilon_\alpha\cdot d\pi$, and in the β-industry by $\varepsilon_\beta\cdot d\pi$. As a result, both the Solow residual and the employment effect will be smaller in the α-industry than in the β-industry. Since rich countries have larger α-industries, domestic shocks have smaller effects on their growth rates, i.e. $(1+\lambda)\cdot\left[x\cdot\varepsilon_\alpha+(1-x)\cdot\varepsilon_\beta\right]\cdot d\pi$. Clearly, if $\varepsilon_\alpha>\varepsilon_\beta$, the converse will be true.

To sum up, in all countries domestic productivity shocks shift outwards the supplies of α- and β-products. Since rich countries produce mainly high-tech products, they face inelastic industry demands (i.e. the competition bias) and experience relatively small shifts in supplies (i.e. the cyclical bias). As a result, the effects of domestic shocks on income are small in rich countries. Poor countries, by virtue of producing primarily low-tech products, face elastic industry demands and experience relatively large shifts in supplies. This is why the effects on income of domestic shocks are large in poor countries.

Why Are Rich Countries More Sensitive to Foreign Shocks?

Foreign shocks shift industry demands. For instance, positive shocks raise production and income in the rest of the world, increasing demand for all products. Whether this leads to an increase in the demand for the domestic industry depends on the extent to which the increase in demand is met by an increase in production abroad. To the extent that the competition bias and the cyclical bias are important, the increase in the demand for the α-industry is always larger than that of the β-industry.

It is useful to start again with the benchmark case in which neither the competition bias nor the cyclical bias are present, i.e. $\theta \to \infty$ and $\varepsilon_\alpha = \varepsilon_\beta = \varepsilon$. A favourable foreign shock consists of an increase in average productivity abroad of magnitude $\varepsilon \cdot d\Pi$ in both industries and therefore raises worldwide demand and production of both α- and β-products. However, it follows from Equation (12) that this has no effect in the domestic economy. The reason is simple and follows from three assumptions. First, the assumption of homothetic preferences ensures that, at given prices, the relative demands for both types of products are unaltered as income grows. Second, the assumption that $\varepsilon_\alpha = \varepsilon_\beta$ ensures that, at given prices, the relative supplies of both industries are unaltered as productivity grows. Third, our assumption that $\theta \to \infty$ ensures that consumers are very willing to switch their consumption expenditures over different varieties of products. The first two assumptions mean that the increases in the foreign supplies of both industries match exactly the increase in demands for both industries. This is why p does not change (recall Equation (9)). The third assumption means that despite the change in relative supplies of different varieties of α-products, there are no changes in their relative prices.

To see how the competition bias affects how a country reacts to foreign shocks, assume that θ is finite and $\varepsilon_\alpha = \varepsilon_\beta = \varepsilon$. It is still true that after a favourable foreign shock the increases in the foreign supplies of both industries match exactly the increase in demands at the industry level. As a result p is not affected. However, since the increase in demand for domestic α-products is not matched by increased

production abroad, the price of these varieties increases. This stimulates wages, employment and production in the α-industry. This effect is measured by

$x \cdot \dfrac{(1+\lambda)^2}{\theta + \lambda} \cdot \varepsilon \cdot d\pi$, and is larger the more inelastic is the demand faced by each α-product (the lower is θ) and the larger is the share of the α-industry (the larger is x). Since rich countries have larger α-industries, foreign shocks have larger effects on their growth rates.

To see how the cyclical bias determines how a country reacts to foreign shocks, assume that $\theta \to \infty$ and $\varepsilon_\alpha < \varepsilon_\beta$. At given prices, we have now that a favourable foreign shock raises the world supply of α-products (β-products) by less (more) than its demand. As a result, there is an excess demand for α-products and an excess supply of β-products that leads to an increase in p (recall Equation (9)). From the point of view of the country, this is an increase in the demand for the domestic α-industry and a decrease in the demand for the domestic β-industry. These demand shifts raise wages, employment and production in the α-industry, while lowering them in the β-industry. The combined effect in both industries is measured by $(1+\lambda) \cdot (x - \nu) \cdot \left(\varepsilon_\beta - \varepsilon_\alpha \right)$ and its sign depends on whether the country is a net exporter of α- or β-products. Since rich countries have larger α-industries, foreign shocks have larger effects on their growth rates.

To sum up, foreign shocks shift the demands of both industries at home. Since rich countries have a larger share of high-tech products, they have little competition from foreign suppliers (i.e. the competition bias) and specialize in industries whose prices move with the world cycle (i.e. the cyclical bias). As a result, effects of foreign shocks are positive and large. Poor countries produce low-tech products and, as a result, face stiff competition form abroad and specialize in products whose price moves against the world cycle. As a result, the effects of foreign shocks are less positive than in rich countries, and they might even be negative.

The Role of Commodity Trade

In this model, the properties of business cycles differ across countries because countries have different industrial structures, as measured by x. There are many determinants of the industrial structure of a country. We focus here on perhaps the most important of such determinants, that is, a country's ability to trade. In fact, if we deny this ability to the countries that populate our theoretical world, their business cycles would have identical properties. In a world of autarky, x=v in every country and commodity prices are determined by domestic conditions. In such a world the sensitivities of growth rates to domestic and foreign shocks would be the same in all

countries, $\xi_\pi^A = (1+\lambda) \cdot \left[v \cdot \varepsilon_\alpha + (1-v) \cdot \varepsilon_\beta \right]$ and $\xi_\Pi^A = 0$; and the Volatility and

Comovement graphs would be flat, $V^A = (1+\lambda) \cdot \left[v \cdot \varepsilon_\alpha + (1-v) \cdot \varepsilon_\beta \right]$ and

$C^A = \sqrt{\sigma}$.[11]

Moving from a world of autarky to a world of free trade affects the industrial structure of countries since in free trade the relative prices of those products in which a country has comparative advantage are higher than in autarky. Higher prices imply higher industry shares, even if production remains constant. But one would also expect higher prices to stimulate employment and production. These increases in employment could come from unemployment, as is the case in the model presented here. Or they could come from employment in other industries, as it would be the case if we changed our assumptions and allowed both industries to use both types of workers.

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[11] This result depends on the assumption that the elasticity of substitution between α-products and β-products is one. Otherwise, industrial structures would also be different in autarky and the cross-section of business cycles would exhibit some variation.

3. Monetary Policy

In this section we extend the model by introducing monetary shocks as an additional source of business cycles fluctuations. As is customary in the literature on money and business cycles, we assume that monetary policy is erratic. This simplification is adequate if one takes the view that monetary policy has objectives other than stabilizing the cycle. For instance, if the inflation tax is used to finance a public good, shocks to the marginal value of this public good are translated into shocks to the rate of money growth. Alternatively, if a country is committed to maintaining a fixed parity, shocks to foreign investors' confidence in the country are translated into shocks to the nominal interest rate, as the monetary authorities use the latter to manage the exchange rate.

