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ABSTRACT

What are the effects of increased trade in goods and services on the trade balance? We study the effects of reducing transport costs in a Ricardian model with complete asset markets and find that this increases the volatility of the trade balance. This result applies regardless of whether supply or demand shocks are the main source of economic fluctuations. Both type of shocks generate fluctuations in the trade balance that are in part moderated by stabilizing movements in the terms of trade. Trade integration dampens these terms of trade movements and, for a given distribution of shocks, amplifies fluctuations in the trade balance. To overturn this result, one must assume that either trade integration is sufficiently biased towards goods with strong comparative advantage and/or risk aversion is sufficiently extreme. We calibrate the model to U.S. data and find that, for reasonable parameter values, increased trade in services could double the volatility of the trade balance.

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In the last thirty years, the volume of trade among industrial countries has more than tripled. During this same period, trade imbalances among these countries have grown larger and more volatile. It is natural to ask whether there is a connection between these two developments and, in particular, whether they are both driven by the same set of economic forces. Many have argued that the increased volume of trade is due to a reduction in the technological and policy-induced costs of trading goods and services.[1] Is it possible that these cost reductions are also responsible for the increase in the size and volatility of trade imbalances? If so, what are the main theoretical channels through which this happens? Are these channels quantitatively important?

Unfortunately, there is little in the form of received "wisdom" that can help us answer these questions.[2] This state of affairs reflects in part the absence of a simple workhorse model incorporating the main insights of the theories of goods and asset trade and the key interactions between them. This paper attempts to fill this gap. Our strategy is to build from the classic continuum model of Dornbusch, Fischer and Samuelson [1977] and add asset markets to it. To motivate trade in goods and services, we assume countries have different industry technologies. To motivate trade in assets, we assume countries experience imperfectly correlated shocks to technology (or "supply") and to preferences (or "demand"). As usual, we assume that some goods can be traded at negligible transport costs (the "traded" sector), while the rest can only be traded at prohibitively high transport costs (the "nontraded" sector). We interpret the process of trade integration as one in which some nontraded goods become traded.

The main theoretical result of this paper is that trade integration increases the volatility of the trade balance. This result applies regardless of whether supply or

[1] Baier and Bergstrand (2001) find that about 31 to 45 percent of the increase in the volume of trade can be explained by reductions in costs of trading goods and services. Of this total, tariff rate reductions and preferential agreements account for 23 to 26 percent, and transport cost declines for 8 to 9 percent. We think that these are very conservative estimates and the real numbers might be even higher.
[2] A remarkable exception is Cole and Obstfeld [1991], who provide an example in which a drastic reduction (from prohibitive to negligible) in the costs of trading all goods and services has no effect on the trade balance. As we shall see later, their model obtains as a special case of ours.

demand shocks are the main source of economic fluctuations. Both type of shocks generate fluctuations in the trade balance that are in part moderated by stabilizing movements in the terms of trade. Trade integration dampens these terms of trade movements and, for a given distribution of shocks, amplifies fluctuations in the trade balance. To overturn this result is not easy in our framework, but it can be done in two cases. The first one requires that trade integration be sufficiently biased towards goods with strong comparative advantage. By this we mean that the newly-traded goods must exhibit cross-country differences in productivity that are 'large' relative to those of existing traded goods. The second case requires that risk aversion be sufficiently extreme. That is, preferences must exhibit a coefficient of relative risk aversion that is either 'large' or 'small' relative to the logarithmic benchmark. However, these two exceptions are not likely to be empirically relevant.

Why does trade integration increase the effects of supply shocks on the trade balance? Economy-wide fluctuations in labour productivity lead to fluctuations in the production of each good and also in the range of traded goods produced by the country. When the traded sector is small, shocks that raise labour productivity primarily raise the production of goods already produced in the country, and this lowers their prices and worsens the terms of trade. This in turn moderates the increase in income and the trade surplus created by the shock. Similarly, shocks that lower labour productivity improve the terms of trade, moderating the resulting trade deficit. When the traded sector is large, shocks to labour productivity are mostly reflected in fluctuations in the range of goods produced at home, with only small effects on their prices and the terms of trade. By increasing the size of the traded sector, trade integration decreases the effects of supply shocks on the terms of trade and so raises the volatility of the trade balance.

Why does trade integration reduce the effects of demand shocks on the trade balance? The intuition is simple and is based on the classic analysis of the transfer problem. In the presence of transport costs, there is a home bias in consumption since domestic goods are cheaper at home than abroad. Under these conditions, shocks that increase spending re-direct demand towards domestic goods and improve the terms of trade. This raises income and finances in part the increase in spending, moderating the trade deficit. Through the same mechanism, shocks that reduce spending worsen the terms of trade, moderating the trade surplus. By weakening the home bias in consumption, trade integration lessens the effects of demand shocks on the terms of trade and raises the volatility of the trade balance.

Armed with these theoretical findings, we calibrate the model to U.S. data to provide a quantitative assessment of the effects of further trade integration. We argue that future trade integration is likely to be concentrated in services. In industrial countries, services account for almost 70 percent of value added but only for 20 percent of exports and imports.[3] To some extent this mismatch reflects a wide variety of technological and policy-induced barriers to trade that are specific to services. Our premise is that some of these barriers are likely to fall significantly over the next decade or two, spurred by improvements in communications technology as well as reductions in regulatory barriers. We therefore study two scenarios in which trade in services goes half the way and all the way towards "catching-up" with trade in the rest of the economy. For plausible parameter values, we find that trade integration almost doubles the volatility of the U.S. trade balance.

The paper is organized as follows: section one presents a version of the Dornbusch-Fischer-Samuelson model of Ricardian trade with asset markets. Section two uses the model to determine the main theoretical effects of trade integration on the trade balance. Section three calibrates the model to actual data and provides a quantitative assessment of the effect of increased trade in services on the U.S. trade balance. Section four concludes.

[3] Moreover, much of existing trade in services is concentrated in transportation and travel. For instance, in the U.S. these two items constitute roughly half of service trade but only five percent of service production.

1. The Dornbusch-Fischer-Samuelson Model with Asset Markets

This section presents a simple model designed to study how the nature and costs of commodity trade affect the behavior of the trade balance. We build on the classic Ricardian trade model with a continuum of goods due to Dornbusch, Fischer and Samuelson [1977], and then add asset markets to it. We consider a world that lasts one period and consists of two countries: Home and Foreign.[4] Each country is endowed with labour, L and L*. As usual an asterisk refers to Foreign variables. Countries use labour to produce a continuum of intermediate goods, indexed by $z \in [0,1]$. These intermediates are then combined to produce a nontraded final good that is used for consumption.

Countries trade in goods to exploit differences in the technology used to produce intermediates. The extent to which they are able to do so depends on the costs of trading these intermediates. In particular, we assume that a fraction τ of the intermediates can be transported across countries without cost. We refer to these intermediates as the traded sector and assign them a low index, $z \in [0,\tau]$. The rest of the intermediates cannot be transported across countries and we refer to them as the nontraded sector, $z \in (\tau,1]$. We shall interpret changes in the equilibrium as τ increases as the effects of trade integration.

Countries trade in assets to insure against risks. At the beginning of the period, countries are uncertain about their labour productivity and their taste for consumption. As usual, we assume that they know the true probability distribution of these variables, but not their realizations. In particular, we assume that there are S

[4] It is not difficult to write a multi-period version of this model. But there is little point in doing so, since we assume throughout that international financial markets are complete and factors of production are non-reproducible. Under the standard assumptions that shocks are independent and identically distributed, and both countries have 'ex-ante' identical time-separable and homothetic preferences, there is no incentive to engage in intertemporal trade and the multi-period model is equivalent to a sequence of one-period models.

states of nature, indexed by s=1,…,S; and assign state s a probability π_s. Since countries are risk-averse, they have an incentive to share risks before the state of nature is revealed. We rule out frictions in financial markets and allow countries to freely trade a full set of Arrow-Debreu securities.

1.1 Firms, Technology and The Labour Market

Each country contains many competitive firms that produce the final good and intermediates. In the final good sector, firms use a symmetric Cobb-Douglas technology that requires the use of all intermediates. We shall see later that consumption is strictly positive in all countries and states of nature. Since the final good is nontraded, this means that the production of the final good is also strictly positive in all countries and states of nature. Therefore, the prices of the final good in Home and Foreign, P_s and P_s^*, are given by:

$$(1) \qquad P_s = \exp\left\{\int_0^1 \ln p_s(z) \cdot dz\right\} \qquad \text{and} \qquad P_s^* = \exp\left\{\int_0^1 \ln p_s^*(z) \cdot dz\right\}$$

where $p_s(z)$ and $p_s^*(z)$ are the prices of variety z of intermediates in Home and Foreign. Since the final good is not traded, purchasing power parity (i.e. $P_s=P_s^*$) applies if the prices of intermediates are equalized across countries. In general, this will not be the case.

In the intermediates sector, Home and Foreign firms produce intermediates using only labour. The cost of producing one unit of intermediate z in Home and Foreign is $\frac{W_s}{f_s} \cdot a(z)$ and $\frac{W_s^*}{f_s^*} \cdot a^*(z)$, respectively. We assume labour productivity varies across countries and states of nature in a way that is captured by the indexes f_s and f_s^*. We shall refer to variation in f_s and f_s^* as technology or supply shocks. This is the first source of uncertainty in this model. We assume that unit labour requirements vary across intermediates and across countries in a way that is captured by the technology schedules a(z) and a*(z).

