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## **Intra-industry Trade and the Open Economy\***

Sven W. Arndt\*\*

This paper explores the implications of cross-border production networks and vertical intra-industry trade for macroeconomic adjustment and for the effectiveness of monetary and fiscal stabilization policies. Vertical intra-industry trade introduces direct links between countries' imports and exports and thereby affects the manner in which trade balances respond to variations in exchange rates and to global shocks more generally.

The precise effects depend on whether the direct link runs from exports to imports or vice versa. In the U.S., for example, exports of auto parts and components rise with an increase of imports of passenger vehicles from Mexico. This produces a change in balance-of-payments adjustment similar to high capital mobility and raises the likelihood that a fiscal expansion will lead to appreciation rather than depreciation of the currency. In China and Mexico, on the other hand, a rise in exports of assembled end products raises imports of parts and components.

The differences in outcome are more pronounced under floating rates, because of the role of the exchange rate in the adjustment process. Direct export-import links undermine the impact of the exchange rate on the trade balance, hence necessitating larger changes in rates in order to achieve a given degree of adjustment and raising exchange-rate volatility as a result. In the case of both types of exchange-rate regime, vertical intra-industry trade weakens the response of the trade balance to price and income shocks.

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## 1. INTRODUCTION

Macroeconomic adjustment in the open economy depends critically on the impact of exchange-rate changes under floating and on price and income changes under both floating and fixed rates. Vertical intra-industry trade introduces direct links between countries' imports and exports and thereby alters the response of the trade balance to changes in prices, incomes and exchange rates.

In a simple example of vertical intra-industry trade, passenger vehicle components are shipped from the United States to Mexico, where they are assembled into finished products, which are exported back to the United States. In more complex patterns, exemplified by global electronics production, parts and components move among countries in Southeast Asia, as production moves through its various stages along the value-added chain. From Mexico's perspective, a rise in the demand for auto exports raises the need to import additional parts and components, so that the direct link runs from exports to imports. Exactly the opposite link pertains to the U.S., where the rise in auto imports generates a rise in component exports. In the multi-country case, a rise in the demand for exports of electronic end products from China gives rise to increased Chinese demand for component imports from Singapore, Taiwan, and other countries.

In the presence of vertical intra-industry trade, some of the imports that enter a country are not destined for final use in that country and the value of some exports exceeds the domestic value-added embodied in those exports. Part of a country's trade essentially "by-passes" the domestic economy and consequently alters trade-balance reactions to movements in prices, incomes, and exchange rates. It changes the manner in which shocks and disturbances are transmitted across borders, and has consequences for the effectiveness of traditional tools of macroeconomic stabilization policy.

The next section reviews some basic consequences for trade balance behavior that flow from vertical intra-industry trade. Section 3 explores the implications for macroeconomic stabilization policy of vertical intra-industry

trade. Section 4 concludes.

## 2. NETWORK TRADE AND THE TRADE BALANCE

Depreciation of a country's currency tends to raise import prices expressed in the domestic currency and thereby to reduce imports, while lowering the foreign-currency prices of exports and hence raising exports. In the case of inter- and horizontal intra-industry trade, imports are destined for use by residents and the value of exports will have been largely generated in the home economy. When the Marshall-Lerner condition holds, the trade balance improves with depreciation.

However, when imports consist of components to be incorporated into exports, the effect of depreciation is to raise their price on the way in and to lower it on the way back out. In arms-length transactions, the higher price of imported components raises the cost of the final product, but that rise is offset when the depreciation reduces the foreign-currency price of the end product and of the components within it.<sup>1)</sup> This suggests a reduced effect of the exchange-rate change on the trade balance compared to traditional "non-processing" trade. The effect of the depreciation on processing trade is limited to the domestic value-added embodied in processed exports.<sup>2)</sup>

When depreciation reduces the foreign-currency price of domestic value-added in a country's exports and thereby raises foreign demand for exports, this rise in exports in turn raises demand for imported parts and components. Hence, processing imports actually rise rather than fall with currency depreciation, while ordinary imports fall. The processing balance of trade is thus less sensitive to the exchange rate and this implies that the overall trade

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<sup>1)</sup> In assessing the importance of this direct relationship, one needs to distinguish between "arms-length" trade and intra-firm trade that is subject to transfer pricing. Moreover, many emerging economies dependent on export markets in advanced countries tend to price their key exports in the currencies of large destination countries and thereby eliminate some of their exchange rates from the adjustment mechanism. For some discussion of arms-length vs. intra-firm vertical intra-industry trade, see Ando, Arndt, and Kimura (2006).

<sup>2)</sup> See Arndt and Huemer (2007) for an empirical study of U.S.-Mexico trade.

balance is less sensitive.

In the presence of production sharing, the equation for the trade balance may be written as follows.

$$b = x[y^*, e; m(y, e)] - m[y, e; x(y^*, e)], \quad (1)$$

where  $x$  and  $m$  represent real exports and imports of goods and services, respectively;  $y$  and  $y^*$  are domestic and foreign real GDP, respectively; and  $e = EP^* / P$  is the real exchange rate composed of the nominal rate,  $E$ , and foreign and domestic price levels, respectively. What distinguishes this expression from the traditional trade equation, is that exports and imports are directly linked to each other. If the country is the United States, for example, then a rise in demand for passenger vehicle imports from Mexico leads to a rise of U.S. exports of vehicle parts and components. The effect of imports on exports is shown in the first bracketed term in equation (1). If the country is Mexico, a rise in exports of motor vehicles to the U.S. raises imports of components. That relationship is expressed in the second bracketed term of equation (1).