We motivate the use of money by assuming that firms face a cash-in-advance constraint.[12] In particular, firms have to use cash in order to pay a fraction of their wage payments before production starts. Firms borrow cash from the government and repay the cash plus interest after production is completed and output is sold to consumers. Monetary policy consists of setting the interest rate on cash, and then distributing the proceeds or losses in a lump-sum fashion among consumers. Increases in the interest rate raise the financing costs of firms, reducing wages, employment and output. In this model, interest-rate shocks are therefore formally equivalent to supply shocks such as changes in production or payroll taxes.

The Model with Money

Let ι be the interest rate on cash. Since monetary policy varies across countries, each country is now defined by a quadruplet (μ,δ,π,ι). We construct the process for interest-rate shocks following the same steps we used to construct the

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[12] See Christiano, Eichenbaum and Evans (1997) for a discussion of related models.

process for productivity shocks in Section 1. The interest rate ι consists of two independent pieces: a global component, I, and a country-specific component, $\iota-I$. Moreover, the country-specific components are independent across countries. Both the global component and the country-specific components of interest rates are reflecting Brownian motions on the interval $\left[-\dfrac{\bar{\iota}}{2}, \dfrac{\bar{\iota}}{2}\right]$, with zero drift and instantaneous variances $\phi \cdot dt$ and $(1-\phi) \cdot dt$ respectively, where $\bar{\iota}$ is a positive constant and $0<\phi<1$. These assumptions imply that the interest rate ι is a Brownian motion with zero drift and unit variance reflected on the interval $\left[I-\dfrac{\bar{\iota}}{2}, I+\dfrac{\bar{\iota}}{2}\right]$. The initial cross-sectional distribution of the country-specific components, $H(\iota-I)$, is uniform on $\left[-\dfrac{\bar{\iota}}{2}, \dfrac{\bar{\iota}}{2}\right]$ and hence does not change over time. From the perspective of a (μ,δ,π,ι)-country, we define $d\iota$ and dI as domestic and foreign interest-rate shocks and note that their correlation coefficient is $\sqrt{\phi}$. Finally, productivity shocks and interest-rate shocks are assumed to be independent.

The introduction of monetary policy leads to minor changes in the equilibrium of the model. Since cash-in-advance constraints only affect firms, the consumer's problem is not altered and both the spending rules and the labour supplies in Equations (3)-(4) remain valid. Regarding firms, we assume that a fraction of wage payments κ_α and κ_β in the α- and β-industries have to be made in cash before production starts. Consequently, the costs of producing a small set of products of measure dz include not only the unit labour requirements, $e^{-\varepsilon_\alpha \cdot \pi} \cdot dz$ and $e^{-\varepsilon_\beta \cdot \pi} \cdot dz$, but also the financing costs, $e^{\kappa_\alpha \cdot \iota} \cdot dz$ and $e^{\kappa_\beta \cdot \iota} \cdot dz$.[13] As a result, Equations (5)-(6) have to be replaced by:

$$p_\alpha = \frac{\theta}{\theta-1} \cdot r \cdot e^{-\varepsilon_\alpha \cdot \pi + \kappa_\alpha \cdot \iota} \tag{15}$$

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[13] We are using the following approximations here: $\kappa_\alpha \cdot \iota \approx \ln(1+\kappa_\alpha \cdot \iota)$ and $\kappa_\beta \cdot \iota \approx \ln(1+\kappa_\beta \cdot \iota)$.

$$p_\beta = w \cdot e^{-\epsilon_\beta \cdot \pi + \kappa_\beta \cdot \iota} \tag{16}$$

An interesting novelty of the model with money is that it indicates another potential source for the cyclical bias. Even if productivity is equally volatile in both industries, i.e. $\epsilon_\alpha = \epsilon_\beta$, unit costs could still be more volatile in the β-industry if the cash-in-advance constraint is more binding there, $\kappa_\beta > \kappa_\alpha$. Finally, a straightforward extension of the arguments in Section 1 can be used to show that Equation (8) is still valid, while Equations (7) and (9) must be replaced by:[14]

$$p_\alpha = \chi \cdot p^{1-v} \cdot \left(\frac{\mu}{\delta}\right)^{\frac{1}{\theta+\lambda}} \cdot e^{-\frac{(1+\lambda)\cdot\epsilon_\alpha\cdot(\pi-\Pi)-\lambda\cdot\kappa_\alpha\cdot(\iota-I)}{\theta+\lambda}} \tag{17}$$

$$p = \psi \cdot e^{(\epsilon_\beta-\epsilon_\alpha)\cdot\Pi-\frac{\lambda}{1+\lambda}\cdot(\kappa_\beta-\kappa_\alpha)\cdot I} \tag{18}$$

Equations (15)-(18) are natural generalizations of Equations (5), (6), (7) and (9). As the cash-in-advance constraints become less important, i.e. $\kappa_\alpha \to 0$ and $\kappa_\beta \to 0$, this model converges to the model without money presented in Section 1.

Properties of Business Cycles

With the addition of interest-rate shocks, income growth in the $(\mu, \delta, \pi, \iota)$-country is given by this generalization of Equation (10):[15]

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[14] The constants χ and ψ are now given by:

$$\chi^{\theta-1} = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \int_{0}^{1} \int_{0}^{1} \mu \cdot \left(\frac{\mu}{\delta}\right)^{-\frac{\theta-1}{\theta+\lambda}} \cdot e^{\frac{\theta-1}{\theta+\lambda}\cdot\left((1+\lambda)\cdot\epsilon_\alpha\cdot(\pi-\Pi)-\lambda\cdot\kappa_\alpha\cdot(\iota-I)\right)} \cdot dF(\mu,\delta) \cdot dG(\pi-\Pi) \cdot dH(\iota-I)$$

$$\psi^{1+\lambda} \cdot \chi^{\theta+\lambda} = \frac{v}{1-v} \cdot \left(\frac{\theta}{\theta-1}\right)^\lambda \cdot \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \int_{0}^{1} \int_{0}^{1} (1-\delta) \cdot e^{\left((1+\lambda)\cdot\epsilon_\beta\cdot(\pi-\Pi)-\lambda\cdot\kappa_\beta\cdot(\iota-I)\right)} \cdot dF(\mu,\delta) \cdot dG(\pi-\Pi) \cdot dH(\iota-I)$$

[15] To compute income, remember that financing costs are not really a cost for the economy as a whole but a transfer from firms to consumers via the government.

$$d\ln y - E[d\ln y] = \xi_\pi \cdot d\pi + \xi_\Pi \cdot d\Pi - \xi_\iota \cdot d\iota - \xi_I \cdot dI \qquad (19)$$

where $\xi_\pi(\mu,\delta,\pi,\iota)$ and $\xi_\Pi(\mu,\delta,\pi,\iota)$ are still defined by Equations (11)-(12) and $\xi_\iota(\mu,\delta,\pi,\iota)$ and $\xi_I(\mu,\delta,\pi,\iota)$, which measure the sensitivity of income growth to domestic and foreign interest-rate shocks, are given by:

$$\xi_\iota = \lambda \cdot \left[x \cdot \kappa_\alpha \cdot \frac{\theta-1}{\theta+\lambda} + (1-x) \cdot \kappa_\beta \right] \qquad (20)$$

$$\xi_I = \lambda \cdot \left[x \cdot \kappa_\alpha \cdot \frac{1+\lambda}{\theta+\lambda} + (x-v) \cdot \left(\kappa_\beta - \kappa_\alpha \right) \right] \qquad (21)$$

Equations (11)-(12) and (19)-(21) provide a complete characterization of the business cycles of a (μ,δ,π,ι)-country. As $\kappa_\alpha \to 0$ and $\kappa_\beta \to 0$, we have that $\xi_\iota \to 0$ and $\xi_I \to 0$ and business cycles are driven only by productivity shocks. As $\varepsilon_\alpha \to 0$ and $\varepsilon_\beta \to 0$, we have that $\xi_\pi \to 0$ and $\xi_\Pi \to 0$ and business cycles are driven only by interest-rate shocks. In the general case, however business cycles result from the interaction of both type of shocks.