Given our assumptions about the technology used to produce the final good, all intermediates are produced in equilibrium. To determine where the traded intermediates are produced, it is useful to order them using the rule that $z \leq z'$ if and only if $\frac{a^*(z)}{a(z)} \geq \frac{a^*(z')}{a(z')}$, for all $z, z' \in [0, \tau]$. This ordering rule implies that traded intermediates with low indexes are Home exports while traded intermediates with high indexes are Home imports. To rule out states of nature in which one country produces all the traded intermediates, assume that $\lim_{z \to 0} \frac{a^*(z)}{a(z)} = \infty$ and $\lim_{z \to \tau} \frac{a^*(z)}{a(z)} = 0$. Let z_s be the index of the cutoff good that separates Home exports and imports, i.e. the good for which costs of production in Home and Foreign are the same:

(2) $$\frac{W_s}{f_s} \cdot a(z_s) = \frac{W_s^*}{f_s^*} \cdot a^*(z_s)$$

The prices of traded intermediates are the same in both countries and can be written as follows:

(3) $$p_s(z) = p_s^*(z) = \begin{cases} \frac{W_s}{f_s} \cdot a(z) & z \in [0, z_s] \\ \frac{W_s^*}{f_s^*} \cdot a^*(z) & z \in (z_s, \tau] \end{cases}$$

Nontraded intermediates are produced in both countries, and their prices might differ:

(4) $$p_s(z) = \frac{W_s}{f_s} \cdot a(z) \qquad \text{and} \qquad p_s^*(z) = \frac{W_s^*}{f_s^*} \cdot a^*(z) \qquad \text{if } z \in (\tau, 1]$$

Equations (1)-(4) summarize firm maximization and provide all the relevant relationships between goods and factor prices. To complete the production side of model, we need to ensure that labour markets clear. Define C_s as Home's consumption of the final good. Then, we have that:

(5) $$\frac{W_s \cdot L}{W_s \cdot L + W_s^* \cdot L^*} = z_s + (1-\tau) \cdot \frac{P_s \cdot C_s}{W_s \cdot L + W_s^* \cdot L^*}$$

Equation (5) states that Home's share of world labour income or production equals the share of world spending on goods produced by Home. The latter consists of the shares of world spending on Home's traded sector and nontraded sector, respectively.

Equations (1)-(5) are almost identical to those of the original Dornbusch-Fischer-Samuelson model. These equations determine the pattern of labour income and goods trade as a function of the world distribution of spending. To complete the model, we therefore need a consumption side for the model. Dornbusch, Fischer and Samuelson [1977] assumed that Home's shares of world labour income and spending differ at most by an exogenously given transfer or trade balance. This modeling strategy permitted an illuminating analysis of the economic effects of war reparations. After World Wars I and II, cross-border financial transactions were severely restricted and the transfers imposed on the defeated countries were determined mainly by political factors. But this does not seem to be the appropriate modeling strategy today, when a sophisticated international financial market exists in which countries can buy and sell a large array of securities. Recognizing this change in the economic environment, we next provide a market-based theory of the determinants of the transfers or trade balances.

1.2 Preferences and Asset Markets

Each country contains a representative consumer that maximizes the following utility function:

$$(6) \qquad U = \sum_{s=1}^{S} \pi_s \cdot \frac{d_s^{\gamma} \cdot C_s^{1-\gamma} - 1}{1-\gamma} \qquad \text{and} \qquad U^* = \sum_{s=1}^{S} \pi_s \cdot \frac{d_s^{*\gamma} \cdot C_s^{*1-\gamma} - 1}{1-\gamma}$$

where d_s and d_s* are variables that measure the value of consuming when the state of nature is s. We assume that d_s and d_s* vary across states of nature, and refer to this variation as preference or demand shocks. These shocks are the second and final source of uncertainty in the model.

Representative consumers obtain income by inelastically supplying a labour endowment equal to L and L*. Therefore, their income is equal to the wage times the labour endowment, and their budget constraints can be written as follows:

$$(7) \qquad \sum_{s=1}^{S} Q_s \cdot (P_s \cdot C_s - W_s \cdot L) \le 0 \qquad \text{and} \qquad \sum_{s=1}^{S} Q_s \cdot \left(P_s^* \cdot C_s^* - W_s^* \cdot L^*\right) \le 0$$

where Q_s is the price of the Arrow-Debreu security that delivers one unit of income in state s. These constraints simply state that the total (across states of nature) value of consumption cannot exceed the total value of income. Naturally, in each state the values of income and consumption need not be equal. Maximizing (6) subject to (7) we obtain:

$$(8) \quad \frac{Q_s \cdot P_s \cdot C_s}{\sum_{s'=1}^{S} Q_{s'} \cdot W_{s'} \cdot L} = \frac{\pi_s^{\frac{1}{\gamma}} \cdot d_s \cdot (Q_s \cdot P_s)^{\frac{\gamma-1}{\gamma}}}{\sum_{s'=1}^{S} \pi_{s'}^{\frac{1}{\gamma}} \cdot d_{s'} \cdot (Q_{s'} \cdot P_{s'})^{\frac{\gamma-1}{\gamma}}} \quad \text{and} \quad \frac{Q_s \cdot P_s^* \cdot C_s^*}{\sum_{s'=1}^{S} Q_{s'} \cdot W_{s'}^* \cdot L^*} = \frac{\pi_s^{\frac{1}{\gamma}} \cdot d_s^* \cdot \left(Q_s \cdot P_s^*\right)^{\frac{\gamma-1}{\gamma}}}{\sum_{s'=1}^{S} \pi_{s'}^{\frac{1}{\gamma}} \cdot d_{s'}^* \cdot \left(Q_{s'} \cdot P_{s'}^*\right)^{\frac{\gamma-1}{\gamma}}}$$

Equation (8) describes how consumers distribute their spending across states of nature. The share of spending is higher in states of nature that are more likely (higher π_s) and consumption yields higher utility (higher d_s). The relationship between spending and the price of consumption ($Q_s \cdot P_s$) is ambiguous. On the one hand, consumers want to achieve the highest possible amount of total consumption. To attain this objective they should spend more on those states in which the consumption good is cheap. On the other hand, consumers are risk averse and want to distribute their total consumption as evenly as possible across states of nature. To attain this objective they should spend more on those states in which consumption is expensive. As usual, the first consideration dominates if risk aversion is low, $\gamma<1$, while the second consideration dominates if risk aversion is high, $\gamma>1$. In the magical case of logarithmic preferences, $\gamma=1$, the two effects cancel and the distribution of spending is not affected by the price of consumption.

Equilibrium in international financial markets requires that the world value of consumption equals the world value of income in each state of nature:

(9) $$P_s \cdot C_s + P_s^* \cdot C_s^* = W_s \cdot L + W_s^* \cdot L^*$$

Equations (8) and (9) implicitly define the distribution of consumption and the prices of all Arrow-Debreu securities as a function of the world distribution of labour income and price levels.

This completes the presentation of the model. Equations (1)-(5) and (8)-(9) describe the solution of the model up to a choice of numeraire. For a given distribution of spending, the production side of the model (as described by Equations (1)-(5)) determines the world distribution of labour income, price levels and the pattern of goods trade. For a given world distribution of labour income and price levels, the consumption side of the model (as described by Equations (8)-(9))

determines the world distribution of spending and the pattern of transfers or trade balances.[5]

2. Determinants of the Trade Balance

Our goal in this section is to develop results about the effects of trade integration on the trade balance. To do this, we make three strategic assumptions:[6]

A1. (Identical size) L=L*=1;

A2. (Symmetric technologies) Let the relative technology schedule for the traded sector be $A(z;\tau) \equiv \frac{a^*(z)}{a(z)}$ for $z \in [0,\tau]$. Then, $A(z;\tau) \cdot A(\tau - z;\tau) = 1$ for all τ;

A3. (Symmetric shocks) Let $\delta_s = \frac{d_s}{d_s^*}$ and $\phi_s = \frac{f_s}{f_s^*}$. If there exists a state s with $\pi_s=\pi$ such that $(\phi_s,\delta_s)=(\phi,\delta)$, then there exists another state s' with $\pi_{s'}=\pi$ such that $(\phi_{s'},\delta_{s'})=(\phi^{-1},\delta^{-1})$.

Assumption A1 simply states that countries have the same size and normalizes it to one. Assumption A2 centers the relative technology schedule at $0.5\cdot\tau$ and forces (log) productivity differences to be symmetric. This can be understood as saying that no country has a superior technology on average. By writing the

[5] The Arrow-Debreu model of asset trade generates predictions about the transfers that countries make in different states of nature. These predictions are robust in the sense that enlarging the menu of assets consumers can choose from would not affect these transfers or trade balances. But it is difficult to find assets that resemble the set of Arrow-Debreu securities that the theory postulates in existing financial markets. Nevertheless, we do not believe that this observation invalidates the theory. The key assumption underlying the model's predictions for the trade balance is not that a full set of Arrow-Debreu securities is actually traded, but instead that it is possible to manufacture them with the available menu of assets. Whether this assumption provides a reasonably good description of actual financial markets is a hotly debated question. Nevertheless, we shall adopt it in what follows. Since we do not specify the available menu of assets, we interpret the theory as being silent on what specific assets are used to implement the equilibrium transfers or trade balances. Recognizing this, we focus only on its predictions for the trade balance.

[6] We will relax these assumptions in the next section when we calibrate the model to the U.S. data.

technology schedule as an explicit function of the size of the traded sector, i.e. A(.;τ), we recognize that its shape depends not only on our technology assumptions, i.e. a(z) and a*(z); but also on how we distribute goods between traded and nontraded sectors. Assumption A3 says that both countries face the same distribution of shocks. Note that this distribution is defined in terms of relative shocks as opposed to absolute shocks. This is in anticipation of the finding that only relative shocks can generate fluctuations in the trade balance and the terms of trade. Together, these three assumptions ensure that the two countries are symmetric and this simplifies the algebra of the problem substantially.