A comparison of (20)-(21) with (11)-(12) reveals that the effects of domestic and foreign monetary shocks are very similar to those of productivity shocks. As mentioned earlier, differences in the prevalence of cash-in-advance constraints provide an alternative source of cyclical bias, i.e. κ_α and κ_β play the same role in (20) and (21) as ε_α and ε_β do in (11) and (12). In contrast to productivity shocks, however, monetary shocks only have indirect effects on production through their effects on wages and labour supplies. Therefore, the sensitivity of income growth to monetary shocks is smaller, i.e. the term $(1+\lambda)$ which premultiplies (11) and (12) is replaced with λ.

Since we now have two sources of business cycles, world average growth is given by:

$$d\ln Y - E[d\ln Y] = \omega_\Pi \cdot d\Pi - \omega_I \cdot dI \tag{22}$$

where ω_Π is still defined by Equation (14) while ω_I is given by:

$$\omega_I = \lambda \cdot \left[v \cdot \kappa_\alpha + (1-v) \cdot \kappa_\beta \right] \tag{23}$$

If productivity shocks are negligible $\varepsilon_\alpha = \varepsilon_\beta = 0$, we have the following result:[16]

PROPOSITION 2: The functions C and V depend, at most, on x. Moreover:

(i) If $\kappa_\beta = \kappa_\alpha \cdot \dfrac{\theta-1}{\theta+\lambda}$, then $\dfrac{\partial V}{\partial x} = \dfrac{\partial C}{\partial x} = 0$ for all x;

(ii) If $\kappa_\beta > \kappa_\alpha \cdot \dfrac{\theta-1}{\theta+\lambda}$, then $\dfrac{\partial V}{\partial x} < 0$ and $\dfrac{\partial C}{\partial x} > 0$ for all x; and

(ii) If $\kappa_\beta < \kappa_\alpha \cdot \dfrac{\theta-1}{\theta+\lambda}$, then $\dfrac{\partial V}{\partial x} > 0$ and $\dfrac{\partial C}{\partial x} < 0$ for all x.

Proposition 2 is the natural analog to Proposition 1 in a world in which business cycles are driven only by interest-rate shocks. The competition and cyclical biases cause cross-country differences in business cycles, regardless of whether the cycles are driven by productivity shocks or interest-rate shocks. The intuition of why the competition bias and the cyclical bias generate these patterns in a cross-section of business cycles has been discussed at length in Section 2 and need not be

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[16] Note that in this case $V = \sqrt{(1-\sigma)\cdot\xi_\iota^2 + \sigma\cdot(\xi_\iota+\xi_I)^2}$ and $C = \dfrac{(\xi_\iota+\xi_I)\cdot\sqrt{\phi}}{\sqrt{(1-\phi)\cdot\xi_\iota^2 + \phi\cdot(\xi_\iota+\xi_I)^2}}$.

The proof is analogous to that of Proposition 1.

repeated here. Instead, we generalize Propositions 1 and 2 to the case where both productivity shocks and interest rate shocks drive business cycles, as follows:[17]

PROPOSITION 3: The functions C and V depend, at most, on x. Moreover, if $\frac{\partial V}{\partial x} < 0$ ($\frac{\partial V}{\partial x} > 0$), then $\frac{\partial C}{\partial x} > 0$ ($\frac{\partial C}{\partial x} < 0$). Define:

$$A = (1 - \sigma) \cdot (1 + \lambda)^2 \cdot \left(\varepsilon_\alpha \cdot \frac{\theta - 1}{\theta + \lambda} - \varepsilon_\beta \right) \cdot \varepsilon_\beta + (1 - \phi) \cdot \lambda^2 \cdot \left(\kappa_\alpha \cdot \frac{\theta - 1}{\theta + \lambda} - \kappa_\beta \right) \cdot \kappa_\beta ;$$

$$B = (1 - \sigma) \cdot (1 + \lambda)^2 \cdot \left(\varepsilon_\alpha \cdot \frac{\theta - 1}{\theta + \lambda} - \varepsilon_\beta \right)^2 + (1 - \phi) \cdot \lambda^2 \cdot \left(\kappa_\alpha \cdot \frac{\theta - 1}{\theta + \lambda} - \kappa_\beta \right)^2 .$$

Then,

(i) If A>0, $\frac{\partial V}{\partial x} > 0$ for all x;

(ii) if -B≤A≤0, $\frac{\partial V}{\partial x} \leq 0$ ($\frac{\partial V}{\partial x} \geq 0$) if $x \leq -\frac{A}{B}$ ($x \geq -\frac{A}{B}$); and

(iii) if A<-B, then $\frac{\partial V}{\partial x} < 0$ for all x.

Proposition 3 provides a set of necessary and sufficient conditions for the functions V and C to exhibit the same slopes than their empirical counterparts. Let x* be the highest value for x in a cross-section of countries. Then, a necessary and sufficient condition for business cycles to be less volatile and more synchronized with the world cycle in rich countries is that A+B·x*≤0. This condition is always satisfied if both types of shocks generate industry responses with the right biases, i.e.

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[17] Note that $V = \sqrt{(1 - \sigma) \cdot \xi_\pi^2 + \sigma \cdot (\xi_\pi + \xi_\Pi)^2 + (1 - \phi) \cdot \xi_\iota^2 + \phi \cdot (\xi_\iota + \xi_I)^2}$ and

$$C = \frac{\sigma \cdot \omega_\Pi \cdot (\xi_\pi + \xi_\Pi) + \phi \cdot \omega_I \cdot (\xi_\iota + \xi_I)}{\sqrt{\left(\sigma \cdot \omega_\Pi^2 + \phi \cdot \omega_I^2 \right) \cdot \left((1 - \sigma) \cdot \xi_\pi^2 + \sigma \cdot (\xi_\pi + \xi_\Pi)^2 + (1 - \phi) \cdot \xi_\iota^2 + \phi \cdot (\xi_\iota + \xi_I)^2 \right)}}.$$ Since neither

$\xi_\pi + \xi_\Pi$ nor $\xi_\iota + \xi_I$ depend on x, V (C) is downward (upward) sloping if and only if $(1 - \sigma) \cdot \xi_\pi^2 + (1 - \phi) \cdot \xi_\iota^2$ is decreasing (increasing) in x. The proposition describes the sign of $\frac{\partial}{\partial x} \left((1 - \sigma) \cdot \xi_\pi^2 + (1 - \phi) \cdot \xi_\iota^2 \right)$ for different parameter values.

$\varepsilon_\beta > \varepsilon_\alpha \cdot \dfrac{\theta - 1}{\theta + \lambda}$ and $\kappa_\beta > \kappa_\alpha \cdot \dfrac{\theta - 1}{\theta + \lambda}$. But this is not a necessary condition. For instance, it might be that the α-industry is more sensitive to domestic productivity (interest-rate) shocks and less sensitive to foreign productivity (interest-rate) shocks than the β-industry, $\varepsilon_\beta < \varepsilon_\alpha \cdot \dfrac{\theta - 1}{\theta + \lambda}$ ($\kappa_\beta < \kappa_\alpha \cdot \dfrac{\theta - 1}{\theta + \lambda}$), yet still business cycles are less volatile and more synchronized with the world cycle in rich countries. This naturally requires that the α-industry be less sensitive to domestic interest-rate (productivity) shocks and more sensitive to foreign interest-rate (productivity) shocks, $\kappa_\beta > \kappa_\alpha \cdot \dfrac{\theta - 1}{\theta + \lambda}$ ($\varepsilon_\beta > \varepsilon_\alpha \cdot \dfrac{\theta - 1}{\theta + \lambda}$).

4. Trade Integration

The postwar period has seen large reductions in both physical and policy barriers to commodity trade. Here we do not attempt to explain these changes but instead explore how parametric reductions in transport costs affect the cross-section of business cycles. Throughout, we assume that transport costs are small enough relative to cross-country differences in factor endowments that all countries are either net importers or net exporters of the β-product, for any value of their domestic productivity and interest rates, and for all possible equilibrium prices. Moreover, we assume that transport costs are small enough relative to cross-country differences in technology in the α-industry that every α-product continues to be produced in only one country. These assumptions ensure that the pattern of trade is unchanged by the introduction of transport costs, although the volume of trade is negatively related to the size of transport costs.

Remember that the main theme of this paper is that the nature of business cycles a country experiences depends on its industrial structure. As transport costs decline, the prices of products in which a country has comparative advantage increase and, as a result, the share in production of these industries increases. A natural conclusion of this argument is that one should expect that reductions in transport costs (globalization?) increase the cross-country variation in the properties of business cycles. We confirm this intuition here.

The Model with Transport Costs

We generalize the model with money by assuming that trade incurs transport costs of the "iceberg" variety, i.e. if $\tau > 1$ units of output are shipped across borders, only one unit arrives at the destination while $\tau - 1$ units "melt" in transit. Let $p_\alpha(z)$ and $p_\beta(z)$ now denote the f.o.b. or international price of variety z of the α-products and of

the β-products, respectively. We use the same normalization rule as before in terms of these international prices, and define p as as the average f.o.b. price of α-products relative to β-products. The presence of transport costs implies that the c.i.f. or domestic product prices vary across countries. In each country, the c.i.f. prices of imports and import-competing products are higher than the f.o.b. prices while the c.i.f. prices of exports are equal to the f.o.b. prices. Since countries import all the varieties of α-products they do not produce, the c.i.f. price of all but the infinitesimal measure μ of domestically-produced α-products is $\tau \cdot p_\alpha(z)$. Similarly, the c.i.f. price of β-products is $\tau \cdot p_\beta(z)$ if the country is a net importer of β-products, and $p_\beta(z)$ otherwise.

Note that the consumer continues to allocate consumption expenditures (evaluated at c.i.f. prices) over commodities exactly as before. The consumer's labour supply decision is also unchanged: consumers work if and only if the applicable wage, expressed in terms of a unit of consumption, exceeds their reservation wage. However, since consumers located in different countries face different c.i.f. prices, the price of a unit of consumption now varies across countries. Let $p_C(\mu,\delta,\pi,\iota)$ denote the ideal price index of consumption in a (μ,δ,π,ι)-country. This index is given by τ if the country is a net importer of the β-product, and τ^ν otherwise.[18] Therefore, we need to replace Equations (3)-(4) by the following generalizations:

$$s = \delta \cdot \left(\frac{r}{\gamma \cdot p_C} \right)^\lambda \tag{24}$$

$$u = (1-\delta) \cdot \left(\frac{w}{\gamma \cdot p_C} \right)^\lambda \tag{25}$$

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[18] To see this, use the normalization rule and recall that all countries import all but the infinitesmal number of α-products produced domestically, and so incurr the transport cost on (almost) their entire consumption of α-products, which constitute a fraction ν of total expenditure. In addition, consumers in countries that are net importers of β-products face a c.i.f. price of $\tau \cdot p_\beta$ for their remaining expenditure on β-products.

Since α-products are exported in all countries, producers face identical c.i.f. and f.o.b. prices and, as a result, Equation (15) is still valid. However, Equation (16) is only valid in countries that export β-products. In countries that import β-products, the producer price of these products is $\tau \cdot p_\beta$, and, as a result, Equation (16) has to be replaced by:

$$\tau \cdot p_\beta = w \cdot e^{-\varepsilon_\beta \cdot \pi + \kappa_\beta l} \tag{26}$$

Straightforward but somewhat tedious algebra reveals that the expressions for equilibrium prices in Equations (8), (17) and (18) still hold, provided that we replace δ and $1-\delta$ with $\delta \cdot \tau^{-\lambda}$ and $\tau \cdot (1-\delta)$ if the country is a net importer of β-products, and with $\delta \cdot \tau^{-\lambda v}$ and $(1-\delta) \cdot \tau^{-\lambda \cdot v}$ otherwise.[19]

While trade patterns are unchanged, the world economy with transport costs exhibits less cross-country variation in industrial structures than the world economy with free trade. The higher the transport costs are, the lower is the price of those industries in which the country has comparative advantage. That is, the lower is the price of α-products (β-products) in rich (poor) countries. For the reasons mentioned before, this leads to an reduction in the share of the α-industry (β-industry) in rich (poor) countries.[20]

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[19]To derive the analog to Equation (17), we can equate the ratio of world expenditure on the (sum of all) α-products in any two countries to the ratio of the value of productions as before. Using the new expressions for wages in the expressions for factor supplies results in

$$p_{\alpha'} = p_\alpha \cdot \left(\frac{\mu' \cdot \delta \cdot p_C^{-\lambda}}{\mu \cdot \delta' p_{C'}^{-\lambda}} \right)^{\frac{1}{\theta+\lambda}} \cdot e^{\frac{1+\lambda}{\theta+\lambda} \cdot \varepsilon_\alpha \cdot (\pi - \pi') - \frac{\lambda}{1+\lambda} \cdot \kappa_\alpha \cdot (\iota - \iota')}$$

. Inserting this in the ideal price index

for the α-industry yields the appropriate modification of Equation (17). Equation (8) is simply a consequence of our unchanged normalization rule. To obtain the analog to Equation (18), note first that the presence of transport costs implies that the market -clearing conditions in the α- and β-industries can now be expressed as equating the value of world production at producer prices to the value of world consumption at consumer prices for all α- and β-products. Then, using the analog to Equation (17), the new expressions for factor prices, and the factor supplies we can equate the ratio of expenditure in both industries to the ratio of productions at producer prices to obtain the appropriate modification of (18).
[20] It is straightforward to verify this by substituting the expressions for equilibrium wages and employment into the definition of x and differentiating with respect to τ.