An implication of assumptions A1-A3 is that both countries have the same real wealth 'ex-ante', i.e. $\frac{\sum_{s \in S} Q_s \cdot W_s \cdot L}{\sum_{s \in S} \pi_s^{\frac{1}{\gamma}} \cdot d_s \cdot (Q_s \cdot P_s)^{\frac{\gamma-1}{\gamma}}} = \frac{\sum_{s \in S} Q_s \cdot W_s^* \cdot L^*}{\sum_{s \in S} \pi_s^{\frac{1}{\gamma}} \cdot d_s^* \cdot (Q_s \cdot P_s^*)^{\frac{\gamma-1}{\gamma}}}$. In this particular case, Equations (8)-(9) admit a simple and intuitive closed-form solution for Home's share of world spending, $e_s \equiv \frac{P_s \cdot C_s}{P_s \cdot C_s + P_s^* \cdot C_s^*}$:

$$\text{(10)} \qquad e_s = e(\omega_s, \delta_s; \tau, \gamma) \equiv \frac{\delta_s \cdot \omega_s^{(1-\tau)\cdot\frac{\gamma-1}{\gamma}}}{1 + \delta_s \cdot \omega_s^{(1-\tau)\cdot\frac{\gamma-1}{\gamma}}}$$

where $\omega_s = \frac{W_s / f_s}{W_s^* / f_s^*}$ is Home's relative labour costs or double-factoral terms of trade. This variable will play a crucial role in what follows and is closely related to the real exchange rate or ratio of price levels since $\frac{P_s}{P_s^*} = \omega_s^{1-\tau}$. Since higher terms of trade lead to an appreciation of the real exchange rate, this means that $\frac{\partial e_s}{\partial \omega_s} \geq 0$ if $\gamma \geq 1$, and

$\frac{\partial e_s}{\partial \omega_s} \leq 0$ if $\gamma \leq 1$. Note also that trade integration reduces the effects of changes in the terms of trade on spending.

Let x_s be the share of traded goods produced in Home, i.e. x_s is implicitly defined as $A(\tau \cdot x_s; \tau) = \omega_s$. Assume $A(.;\tau)$ is invertible and let $A^{-1}(.;\tau)$ be its inverse function. Then, $x_s = x(\omega_s;\tau) \equiv \frac{A^{-1}(\omega_s;\tau)}{\tau}$, with $x(\omega_s;\tau) = 1 - x(\omega_s^{-1};\tau)$ and $\frac{\partial x_s}{\partial \omega_s} \leq 0$. The effects of changes in τ on x_s are ambiguous, since they depend on how the distribution of unit labour requirements of the marginal traded goods compares to that of existing traded goods. In the top (bottom) panel of Figure 1, we depict the case in which the distribution of unit labour requirements is uniformly less (more) dispersed across marginal goods than across existing traded goods. This leads to a counter-clockwise (clockwise) rotation in the x_s schedule. Since dispersion in unit labour requirements is the source of comparative advantage, we say that in the top panel trade integration is biased towards goods where comparative advantage is weak, while in the bottom panel it is biased towards goods where comparative advantage is strong.[7]

Using this notation, we can now rewrite Equation (5) to obtain:

(11) $$\frac{\phi_s \cdot \omega_s}{1 + \phi_s \cdot \omega_s} = \tau \cdot x(\omega_s;\tau) + (1-\tau) \cdot e(\omega_s, \delta_s; \tau, \gamma)$$

[7] This definition is not devoid of some ambiguity, since there is no reason for the distribution of unit labour requirements of the marginal traded goods to always be uniformly more or uniformly less dispersed than that of existing traded goods. For instance, if trade integration is biased towards goods that exhibit either very strong or very weak comparative advantage, the distribution of unit labour requirements of the marginal traded goods has more mass both in the tails and around the mean than that of existing traded goods. In this case, the rotation of the x_s schedule is counter-clockwise near the middle, but clockwise in the extremes. Obviously, more complicated shifts are also possible. To eliminate any ambiguity, we assume from now on that the distribution of unit labour requirements of the marginal traded goods is either uniformly more or uniformly less dispersed than that of existing traded goods. It is straightforward to extend the analysis to the general case.

The left-hand side of Equation (11) is Home's share of world labour income or production, while the right-hand side is world spending on Home produced goods. Equation (11) implicitly defines the equilibrium value of ω_s. Since Home's trade balance as a share of world income, t_s, is the difference between exports, $\tau \cdot x_s \cdot (1-e_s)$, and imports, $\tau \cdot (1-x_s) \cdot e_s$, we can write:

(12) $$t_s = \tau \cdot \left[x(\omega_s;\tau) - e(\omega_s,\delta_s;\tau,\gamma)\right]$$

We shall next use Equations (11)-(12) to study the cyclical behavior of the trade balance and the effects of trade integration. To streamline the discussion, in sections 2.1 and 2.2 we assume that fluctuations in the terms of trade have no effect on spending. That is, we restrict the analysis to the logarithmic case in which $\gamma=1$. This restriction leads to a clean description of the effects of trade integration on the trade balance. In section 2.3, we examine the consequences of removing this restriction.

2.1 The Cyclical Behavior of the Trade Balance

In this world economy, countries use asset markets ex-ante to transfer income to those states of nature in which their labour productivity is low and the value of consumption is high. The trade balance records the transfers between countries that are made ex-post. In general, the nature of these transfers depends on the distribution of shocks and their effects. To isolate the main forces at work, we study next two polar examples where all the shocks are of the same type.

Consider first an economy where fluctuations in the trade balance are driven exclusively by technology or supply shocks. In the top panel of Figure 2, we assume that there are two states of nature s=H,L; with $(\phi_H,\delta_H)=(\phi,1)$ and $(\phi_L,\delta_L)=(\phi^{-1},1)$ with $\phi>1$. We refer to these as the high and low states, respectively. The AS schedule plots Home's share of world labour income for different values of the terms of trade, i.e. the left-hand side of Equation (11). The slope is positive because, ceteris paribus, higher terms of trade raise Home's relative wages and its share of labour income. The AS schedule shifts across states since, holding constant the terms of trade, the larger is Home's relative productivity the larger is its relative labour income. The AD schedule plots the share of world spending on Home produced goods for different values of the terms of trade, i.e. the right-hand side of Equation (11). The slope of this schedule is negative because ceteris paribus higher terms of trade reduce the demand for Home traded goods. The top panel of Figure 2 also shows the TB schedule plotting the trade balance for different values of the terms of trade, i.e. Equation (12). The equilibrium value for ω_s is obtained by crossing the AS and AD schedules, while the equilibrium value for t_s is obtained by projecting the equilibrium value for ω_s to the TB schedule.

The story depicted in the top panel of Figure 2 is quite standard. Home uses asset markets to purchase income in the low state and finances this by selling income in the high state. By running a trade surplus in the high state and a trade deficit in the low state, Home is able to achieve the same spending in both states despite the fluctuations in labour income. The size of the trade balances that are required to achieve this depends on the effects of productivity gains on the terms of trade, i.e. on the slope of the AD schedule. When Home's productivity is high, its terms of trade deteriorate moderating the increase in Home's share of world labour income and lowering the required trade surplus. Naturally, the opposite applies when Home's productivity is low. If these movements in the terms of trade are strong, trade balances are small in absolute value.[8]

[8] Cole and Obstfeld [1991] were the first to provide an influential example of how these terms of trade movements could be large enough to eliminate trade balances. Their example is the special case of our model in which (i) there are only supply shocks, (ii) $\frac{\partial x_S}{\partial \omega_S} = 0$ and (iii) τ=0. Our model shows that their result also holds if τ<1, provided that γ=1.

Consider next an economy where fluctuations in the trade balance are driven exclusively by preference or demand shocks. In the bottom panel of Figure 2, we assume there are two states of nature s=H,L; with $(\phi_H,\delta_H)=(1,\delta)$ and $(\phi_L,\delta_L)=(1,\delta^{-1})$; and $\delta>1$. Once again, we refer to these as the high and low states. The AD schedule shifts across states because, ceteris paribus, the larger is Home's share of world spending the higher is the demand for Home nontraded goods. The TB schedule also shifts because, ceteris paribus, the larger is Home's share of world spending the lower is the demand for Home exports and the higher is the demand for Home imports.

The story depicted in the bottom panel of Figure 2 is also quite standard. Home uses asset markets to purchase income in the high state and finances this by selling income in the low state. By running a trade deficit in the high state and a trade surplus in the low state, Home is able to spend more when the value of consumption is high. The size of the trade balances that are required to achieve this depends on the effects of increases in spending on the terms of trade, i.e. on both the shift and the slope of the AD schedule. When Home spending is high, its terms of trade improve, raising Home's share of world labour income and lowering the required trade deficit. Of course, the opposite applies when Home spending is low. Once again, we find that if movements in the terms of trade are strong, trade balances are small in absolute value.

The intuitions developed in these two polar examples carry almost directly to the general case with many states of nature and with some of these states involving a mixture of supply and demand shocks. We shall not pursue this point further though. Instead, we build on these intuitions to address the main question of this paper: how does trade integration change the cyclical behavior of the trade balance?

2.2 The Effects of Trade Integration

We have seen that supply and demand shocks generate fluctuations in the trade balance that are moderated in part by stabilizing movements in the terms of trade. Next, we show how trade integration dampens these terms of trade movements and, for a given distribution of shocks, this amplifies fluctuations in the trade balance. To see this, apply the implicit function theorem to Equations (11)-(12) with γ=1 to obtain:

$$(13) \qquad \frac{dt_s}{d\tau} = \frac{\dfrac{\phi_s}{(1+\phi_s \cdot \omega_s)^2}}{\dfrac{\phi_s}{(1+\phi_s \cdot \omega_s)^2} - \tau \cdot \dfrac{\partial x_s}{\partial \omega_s}} \cdot \left(\frac{t_s}{\tau} + \tau \cdot \frac{\partial x_s}{\partial \tau} \right)$$

Our symmetry assumptions A1-A3 imply that the average trade balance is zero. Therefore, a necessary condition for the volatility of the trade balance to increase with τ is that $\text{sign}(t_s) = \text{sign}\left(\frac{dt_s}{d\tau}\right)$ for all s. Since $\frac{\partial x_s}{\partial \omega_s} \leq 0$, we have established the following result:

<u>Result #1:</u> *Assume that changes in the terms of trade do not affect spending, i.e. γ=1; and trade integration is unbiased, i.e.* $\frac{\partial x_s}{\partial \tau} = 0$. *Then, trade integration increases the volatility of the trade balance*.