Business Cycles and Transport Costs

The (demeaned) growth rate of income is still given by Equations (11)-(12) and (19)-(21). Consequently, Proposition 3 relating the properties of business cycles to a country's industrial structure still holds. However, transport costs reduce the volume of trade and, as a result, the cross-sectional dispersion in x. This implies that the cross-section of business cycles exhibits less variation in the model with transport costs than in the free-trade model.

A process of parametric reductions in transport costs has opposite effects on the business cycles of rich and poor countries. If the competition and cyclical biases are important, we know that the Volatility and Comovement graphs are downward and upward sloping with x, respectively. Therefore, reductions in transport costs lower the volatility of business cycles in rich countries (as their x increases) and raise volatility in poor countries (as their x decreases). Similarly, reductions in transport costs make business cycles more synchronized with the world cycle in rich countries (as their x increases) and less synchronized with the world cycle in poor countries (as their x decreases).

5. Terms of Trade Shocks

In this section, we develop implications of the theory for the cross-section of the (growth of the) terms of trade. Often, changes in the terms of trade are assumed to be exogenous to the model, as part of the description of the "shocks" to the system. The advantage of a world equilibrium model is that it removes this degree of freedom by determining the behavior of the terms of trade in terms of more primitive sources of fluctuations. We exploit this feature here to show that the competition and cyclical bias hypothesis have different implications for how the volatility and comovement of the (growth rate of the) terms of trade vary with the industrial structure of a country. Although in principle these implications could be used to empirically distinguish between our two hypotheses, a first look at the data yields somewhat inconclusive results.

Properties of the Terms of Trade

Let $T(\mu,\delta,\pi,\iota)$ denote the terms of trade of a (μ,δ,π,ι)-country, defined as the ideal price index of production relative to the ideal price index of consumption. We refer to the (detrended) growth rate in the terms of trade of a country as its terms of trade shock.[21] Using the expressions for prices in Equations (8) and (19)-(20), this is given by:

$$d\ln T - E[d\ln T] = \xi_\pi^T \cdot d\pi + \xi_\Pi^T \cdot d\Pi - \xi_\iota^T \cdot d\iota - \xi_I^T \cdot dI \tag{27}$$

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[21] It is straightforward to show that the growth rate of T in (27) is equivalent to the growth rate in the ideal price index for exports, weighted by the share of exports in income, less the growth rate of the ideal price index for imports weighted by the share of imports in income. We use this alternative formulation when we turn to the data.

where $\xi_\pi^T(\mu,\delta,\pi,\iota)$ and $\xi_\Pi^T(\mu,\delta,\pi,\iota)$ measure the sensitivity of the growth in the terms of trade to domestic and foreign productivity shocks, while $\xi_\iota^T(\mu,\delta,\pi,\iota)$ and $\xi_I^T(\mu,\delta,\pi,\iota)$ measure the sensitivity to domestic and foreign monetary shocks, and are given by

$$\xi_\pi^T = -x\cdot\varepsilon_\alpha\cdot\frac{1+\lambda}{\theta+\lambda} \tag{28}$$

$$\xi_\Pi^T = x\cdot\varepsilon_\alpha\cdot\frac{1+\lambda}{\theta+\lambda}+(x-v)\cdot(\varepsilon_\beta-\varepsilon_\alpha) \tag{29}$$

$$\xi_\iota^T = -x\cdot\kappa_\alpha\cdot\frac{\lambda}{\theta+\lambda} \tag{30}$$

$$\xi_I^T = x\cdot\kappa_\alpha\cdot\frac{\lambda}{\theta+\lambda}+(x-v)\cdot(\kappa_\beta-\kappa_\alpha)\cdot\frac{\lambda}{1+\lambda} \tag{31}$$

The intuitions for these expressions should be familiar. Increases in domestic productivity (decreases in domestic interest rates) raise the supply of domestically-produced varieties of the α-products. If the competition bias is present, this leads to a decline in their price as countries are "large" suppliers in their export markets, constituting an adverse terms of trade shock for the domestic economy. This is captured by Equations (28) and (30), which vanish as $\theta\to\infty$ and the competition effect disappears. Increases in foreign productivity (decreases in foreign interest rates) raise the demand for α-products in all countries and provided that θ is finite, raise their price as well (See Equation (17)). This constitutes a favourable terms of trade shock for all countries, and is larger the richer is a country (the larger is its share of α-products in production). In addition, provided that $\varepsilon_\alpha<\varepsilon_\beta$ ($\kappa_\alpha<\kappa_\beta$), foreign shocks create an excess demand for all α-products relative to β-products, leading to an increase in the relative price of all α-products (See Equation (18)). This constitutes a positive (negative) terms of trade shock for net exporters (importers) of α-products with $x>v$ ($x<v$).

Empirical Implications

Let $V^T(\mu,\delta,\pi,\iota)$ denote the standard deviation of the (detrended) growth of the terms of trade of a (μ,δ,π,ι)-country, and let $C^T(\mu,\delta,\pi,\iota)$ denote its correlation with world average output growth. We refer to these statistics as the Terms of Trade Comovement and Volatility graphs. We have the following result:[22]

PROPOSITION 4: The functions C^T and V^T depend, at most, on x. Define:

$$D = \left[(1-\sigma)\cdot\varepsilon_\alpha + (1-\phi)\cdot\kappa_\alpha\right]\cdot\frac{1+\lambda}{\theta+\lambda};$$

$$E = \sigma\cdot\left(\varepsilon_\beta - \varepsilon_\alpha\right)^2 + \phi\cdot\left(\kappa_\beta - \kappa_\alpha\right)^2;$$

$$M = \sigma\cdot(1+\lambda)\cdot\left[v\cdot\varepsilon_\alpha + (1-v)\cdot\varepsilon_\beta\right]\cdot(\varepsilon_\beta - \varepsilon_\alpha) + \phi\cdot\lambda\cdot\left[v\cdot\kappa_\alpha + (1-v)\cdot\kappa_\beta\right]\cdot(\kappa_\beta - \kappa_\alpha).$$

Then,

(i) $\dfrac{\partial V^T}{\partial x} \le 0$ ($\dfrac{\partial V^T}{\partial x} \ge 0$) if $x \le v\cdot\dfrac{E}{D+E}$ ($x \ge v\cdot\dfrac{E}{D+E}$); and

(ii) $C^T = 0$ if $x = v$ and $\dfrac{\partial C^T}{\partial x} \le 0$ ($\dfrac{\partial C^T}{\partial x} \ge 0$) if $M \le 0$ ($M \ge 0$) for all x.

Proposition 4 shows that the model predicts the Volatility graph for the terms of trade to have a U-shaped form, with minimum at $v\cdot\dfrac{E}{D+E}$. Since both D and E are non-negative, the minimum of this function is in the interval [0,v]. Empirically, one should expect most countries to have x<v, as the average country lies well above the median country in the world income distribution. Therefore, the theory does not impose tight restrictions on how a cross-section of terms of trade shocks would look. If D is small relative to E, we would expect most countries to be in the downward-

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[22]To prove this, note first that V^T and C^T are identical to V and C as given in footnote 17, provided that we replace the growth rate sensitivities with the terms of trade sensitivities given in (28)-(31).

Performing this substitution, we find that $V^T = \sqrt{D\cdot x^2 + E\cdot(x-v)^2}$ and

$C^T = \dfrac{M\cdot E\cdot v\cdot x}{V^T\cdot\sqrt{\sigma\cdot\left[v\cdot\varepsilon_\alpha + (1-v)\cdot\varepsilon_\beta\right]^2 + \phi\left[v\cdot\kappa_\alpha + (1-v)\cdot\kappa_\beta\right]^2}}$. The proposition then describes the signs of

the derivatives of these expressions with respect to x.

sloping region of V^T. If D is large relative to E, we would expect most countries to be in the upward-sloping region of V^T. Interestingly, D and E can be loosely interpreted as a measure of the strength of the competition and cyclical biases respectively. As $\theta \to \infty$, the competition bias becomes irrelevant and $D \to 0$. As both $\varepsilon_\beta \to \varepsilon_\alpha$ and $\kappa_\beta \to \kappa_\alpha$, the cyclical bias disappears and $E \to 0$. Note that, for $E \to 0$ it is necessary that both shocks have small cyclical biases. If, for instance, $\varepsilon_\beta >> \varepsilon_\alpha$ and $\kappa_\beta << \kappa_\alpha$, the country as a whole might not exhibit a strong cyclical bias and yet E could be quite large.

Proposition 4 also shows that the Comovement graph for the terms of trade is upward-sloping if M>0 and downward-sloping if M<0. Since $C^T=0$ if x=v, it follows that, if M>0, changes in the terms of trade are positively correlated with the world cycle in rich countries, and negatively in poor countries. If M<0, the opposite is true. If M=0, the Comovement graph for the terms of trade be flat at zero. Note that M could be zero if the cyclical bias is small for both shocks, i.e. $\varepsilon_\beta \to \varepsilon_\alpha$ and $\kappa_\beta \to \kappa_\alpha$. Alternatively, M could be small even if the cyclical biases of both shocks are large but offsetting, i.e. if $\varepsilon_\beta >> \varepsilon_\alpha$ and $\kappa_\beta << \kappa_\alpha$ or $\varepsilon_\beta << \varepsilon_\alpha$ and $\kappa_\beta >> \kappa_\alpha$.

Turning to the data, Figure 3 plots the volatility and comovement of the growth rate of the terms of trade against the log-level of income for a subset of countries we used to construct Figure 1 (See also Table 2). Figure 3 suggests that changes in the terms of trade are less volatile in rich countries than in poor ones, and that changes in the terms of trade are more or less equally correlated with the world cycle in rich and poor countries. If one is willing to assume that the theory is approximately correct, one could read the top panel of Figure 3 as indicating that E>>D, while the lower panel would show that M≈0. These restrictions are consistent with the notion that the cyclical biases are large (E>>D) but go in different directions for different shocks (M≈0).

However, this neither rules out nor confirms whether the cyclical bias is more important than the competition bias in shaping the cross-section of business cycles. On the one hand, one could point to the condition that E>>D to support the view that the cyclical bias is more important than the competition bias. On the other hand, one

could stress that E>>D does not necessarily mean that D is small in absolute value, and use the condition M≈0 to argue that the competition bias is more important than the cyclical bias. In any case, given our very crude measures of the terms of trade, we are reluctant to use Figure 3 to draw sharp conclusions regarding the relative importance of our two hypotheses.

6. Concluding Remarks

We have developed two alternative explanations of the main features of the cross-section of business cycles. Both explanations rely on the observation that the law of comparative advantage leads rich countries to specialize in "high-tech" products produced by skilled workers, while poor countries specialize in "low-tech" products produced by unskilled workers. To the extent that "high-tech" and "low-tech" industries respond differently to domestic and foreign shocks, business cycles depend on the industrial structure of a country and, as a result, have different properties in rich and poor countries. We have focused on two such asymmetries: the competition bias and the cyclical bias.

Our work suggests some natural avenues for further research. On the empirical front, the theory developed here provides a rich set of testable predictions regarding the connection between the industrial structure of a country and the nature of the business cycles that it experiences. To investigate the empirical validity of these predictions, one would have to first identify asymmetries in how industries react to domestic and foreign shocks. With this evidence in hand, it would then be possible to quantify the extent to which cross-country differences in industry structure contribute to cross-country differences in the properties of business cycles.

On the theoretical front, it is natural to ask how the possibility of cross-border trade in financial instruments affects the shape of the cross-section of business cycles. In the models presented here, the price of consumption in different dates and states of nature varies across countries, creating an incentive for the establishment of an international financial market that redistributes consumption across dates and states. However, since neither factor supplies nor their productivities depend on consumption, a redistribution of the latter cannot affect output, although it certainly would affect consumption. If we want to construct an argument relating financial integration to the shape of a cross-section of business cycles, we need to link factor supplies and their productivities to consumption. One way achieve this is to modify

preferences so as to introduce income effects on the labour supply. In our opinion, a preferred option would be to allow workers and firms to invest in skills and technology, and then study how trade in financial instruments, by affecting these investments, combines with commodity trade in shaping the cross-section of business cycles.