This is the main result of the paper and provides theoretical support for the view that a reduction in the costs of trading goods and services is in part responsible for larger trade imbalances. Note that Result #1 does not place any restriction on the distribution of shocks beyond assumption A3. In particular, there could be any number of states of nature with any mix of demand and supply shocks. The intuition is simple: trade integration both flattens the AD schedule and makes it less sensitive to changes in the world distribution of spending. The first of these effects reduces the impact of supply shocks on the terms of trade and increases their impact on the trade balance. The two effects combine also to reduce the impact of demand shocks on the terms of trade while increasing their impact on the trade balance.

It is also immediate to provide a first qualification to our main result:

<u>Result #2:</u> *If trade integration is sufficiently biased towards goods with strong comparative advantage, it could lead to reduction in the volatility of the trade balance.*

If trade integration is biased towards goods with strong comparative advantage, the x_s schedule rotates clockwise. If this effect is strong enough, the AD schedule might become steeper in the middle range. Assume that shocks are not too large and the equilibrium lies in this range. Then, trade integration increases the impact of supply shocks on the terms of trade and reduces their impact on the trade balance. Therefore, the economy with supply shocks of section 2.1 provides an example that proves Result #2. It is also possible that trade integration increases the effects of demand shocks on the terms of trade and reduces their impact on the trade balance. But since trade integration makes the AD schedule less sensitive to changes in the world distribution of spending, we need the extra requirement that the increase in slope more than "compensates" for the smaller shift. When this happens, the economy with demand shocks of section 2.1 provides an additional example that also proves Result #2.[9]

Is there any reason to expect trade integration to be biased towards goods with strong comparative advantage? Naturally, this question cannot be answered without actual data. But some intuition can be obtained by comparing our model of trade integration with its most popular alternative. We have modeled trade integration as a situation in which the transport costs of a small set of goods falls dramatically

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[9] Note that in these two examples, $\tau \cdot \frac{\partial x_s}{\partial \tau}$ has different sign and is larger in absolute value than $\frac{t_S}{\tau}$.

from prohibitive to negligible, without placing any restrictions on the characteristics of these goods. An alternative way to model trade integration is to assume the same transport cost for all goods and consider a small reduction in this cost. In this case, at high transport costs only goods with strong comparative advantage are traded. As transport costs fall goods with weaker comparative advantage start to be traded as well. In this alternative model, trade integration is always biased towards goods in which comparative advantage is weak.

2.3 Spending and the Terms of Trade

We now return to the more general case in which changes in the terms of trade affect spending. That is, we remove the restriction that γ=1. As will become apparent shortly, it is not possible to derive general results on the effects of trade integration on the trade balance. However, a detailed examination of the two polar cases of section 2.1 allows us to derive useful intuitions. To simplify matters, we assume throughout this section that trade integration is unbiased, i.e. $\frac{\partial x_s}{\partial \tau} = 0$.

Consider first the economy where fluctuations are driven by supply shocks. If risk aversion is high, γ>1, spending depends positively on the terms of trade and both the AD and the TB schedules rotate clockwise with respect to the benchmark case of logarithmic preferences. If risk aversion is low, γ<1, spending depends negatively on the terms of trade and the AD and the TB schedules rotate counter-clockwise with respect to the benchmark. If the effects of terms of trade changes on Home's share of spending are not too strong, i.e. $\frac{\partial x_s}{\partial \omega_s} \leq \frac{\partial e_s}{\partial \omega_s} \leq \frac{-\tau}{1-\tau} \cdot \frac{\partial x_s}{\partial \omega_s}$, the qualitative description of the effects of supply shocks in Figure 2 still applies. The only difference with the benchmark case is quantitative. If risk aversion is high, spending becomes counter-cyclical and this increases the volatility of the trade balance with respect to the benchmark case. If risk aversion is low, the opposite applies.

Figure 3 shows what can happen if the effects of changes in the terms of trade on spending are strong. The top panel shows the case in which risk aversion is so high that the AD schedule becomes upward sloping in the region of the equilibrium, $\frac{\partial e_s}{\partial \omega_s} > \frac{-\tau}{1-\tau} \cdot \frac{\partial x_s}{\partial \omega_s}$.[10] When Home's productivity is high, the deterioration in the terms of trade is so large than Home's share of labour income falls. However, the decline in spending is even larger and, as a result, the qualitative behavior of the terms of trade and the trade balance remain the same as in the benchmark case. The bottom panel shows the case in which risk aversion is so low that the TB schedule becomes upward sloping in some range, $\frac{\partial e_s}{\partial \omega_s} < \frac{\partial x_s}{\partial \omega_s}$. That is, the Marshall-Lerner condition that an improvement in the terms of trade worsens the trade balance fails. This is the only case in which the qualitative behavior of the terms of trade and the trade balance are different than in the benchmark case. When Home's productivity is high, the deterioration in the terms of trade leads to an increase in spending that exceeds the increase in labour income. The opposite occurs when productivity is low. Unlike Figure 2, the economy now runs trade deficits in the high state and trade surpluses in the low state. An implication of this discussion is that, unless γ is so small that the Marshall-Lerner condition fails, the volatility of the trade balance is increasing in risk aversion.

In this more general model, the size of the traded sector affects the relationship between spending and changes in the terms of trade. Trade integration weakens this relationship as the real exchange rate becomes less sensitive to the terms of trade. In the limit as $\tau \rightarrow 1$, changes in the terms of trade have no effects on spending regardless of risk aversion. This is a new channel through which trade integration affects the volatility of the trade balance. If the Marshall-Lerner condition holds, through this channel trade integration increases the volatility of the trade

[10] The AD schedule might be increasing in some ranges and decreasing in others. Despite this, an analysis of Equation (11) shows that the AD schedule always crosses the AS schedule from below and, as a result, the equilibrium is unique.

balance if risk aversion is low, but lowers it if risk aversion is high. If the Marshall-Lerner condition fails, trade integration always lowers the volatility of the trade balance through this channel.

If risk aversion is high enough, or else sufficiently low that the Marshall-Lerner condition fails, this new channel might be strong enough to generate a negative relationship between trade integration and the volatility of the trade balance. Figure 4 illustrates this by plotting the volatility of the trade balance against the size of the traded sector for different values of risk aversion. Not surprisingly, we find that at values of γ that do not depart much from one, trade integration monotonically increases the volatility of the trade balance. But if risk aversion is sufficiently extreme, there might be some ranges in which an increase in the size of the traded sector lowers the volatility of the trade balance.

The other polar case in which fluctuations are driven only by demand shocks is much simpler to analyze. Naturally, if the effects of terms of trade changes on Home's share of spending are not too strong, i.e. $\frac{\partial x_s}{\partial \omega_s} \leq \frac{\partial e_s}{\partial \omega_s} \leq \frac{-\tau}{1-\tau} \cdot \frac{\partial x_s}{\partial \omega_s}$, the qualitative description of the effects of supply shocks in Figure 2 still applies. But even if risk aversion is so high that the AD schedule becomes upward sloping or so low that the TB schedule becomes upward sloping, the qualitative description in Figure 2 still applies. This is shown in Figure 5. The only difference with the benchmark case is quantitative. If risk aversion is high, increases in spending are reinforced by improvements in the terms of trade and this increases the volatility of the trade balance with respect to the benchmark case of logarithmic preferences. If risk aversion is low, the opposite applies. An implication is that the volatility of the trade balance is increasing in risk aversion. Unlike the case of supply shocks, this relationship holds at all levels of risk aversion.

As we have already discussed, in the more general case of this section trade integration has the additional effect of weakening the effects of the terms of trade on spending. In the economy with demand shocks, through this channel trade integration increases the volatility of the trade balance if risk aversion is low, but lowers it if risk aversion is high. It is conceivable that if risk aversion is high enough this effect becomes strong enough to create a range in which trade integration reduces the volatility of the trade balance. We have however been unable to find a numerical example in which this happens. Figure 6, which is analogous to Figure 4, shows how the volatility of the trade balance changes as the size of the traded sector increases for different values of γ. In all cases, the relationship is monotonically increasing.

The results of this section can now be summarized as follows:

Result #3: *If risk aversion is sufficiently higher or sufficiently lower than the benchmark case of logarithmic preferences, trade integration might lead to a reduction in the volatility of the trade balance.*

Figure 4 provides examples that prove this claim.

To sum up, Result #1 provides theoretical support for the view that trade integration raises the volatility of the trade balance. Results #2 and #3 qualify this view by showing what can go wrong if the two conditions stated in Result #1 are violated. These cases however do not seem likely to be empirically relevant.

3. An Application to Trade in Services

Our objective in this section is to develop a sense of the quantitative importance of the effects of trade integration on the trade balance. To achieve this goal, we calibrate the model and use it to study the effects of an increase in the tradeability of services.[11] While further trade integration is likely to occur in many different industries, we think that the example of services is particularly interesting given the glaring mismatch between the share of services in production and their share in international trade. In industrial countries, the service sector accounts for almost 70 percent of value added but only 20 percent of exports and imports. To a large extent, this bias in trade flows is the result of both technological and policy-induced barriers to trade in services. There are signs however that this is likely to change in the near future.[12]

We interpret the two-country model in section 1 as describing the United States (Home) and the rest of the O.E.C.D. countries (Foreign). We calibrate the model using available data and then consider two scenarios. In the first one, we increase the share of traded goods in services to half of that observed in the rest of the economy. In the second one, we increase the share of traded goods in services to that observed in the rest of the economy.

3.1 Calibration

To calibrate the model, we need three pieces of information: (1) the size of the traded sector; (2) the relative technology schedule; and (3) the distribution of shocks.

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[11] Throughout this section, we will use the term services to refer to transportation, communication, utilities, wholesale and retail trade, FIRE (finance, insurance and real estate), and other services (notably health, education, and other professional services).

[12] As the textbook example of haircuts suggests, many services are inherently more difficult to transport than manufactures and commodities. Services also tend to be more vulnerable to a wide variety of non-tariff barriers to trade, such as professional licensing requirements that discriminate against foreigners, domestic content requirements in public procurement, or poor protection of intellectual property rights. But this seems to be changing rapidly. The last decade has brought a series of technological improvements that are making many services increasingly tradeable. As a result of advances in telecommunications technology, outsourcing abroad of computer programming, data entry, and call center services is becoming common practice. With the appearance of e-commerce, wholesale/retail sales and brokerage services can now be offered worldwide online. And the development of new software has raised the ability of architectural, engineering and other types of consulting firms to better interact around the globe. But this is not all. Recent multilateral negotiations under the World Trade Organization's General Agreement on Trade in Services have made substantial progress towards dismantling a wide array of policy-induced barriers to trade in services. The harmonization of rules and regulations within the European Union has also contributed to this process.

For reasons of data availability, we choose 1997 as the reference year, and we discuss how to obtain each of these three items in turn.

Item 1. The size of the traded sector: In all industries, some goods are traded while others are not. Our objective here is to determine the size of the traded sector for the economy as a whole, and at the industry level. We do so by taking seriously the theoretical implication that every traded good is produced either at home or abroad. Define X and M as overall U.S. exports and imports, and let v be the share of the U.S. in O.E.C.D. GDP in 1997. O.E.C.D. spending on U.S. exportables is $X/(1-v)$. This is the sum of foreign spending on U.S. exportables plus U.S. spending on these exportables. The former is simply X, and since all countries distribute their spending equally across goods, the latter is simply $X \cdot v/(1-v)$. Following the same argument, we can calibrate O.E.C.D. spending on U.S. importables as M/v. This means that the traded sector of the O.E.C.D. is $X/(1-v)+M/v$. To obtain the nontraded sector in the U.S., we simply take gross output, G, and subtract the traded sector, $X/(1-v)$. Under the assumption that the U.S. share in O.E.C.D. production is the same as its share in GDP, the non-traded sector of the O.E.C.D. is $(G-X/(1-v))\cdot(1-v)/v$. We use data on G, X, and M from the 1997 U.S. input-output table to compute the traded and nontraded sectors and find that the share of traded goods, τ, is roughly 10 percent.[13]

To obtain the size of the traded sector industry-by-industry, we repeat the procedure using data on G, X and M for 33 3-digit industries spanning the entire economy. The first column of Table 1 reports the share of tradeables in gross output or production by industry. There are substantial differences in the share of traded goods across industries. In services, which account for 62 percent of production, tradeables represent only 3 percent of production. In the rest of the economy (primarily manufacturing which accounts for 28 percent of production), tradeables represent 22 percent of production.

[13] Note that we are expressing tradeables as a fraction of production, rather than value added. For the U.S., the share of exports plus imports in value added in 1997 is 0.23.

Item 2. The relative technology schedule: We calibrate differences in industry technologies to match data on trade in goods and services.[14] To do so we need to impose some additional structure on the data. In particular, we treat the distribution of relative productivities within each of the 33 industries as unobservable, but assume that it is well approximated by a lognormal distribution. This means that our calibration procedure must come up with two parameters per industry, namely, the mean (μ_i) and variance (σ_i) of log productivity differences. Unfortunately, we do not have enough information to do so. We therefore set $\sigma_i=\sigma=0.5$ for all industries and use the trade data to determine μ_i for each industry. This assumption means that we restrict the relative productivity of goods in the 95th percentile to be roughly 5 times that of goods in the 5th percentile within each industry. This does not seem unreasonable. Moreover, we find that the results are robust to sensible changes in the value of σ.

Define the relative technology schedule for the traded sector of industry i as $A_i(z) \equiv \frac{a_i^*(z)}{a_i(z)}$; and order goods by using the rule that $z \le z'$ if and only if $\frac{a_i^*(z)}{a_i(z)} \ge \frac{a_i^*(z')}{a_i(z')}$. Assume that, within an industry, the distributions of log productivities in the traded and nontraded sectors are identical. Then, our assumptions imply that $\ln A_i(z) \sim N(\mu_i, \sigma)$ for industry i. To obtain the value of μ_i for each industry, note that on average the share of exports in the traded sector of industry i corresponds to the share of traded goods for which $A_i(z) > \omega$. We therefore choose μ_i to ensure that $P[A_i(z) > \omega] = x_i$ where $x_i = \frac{X_i/(1-v)}{X_i/(1-v) + M_i/v}$. Inverting this probability gives:

[14] Could we have estimated productivity differences directly? A vast number of papers report cross-country estimates of productivity levels. However, only very few provide disaggregated productivity comparisons based on disaggregated purchasing power parity adjustments for inputs and outputs, which are essential for meaningful productivity level comparisons (see Harrigan (1999) for a review). Because of the difficulties in collecting disaggregated price data, these papers focus on only a subset of industries (for example, Harrigan (1999) reports estimates for machinery and equipment manufacturing productivity levels across several O.E.C.D. countries). But without information on productivity levels comparisons for all sectors and for all potential trading partners, it is impossible to construct a relative technology schedule.

(14) $\mu_i = \ln(\omega) - \sigma \cdot \Phi^{-1}(1 - x_i)$

where $\Phi(.)$ denotes the cumulative normal distribution function. To implement this procedure, we need information on the average values of productivity-adjusted relative wages, ω. We obtain average relative wages by equating the U.S. share of O.E.C.D. income with the observed 40 percent U.S. share in O.E.C.D. GDP in 1997. We interpret differences in average productivity as reflecting differences in human capital between the U.S. and the rest of the O.E.C.D., and measure them using data on years of total education.[15] This leads us to an estimate of the productivity-adjusted wage of $\omega = 1.33$.

With this number at hand, and the assumption that σ=0.5, we use Equation (14) to obtain a set of estimates for the μ_is. The results are shown in the third column of Table 1. There are large differences across sectors in calibrated mean relative productivities, ranging from 0.47 to 2.68. By construction, these differences in average relative productivities reflect differences across industries in exports as a share of tradeable production (reported in the second column of Table 1). Perhaps the most noticeable feature of column 3 is again the difference between services and the rest of the economy. Although tradeables as a fraction of services production is quite small, exports as a share of tradeables is much larger in services than in the rest of the economy (79 percent versus 30 percent). This implies that average relative productivity must be substantially higher in services than in the rest of the economy (2.54 versus 1.31).

Given values of μ_i obtained in this way, we can construct the empirical analog of the inverse of the relative technology schedule as a weighted average of the industry distributions of relative productivities:

[15] Specifically we use the Barro-Lee (2000) data on human capital stocks to find that average total years of education in the U.S. and in the rest of the O.E.C.D. in 1995 are 12.2 and 8.3, respectively. We then assume a Mincer coefficient of 0.1, and adjust relative wages by a factor of $e^{0.1 \cdot (12.3 - 8.3)} = 1.07$.

(15) $$x(\omega;\tau) \equiv \frac{A^{-1}(\omega;\tau)}{\tau} = \sum_{i=1}^{33} t_i \cdot \left(1 - \Phi\left(\frac{\ln(\omega) - \mu_i}{\sigma}\right)\right)$$

where t_i denotes the share of industry i in the overall traded sector. The results of this procedure are depicted in Figure 7 under the label “baseline”. Note that there are substantial cross-country differences in productivities. The ratio of productivities between goods in the 95th and 5th percentiles is around 7.5.

The schedules labeled “Scenario 1” and “Scenario 2” correspond to our assumptions that the share of traded goods in services increases from 2.5 to 10, and to 22 percent, respectively. In particular, for each industry i within services, we assume that the share of traded goods in that industry increases to half the level of the trade share in the rest of the economy (in the first scenario), and increases all the way to the level of the trade share in the rest of the economy (in the second scenario). This in turn increases t_i (the share of industry i in the overall traded sector) for each of the industries within services, in Equation (15). To understand the effects of trade integration on the relative technology schedule, remember that our calibrations indicate that US relative productivity in services is substantially higher than in the rest of the economy. This means that in our example, trade integration is biased towards goods in which the U.S. has comparative advantage. As a result, the relative technology schedule shifts to the right and becomes steeper than in the benchmark case. Note also that such a rightward shift in the relative technology schedule was not possible in the examples in Section 2 where we restricted attention to the case of symmetric technology differences across countries.

Item 3. The distribution of shocks: We calibrate shocks to demand and supply to match the cyclical properties of the U.S. trade balance. To do this, we first need to know the value of the risk aversion coefficient, γ. It is clear from the discussion in section 2 that this coefficient plays an important role in determining the volatility of the trade balance. In the absence of strong priors on the magnitude of this parameter, we consider scenarios in which γ takes the values 0.5, 1 and 5. We then assume that there are two equally likely states of nature s=H,L; in which $(\phi_H,\delta_H)=(\phi,\delta)$ and $(\phi_L,\delta_L)=(\phi^{-1},\delta^{-1})$. As in Section 2, the parameters ϕ and δ regulate the standard deviation of shocks to supply and demand, respectively. We then choose ϕ and δ to match the cyclical properties of the U.S. trade balance as a share of O.E.C.D. income over the period 1970-1999, as summarized by (1) its standard deviation, which is 0.5 percent; and (2) its comovement with income measured as the slope of a regression of the U.S. trade balance on U.S. income (both as a share of O.E.C.D. income), which is –0.3. We do this for each of the three values of the coefficient of relative risk aversion that we consider.