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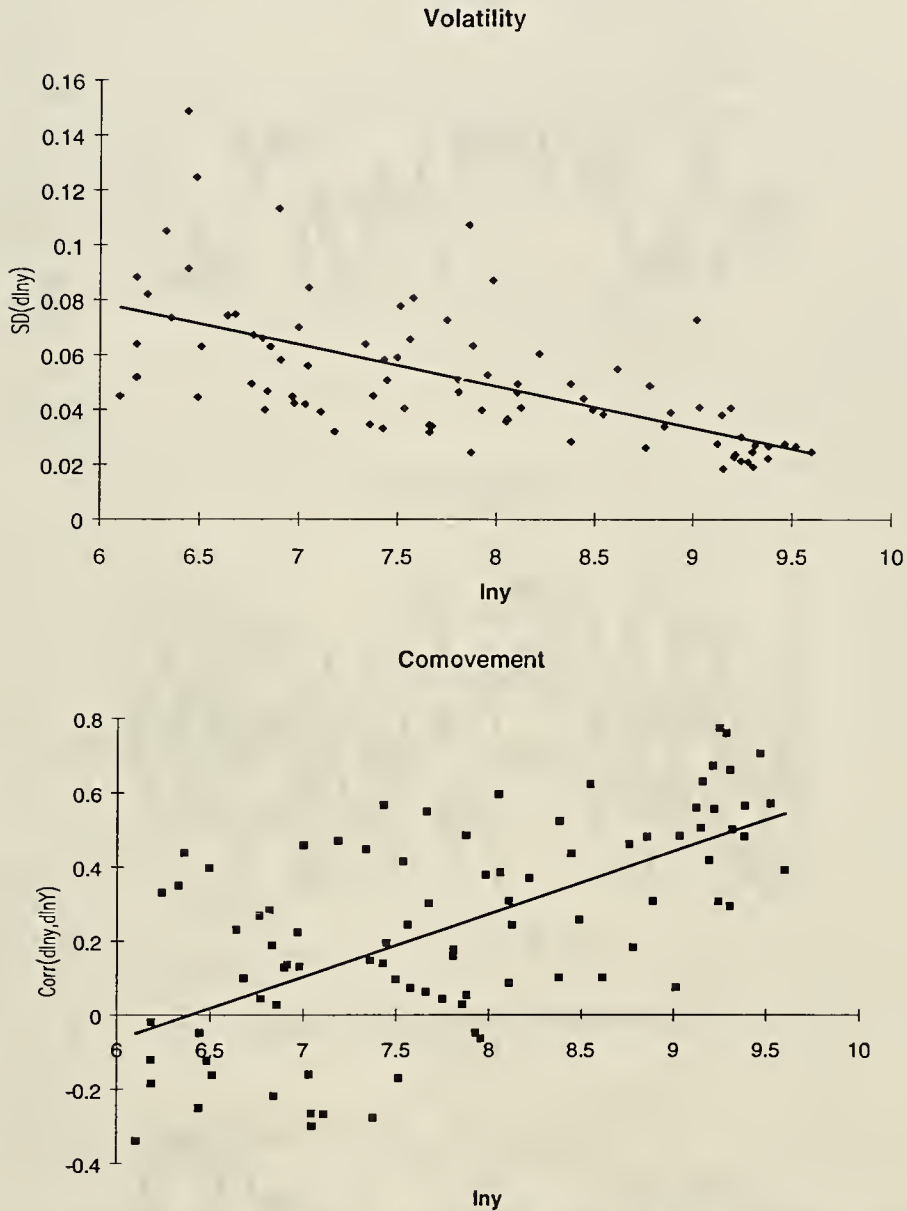Harrison, J.M. (1990), *Brownian Motion and Stochastic Flow Systems*, Krieger.

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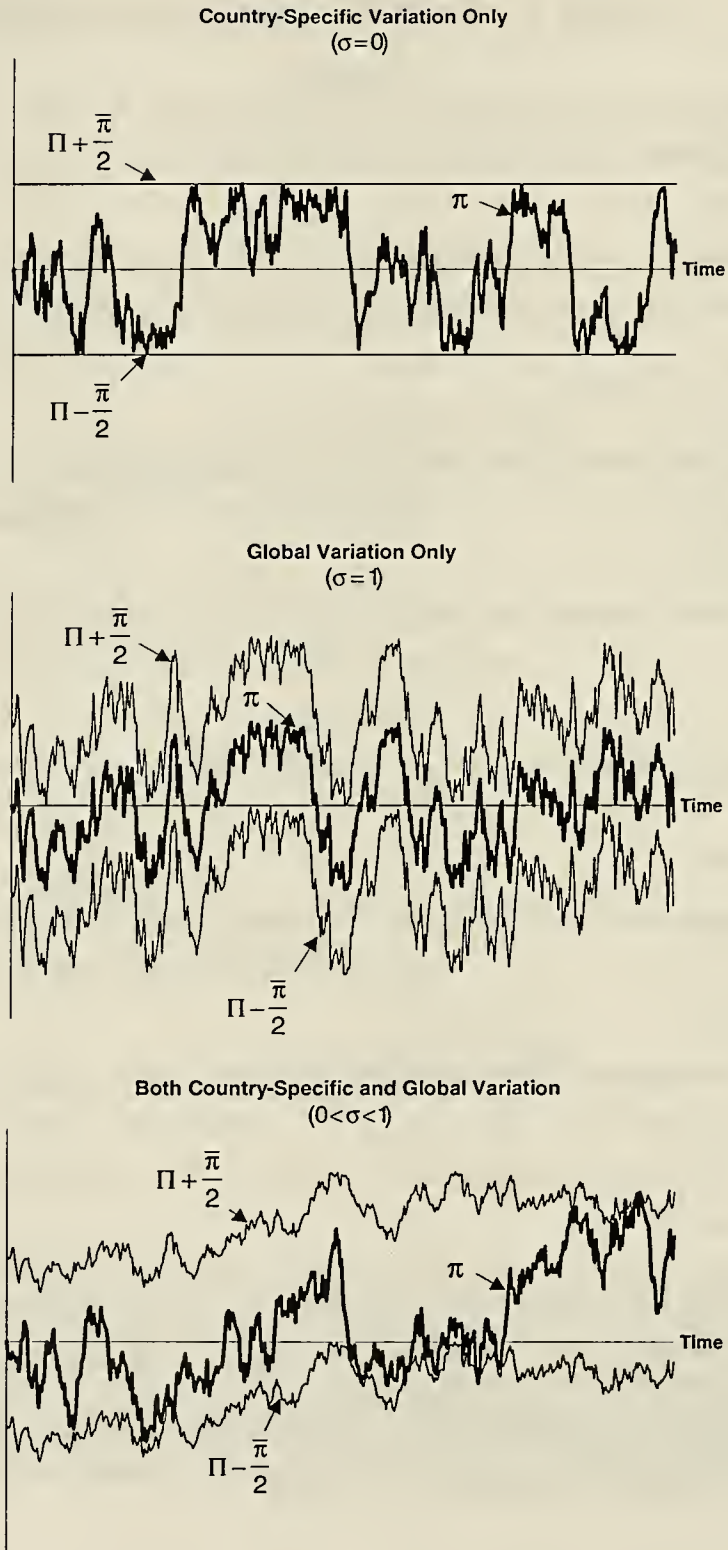Obstfeld, M. and K. Rogoff (1998), "Risk and Exchange Rates", *mimeo*.
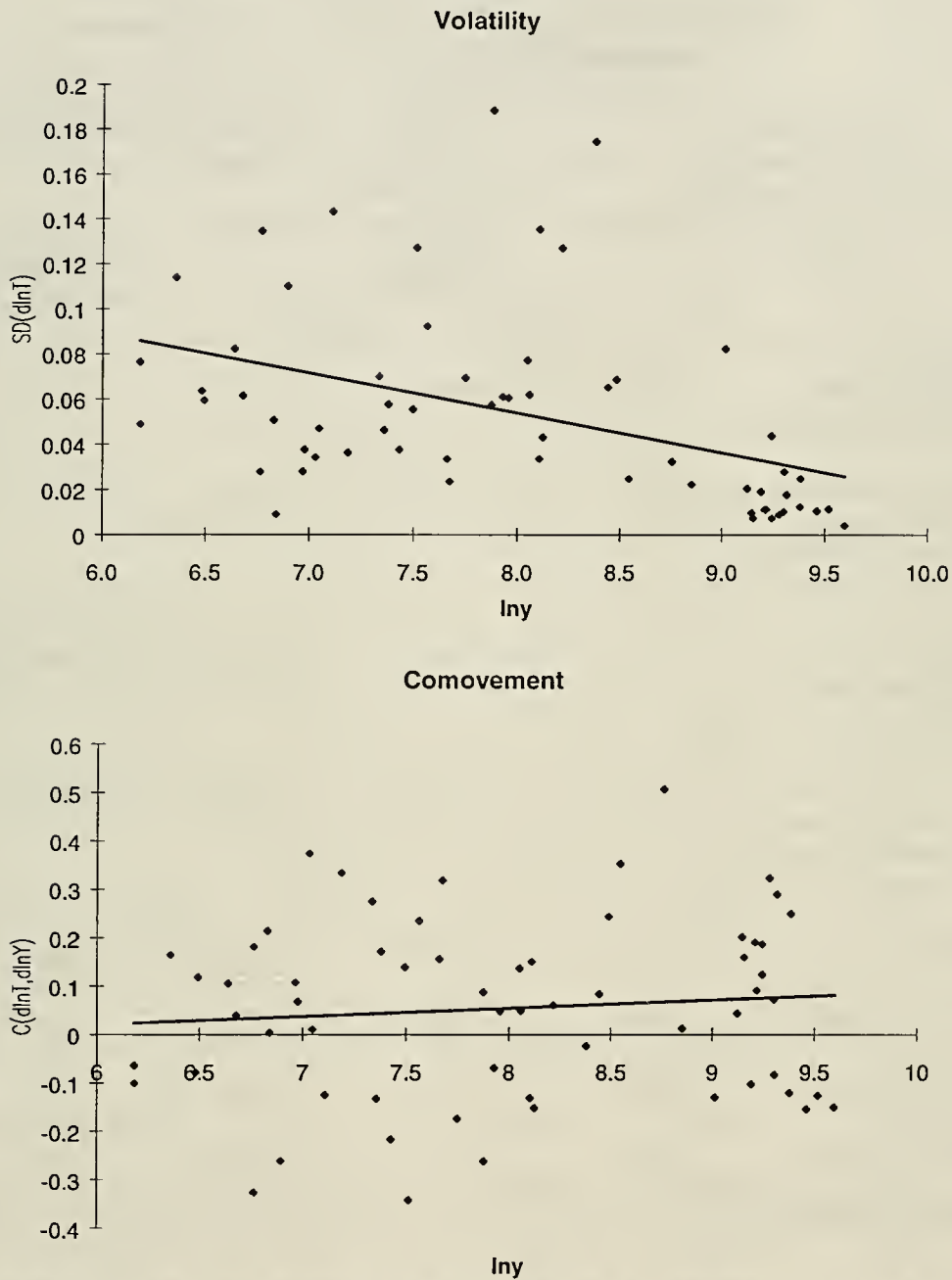
Figure 1: Volatility and Comovement