The results of this procedure are presented in the first two columns of Table 2. In the benchmark case of γ=1, a combination of supply shocks with a standard deviation of 2 percent and demand shocks with a standard deviation of 10 percent are required to match the cyclical properties of the trade balance. Since the U.S. trade balance tends to decline when incomes are high, we require large demand shocks and small supply shocks in order to match the data. If γ=5, we need a smaller difference between demand and supply shocks (with standard deviations of 8 percent and 5 percent, respectively). If γ=0.5, we need a larger differences in the volatility of demand and supply shocks (with standard deviations of 17 percent and 3 percent respectively) in order to match the observed cyclical properties of the trade balance. To understand these differences, remember that fluctuations in the terms of trade magnify (dampen) the effects of demand shocks if γ>1 (γ<1). This is why we need smaller demand shocks the larger is γ.

3.2 Results

The remaining columns of Table 2 summarize the result of our trade integration exercise, reporting the predicted standard deviation of the U.S. trade balance as a fraction of O.E.C.D. income in the baseline 1997 scenario, and the two integration scenarios discussed above. By construction, the standard deviation of the trade balance is equal to its observed value of 0.5 percent of O.E.C.D. income in all three rows of the first column. Moving to the right illustrates the effects of goods and services trade liberalization on asset trade.

In the benchmark case of γ=1, we find quite substantial effects of further trade integration on the volatility of the trade balance, which rises from 0.5 percent to 0.7 percent when services are half as tradeable as the rest of the economy, and to 0.9 percent when services are equally tradeable than the rest of the economy. This suggests that the main effect of trade integration on the volatility of the trade balance summarized in Result #1 is quantitatively important. On the other hand, Result #2 which qualifies our main result does not appear to be empirically very important. Although in this example trade integration is biased towards goods in which the U.S. has comparative advantage, we find that the quantitative effects of this bias are trivial. To isolate the effects of this bias, we re-estimate Scenario 2, but do so under the assumption that the relative technology schedule does not change relative to the baseline scenario. In this case, we find that the standard deviation of the trade balance is 0.95%, as opposed to 0.94% when we allow for a bias in trade integration.

Finally, the rows with γ=5 and γ=0.5 show the effects of trade integration when we allow for the possibility that changes in the terms of trade also affect spending.[16] When γ=5 we find that the effects of trade integration on the standard deviation of the trade balance are substantially smaller, with the latter rising to only 0.6 percent in the second integration scenario. To understand this difference, remember that when γ>1, fluctuations in the terms of trade induce fluctuations in spending which amplify fluctuations in the trade balance. As trade integration proceeds, the effects of fluctuations in the terms of trade on spending fall, and so the volatility of the trade

[16] Remember that we have re-calibrated the underlying shocks in each row of Table 2 to replicate observed fluctuations in the trade balance. As a result, changes in the volatility of the trade balance aross different values of γ for a given level of trade integration reflect changes in our assumptions about both (i) the shocks which drive fluctuations, and (ii) the degree of risk aversion.

balance increases by less than in the benchmark case of γ=1. When γ=0.5, we find a much larger effect of trade integration on the volatility of the trade balance, with the latter rising to 0.9 percent in the first scenario, and 1.2 percent in the second. The intuition for this is just the converse of the case where γ=5: through their effects on spending, fluctuations in the terms of trade attenuate fluctuations in the trade balance, and the importance of this attenuation declines with trade integration.

To sum up, our empirical example suggests that the effects of trade integration on the volatility of trade balance can be substantial, with the volatility of the trade balance almost doubling in the benchmark case of log preferences. Although in our example trade integration is biased towards goods in which the U.S. has comparative advantage, the quantitative effects of this bias are negligible. Departures from the assumption of log preferences do affect the quantitative effects of trade integration, with larger (smaller) increases in the volatility of the trade balance when risk aversion is low (high). However, in our calibrations the additional effects of risk aversion are never sufficiently strong to reverse our qualitative conclusion that trade integration will increase the volatility of the trade balance.

4. Concluding Remarks

In this paper, we have used a simple model of trade in goods and assets to analyze the question of how trade integration affects the trade balance. We hope our contribution will induce others to explore this issue from alternative theoretical perspectives. We have motivated trade in goods and assets by postulating differences in technology and imperfectly correlated shocks. But one could for instance allow for differences in factor endowments and/or increasing returns to scale as an additional motive for trade in goods. Similarly, one might introduce differences in time preference and/or rates of return to capital as an additional motive to trade in assets. We conjecture that the main results of this paper would survive in these more general frameworks, except for extreme cases. The interesting question is whether new and realistic effects would arise that cannot be studied in our simple framework.

Finally, we hope that our contribution also provides a good theoretical grounding to empirical studies of the effects of trade integration. By isolating key theoretical channels, the model here can sharpen the interpretation of econometric studies on this subject. By providing a fully specified model, we also hope to aid in the task of developing quantitative assessments of the effects of trade integration on the trade balance. In this respect, our calibration exercise should be interpreted only as a simple illustration or example. A serious quantitative analysis of the effects of trade integration on the trade balance would be a major project on its own.

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Table 1: Trade and Relative Productivity by Industry

	Tradeables/ Production	Exports/ Tradeables	Average Relative Productivity(1)
Agriculture and Mining			
Agriculture	0.13	0.41	1.34
Metallic ores mining	0.21	0.31	1.18
Coal mining	0.09	0.84	2.46
Crude petroleum and natural gas	0.38	0.03	0.60
Nonmetallic minerals mining	0.11	0.29	1.15
Construction			
Construction	0.00	0.00	0.47
Manufacturing			
Food	0.10	0.39	1.32
Tobacco	0.15	0.74	2.08
Textiles	0.17	0.32	1.19
Apparel	0.44	0.09	0.78
Lumber and wood products	0.15	0.22	1.03
Furniture and fixtures	0.21	0.18	0.96
Paper	0.16	0.36	1.25
Printing	0.05	0.49	1.49
Chemicals	0.26	0.39	1.30
Petroleum Refining	0.11	0.33	1.22
Rubber and Plastics	0.17	0.28	1.13
Leather	0.75	0.06	0.71
Nonmetal Production	0.16	0.23	1.04
Primary Metals	0.22	0.22	1.02
Fabricated metals	0.13	0.31	1.18
Industrial Machinery	0.39	0.43	1.37
Electrical machinery	0.50	0.31	1.18
Motor Vehicles	0.37	0.16	0.92
Other Transportation Equipment	0.44	0.51	1.53
Other Manufacturing	0.40	0.30	1.16
Services			
Transportation Services	0.12	0.77	2.17
Communications	0.00	0.00	0.89
Electric Utilities	0.01	0.15	0.89
Gas Utilities	0.00	0.00	0.89
Trade	0.05	0.71	2.00
FIRE	0.02	0.88	2.68
Other Services	0.01	0.77	2.19
Weighted Averages (2)			
Overall	0.10	0.37	1.49
Rest of Economy	0.22	0.30	1.31
Services	0.03	0.79	2.54

Notes:

(1) This column reports $E[A_i] = e^{\mu_i + \sigma^2/2}$

(2) The first column uses shares in total production as weights; the remaining columns uses shares in tradeables production as weights.

Table 2: Calibration Results

Standard Deviation of US Trade Balance/OECD GDP

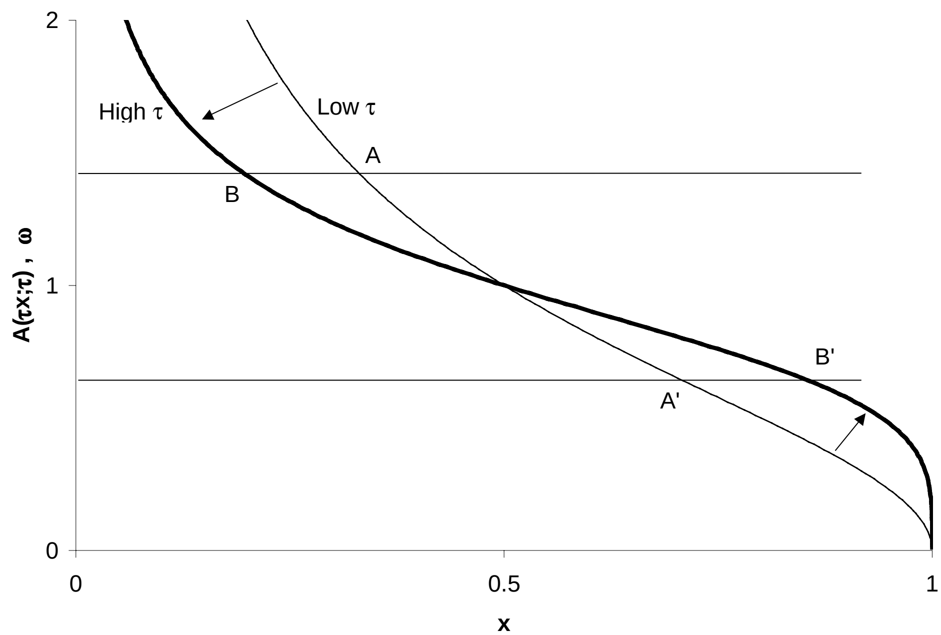
γ	ϕ	δ	Before	After: Scenario 1	After: Scenario 2
0.5	1.03	1.17	0.50%	0.91%	1.24%
1	1.02	1.10	0.50%	0.74%	0.94%
5	1.05	1.08	0.50%	0.58%	0.60%

Notes:

(1) To obtain the standard deviation of the trade balance as a fraction of U.S. GDP simply multiply by 2.5.

Figure 1: Effects of Trade Integration on Relative Technology Schedule

Case 1: Trade Integration Weakens Comparative Advantage



Case 2: Trade Integration Strengthens Comparative Advantage

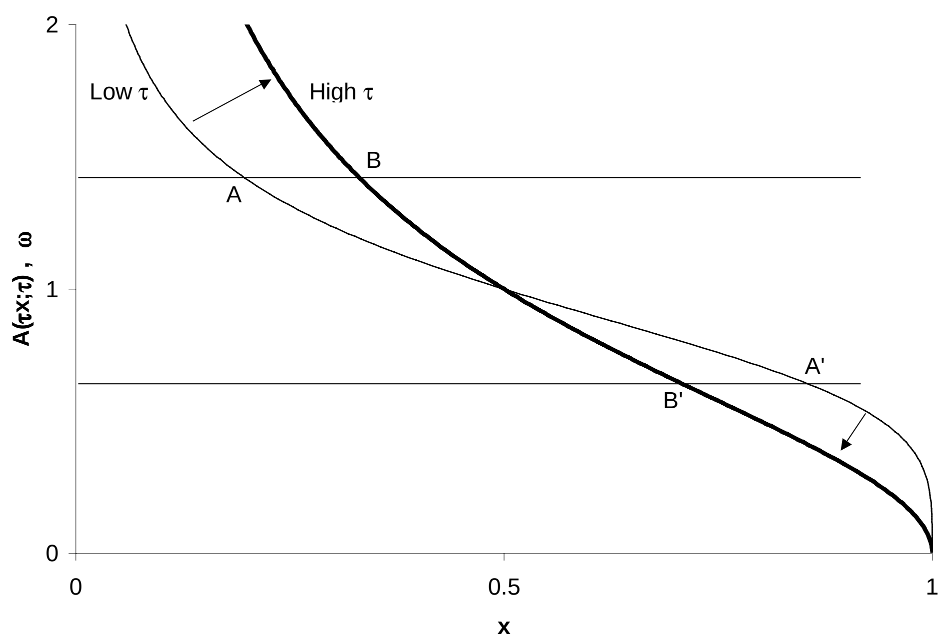
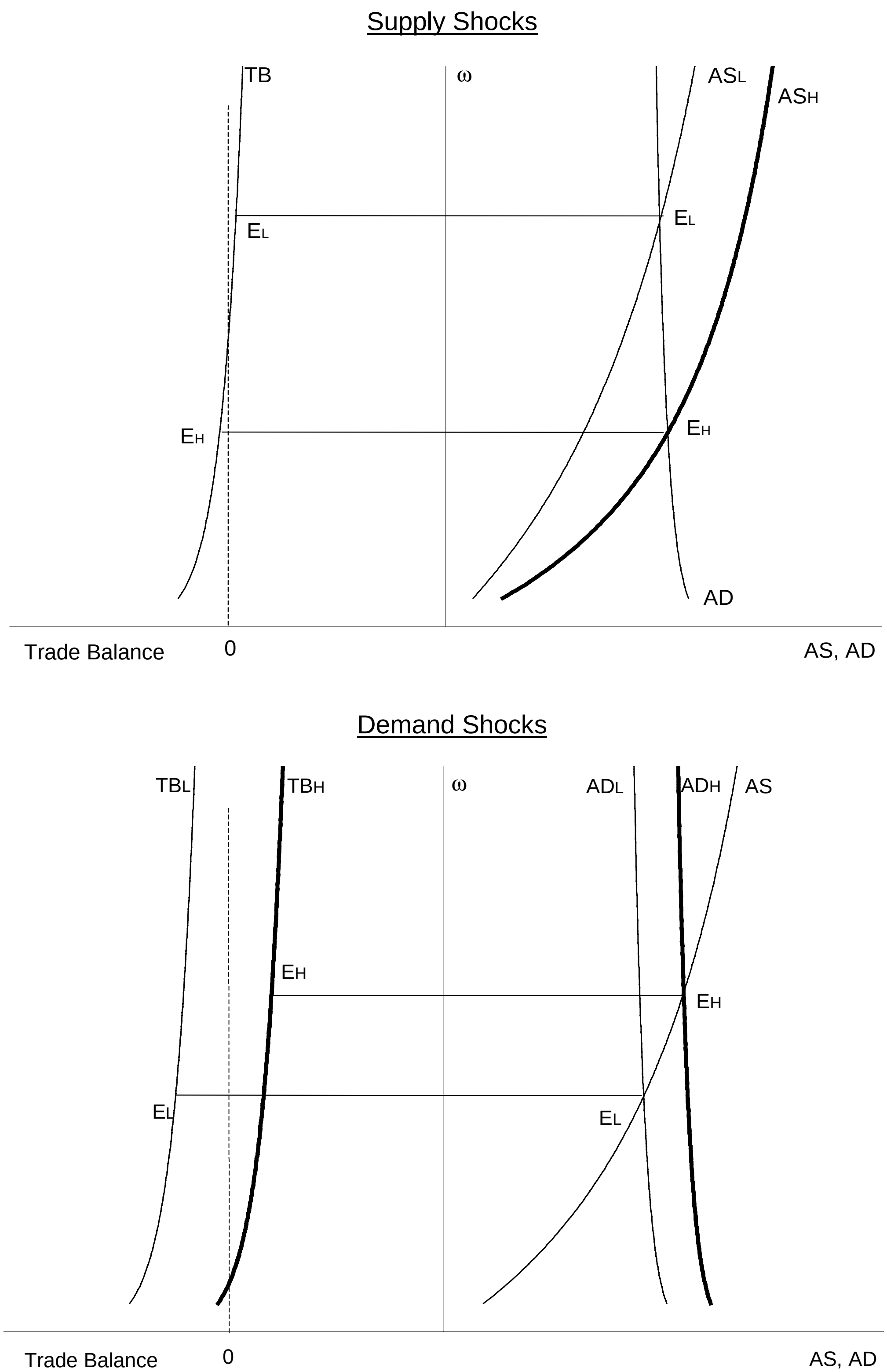
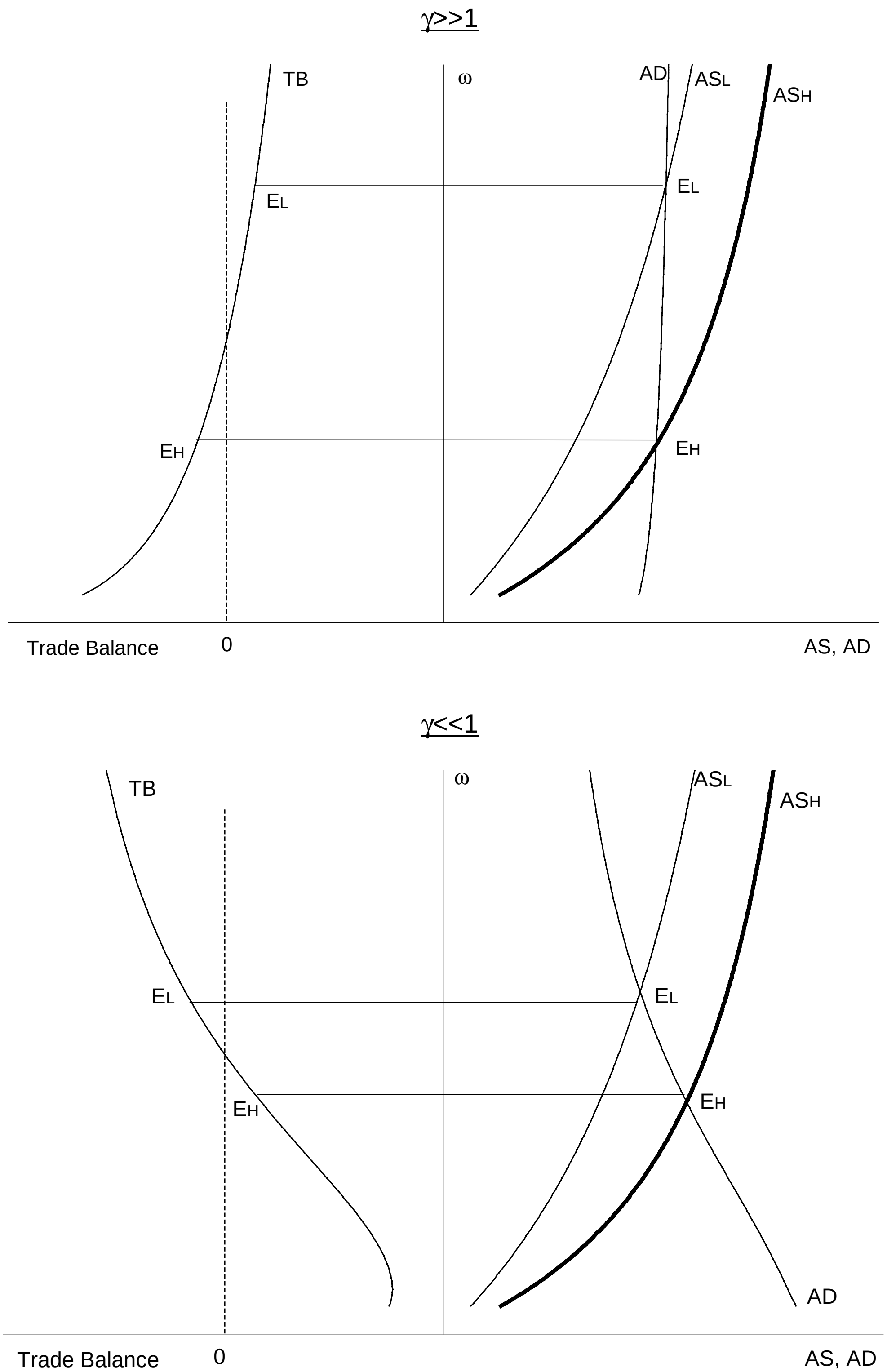