Volatility

Comovement

The top panel plots the standard deviation of the growth rate of real per capita GDP (dlny) over the period 1960-1994 against the log-level of average per capita GDP in 1985 PPP dollars over the same period (lny), for a sample of 88 countries. The bottom panel plots the correlation of real per capita GDP growth with world average per capita GDP growth excluding the country in question (dlnY) over the period 1960-1994 agains the log-level of average per capita GDP over the same period. All data are at annual frequency. The sample consists of all non-OPEC market economies with at least 30 observations on per capita income (RGDPCH) beginning in 1960 in the Penn World Tables Version 5.6, extended to 1994 using constant price local currency growth rates from the World Bank World Tables.

Figure 2: Sample Paths of the Productivity Index

Country-Specific Variation Only
$(\sigma = 0)$

$\Pi + \dfrac{\bar{\pi}}{2}$

π

Time

$\Pi - \dfrac{\bar{\pi}}{2}$

Global Variation Only
$(\sigma = 1)$

$\Pi + \dfrac{\bar{\pi}}{2}$

π

Time

$\Pi - \dfrac{\bar{\pi}}{2}$

Both Country-Specific and Global Variation
$(0 < \sigma < 1)$

$\Pi + \dfrac{\bar{\pi}}{2}$

π

Time

$\Pi - \dfrac{\bar{\pi}}{2}$

Figure 3: Volatility and Comovement of Terms of Trade

Volatility

Comovement

The top panel plots the standard deviation of the growth rate of terms of trade (dlnT) over the period 1960-1994 against the log-level of average per capita GDP in 1985 PPP dollars over the same period (lny), for a sample of 63 countries. The bottom panel plots the correlation of the growth rate of the terms of trade with world average per capita GDP growth excluding the country in question (dlnY) over the period 1960-1994 agains the log-level of average per capita GDP over the same period. All data are at annual frequency. Terms of trade growth is defined as the growth rate of the national accounts local currency export deflator times the share of exports in GDP at constant local currency prices, less the growth rate of the corresponding import deflator times the share of imports in GDP. The sample consists of all countries with complete time series on these variables in the World Bank World Tables over the period 1960-1994. Five countries for which terms of trade volatility was more than two standard deviations above the mean for all countries were dropped from the sample (Argentina, Zambia, Israel, Bolivia and Nicaragua).

Table 1: Volatility and Comovement

	Volatility (Standard deviation of real per capita GDP Growth)		Comovement (Correlation of real per capita GDP growth with world average excluding country in question)	
	Average	Correlation with ln(per capita GDP)	Average	Correlation with ln(per capita GDP)
Full Sample (88 countries, 1960-94)	.051	-.621	.240	.627
Full Sample, Non-Oil Shock years (88 countries, 1960-72, 1976-78, 1982-94)	.050	-.624	.264	.539
Full Sample, using unweighted world average growth	--	--	.259	.440
Full Sample, using deviations from linear trend instead of growth rates	.097	-.431	.525	.428
Top Quartile by Income	.031	-.573	.496	.425
Second Quartile	.050	-.407	.260	.430
Third Quartile	.051	-.094	.140	.297
Bottom Quartile	.074	-.144	.066	.238

Note: See notes to Figure 1.

Table 2: Volatility and Comovement of the Terms of Trade

	Volatility (Standard deviation of terms of trade growth)		Comovement (Correlation of terms of trade growth with world average excluding country in question)	
	Average	Correlation with ln(per capita GDP)	Average	Correlation with ln(per capita GDP)
Full Sample (84 countries, 1960-92)	.054	-.420	.054	.095
Full Sample, Non-Oil Shock years (84 countries, 1960-72, 1976-78, 1982-92)	.051	-.416	.044	-.257
Full Sample, using unweighted world average growth	--	--	.072	-.338
Full Sample, using deviations from linear trend instead of growth rates*	.066	-.387	.211	-.330
Top Quartile by Income	.015	-.153	.072	-.563
Second Quartile	.068	-.299	.074	.202
Third Quartile	.069	.238	.053	-.263
Bottom Quartile	.074	-.048	.006	.038

Note: See notes to Figure 3.
* For this row only, the level of the terms of trade is defined as a geometric average of the import and export deflators, using the export and import shares in GDP as weights.