Figure 2: Effects of Supply and Demand Shocks, γ=1



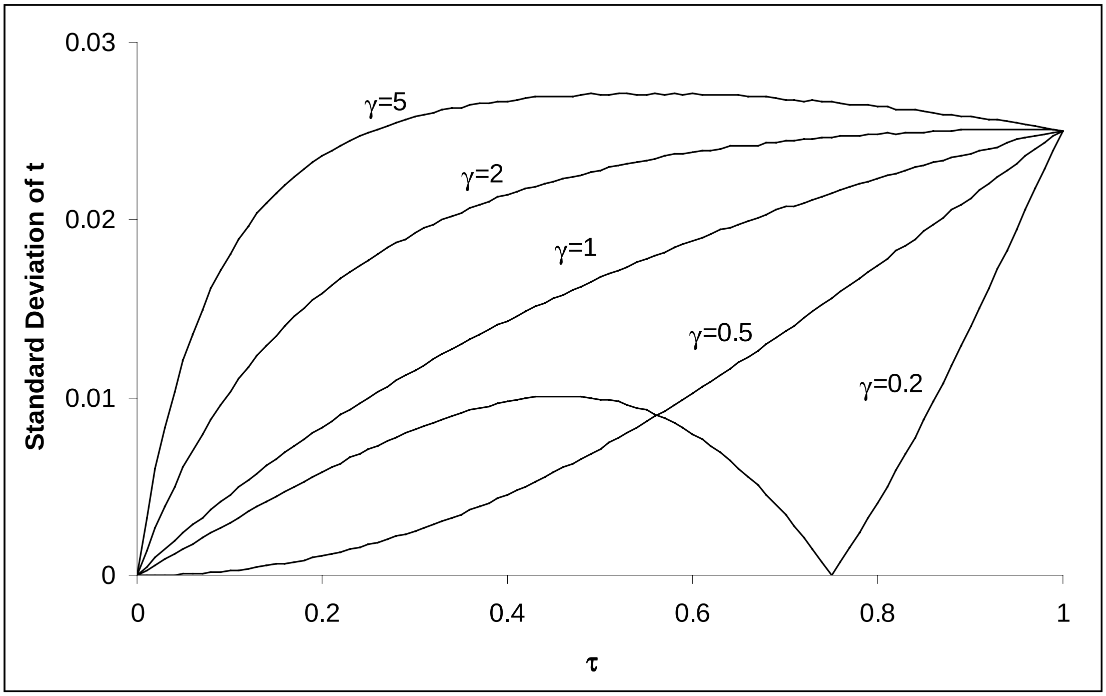
Note: These figures are drawn under the assumption that $x(\omega)=\omega^{-\alpha}/(1+\omega^{-\alpha})$ with α=0.2; τ=0.5; ϕ_H=1.5 in the top panel and δ_H=1.5 in the bottom panel; and γ=1.

Figure 3: Effects of Supply Shocks



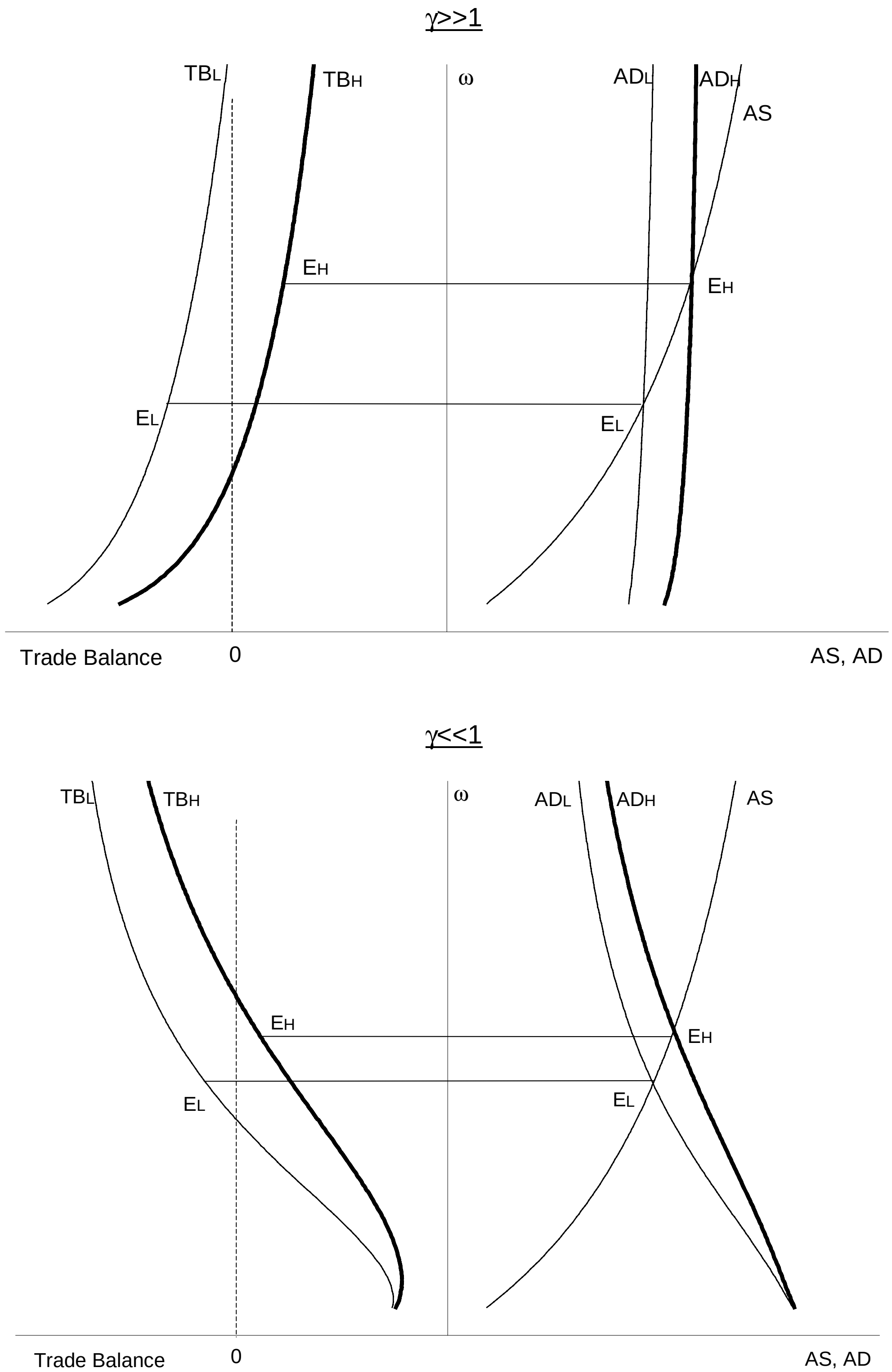
Note: These figures are drawn under the assumption that $x(\omega)=\omega^{-\alpha}/(1+\omega^{-\alpha})$ with $\alpha=0.2$, $\tau=0.5$; $\phi_H=1.5$; and $\gamma=5$ in the top panel and $\gamma=0.2$ in the bottom panel.

Figure 4: Effects of Trade Integration with Supply Shocks



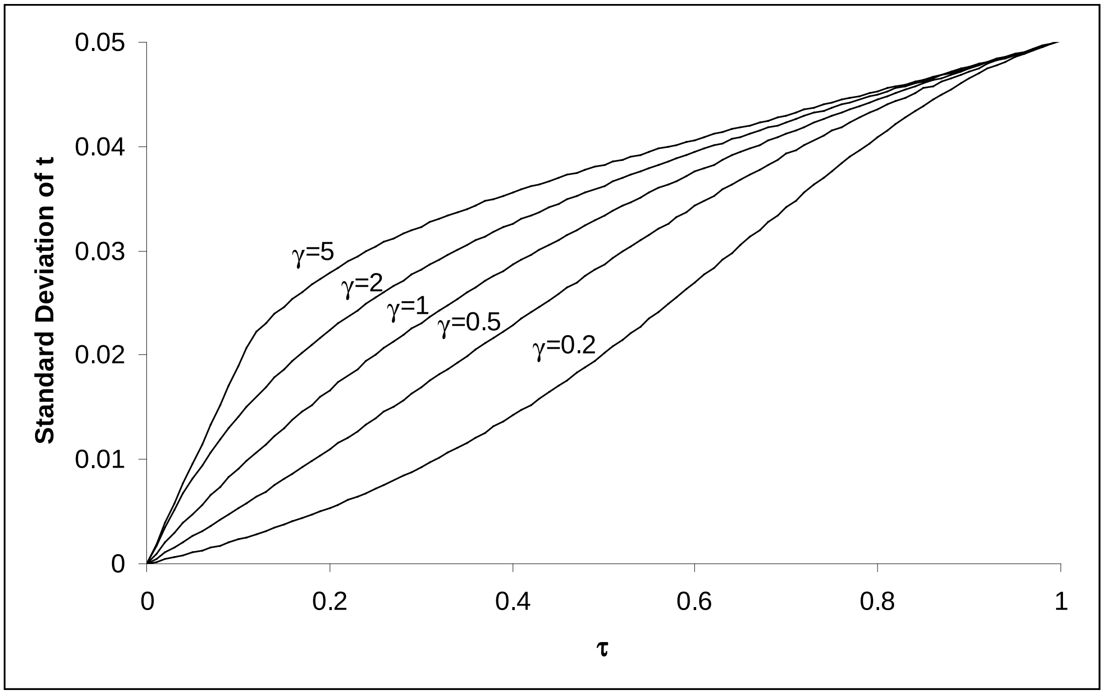
Note: This figure is drawn under the assumption that $x(\omega)=\omega^{-\alpha}/(1+\omega^{-\alpha})$ with $\alpha=1$; $\tau=0.5$; $\phi_H=1.5$; and for the indicated values of γ.

Figure 5: Effects of Demand Shocks



Note: These figures are drawn under the assumption that $x(\omega)=\omega^{-\alpha}/(1+\omega^{-\alpha})$ with $\alpha=0.2$; $\tau=0.5$; $\delta_H=1.5$; and $\gamma=5$ in the top panel and $\gamma=0.2$ in the bottom panel.

Figure 6: Effects of Trade Integration with Demand Shocks



Note: This figure is drawn under the assumption that $x(\omega)=\omega^{-\alpha}/(1+\omega^{-\alpha})$ with $\alpha=1$; $\tau=0.5$; $\delta_H=1.5$; and for the indicated values of γ.

Figure 7: Estimated Relative Technology Schedule