It is important to note that there is only one exchange rate in the present example of production sharing between two countries. In the more general case, a country's exports of the end product to another country may contain parts and components from third countries. That would be the example of electronic exports by China to the United States containing intermediates from Singapore, Taiwan and various Southeast Asian countries. In this case, it is necessary to consider movements in exchange rates between China and its supplier countries as well.<sup>3)</sup>

## 2.1. Imports Linked to Exports

Total differentiation of equation (1) yields the following:

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<sup>3)</sup> See Arndt (2008) for a discussion.

$$db = x_y^*(1 - m_x)dy^* + [x_e(1 - m_x) + m_e(1 - x_m)]de - m_y(1 - x_m)dy, \quad (2)$$

where all partial derivatives except  $m_e$  are positive. In the case of trade between Mexico and the United States in motor vehicles, the amended feature from Mexico's perspective is the import term in equation (1), in which imports are a function of exports. When price levels are held constant, the real exchange rate changes one-for-one with the nominal rate. The effect of changes in the nominal rate on the trade balance is given by

$$\frac{db}{dE} = \frac{(dx - dm)}{dE} = x_e(1 - m_x) - m_e > 0, \quad (3a)$$

where  $0 < m_x < 1$  in order to allow for non-processing exports and for the presence of some domestic value-added in the country's processing exports. The magnitude of  $m_x$  rises as the share of processing exports in total exports rises, and that rise reduces the response of the trade balance to movements in the exchange rate.

It is clear from equation (1), that the effects on the balance of trade of the other components of the real exchange rate, namely, domestic and foreign inflation, may be explained in analogous ways. The influence on the trade balance of foreign inflation, for example, may be seen in expression (3a) if we substitute  $dP^*$  for  $dE$ : its effect is attenuated by the presence of network trade. Expression (3a) with  $-dP$  replacing  $dE$  gives the result for domestic inflation. Its effect on the trade balance — deterioration — is weakened, because it affects the price of exports only to the extent of the share of domestic value-added in exports. Furthermore, to the extent that the higher cost of domestic value-added reduces exports of assembled products, it also reduces imports of parts and components.

The implications for the trade balance of changes in foreign GDP are also altered by production sharing. A recession abroad reduces foreign demand for the country's exports in the traditional manner ( $x_y^* dy^*$ ). If network trade is present, however, then the decline in exports is mitigated by a decline in

imports, reducing the overall effect on the trade balance. Moreover, the transmission of the shock to the rest of the economy is limited to the domestic value-added contained in the country's exports.

## 2.2. Exports Linked to Imports

Mexico and China are two important examples of countries with strong links from exports to imports. The trade of many countries in East Asia also has this characteristic. In other cases, however, a country's exports will be directly linked to its imports. In the simple bilateral example discussed above, the United States is in this position with respect to imports of finished automobiles from Mexico. The relevant condition for the trade balance response to the exchange rate is now given by:

$$\frac{db}{dE} = \frac{(dx - dm)}{dE} = x_e - (1 - x_m)m_e. \quad (3b)$$

When the U.S. demand for auto imports rises, it raises the demand for exports of auto parts and components. The terms containing  $x_m$  in expression (2) are relevant in this case. When the dollar appreciates, Americans demand more passenger vehicles from Mexico, because the peso's depreciation reduces the dollar price of Mexican value-added. This tends to worsen the U.S. trade balance, but by less than would be the case if the rise in U.S. imports had not directly raised U.S. exports. Countries involved in regional production networks may experience both types of linkage effects simultaneously.

These direct linkages between exports and imports complicate the analysis of exchange-rate pass-through. Consider, again, a depreciation of the peso against the U.S. dollar. As we saw earlier, for a given dollar price of U.S.-made components, the depreciation will raise their price in pesos and thus raise the manufacturing cost of motor vehicles. Meanwhile, however, the depreciation will reduce the dollar price of the vehicles, helping to mitigate

the effect of the cost increase on their final price.

Moreover, the dollar price of the Mexican value-added embodied in the vehicle will fall, so that a depreciation of a given percentage will reduce the price of the imported vehicle by a smaller percentage than would otherwise be the case. It is not appropriate, however, to interpret this as weak or incomplete pass-through, because the pass-through applied to Mexican value-added is the relevant measure of the completeness of the pass-through.<sup>4)</sup>

### 3. MACRO POLICY IN AN OPEN ECONOMY WITH PRODUCTION SHARING

The preceding discussion suggests that vertical intra-industry trade changes the behavior of the trade balance relative to traditional patterns involving inter- and horizontal intra-industry trade. In this section, we explore the implications of these tendencies for macroeconomic adjustment and stability and for macroeconomic policy. We do so by incorporating vertical intra-industry trade into the well-known open economy of the Mundell-Fleming model, which will serve as the benchmark model for comparison purposes. Given the established nature of this model, we see no need to review its major findings. For current purposes, the standard specification of money market equilibrium is retained as:

$$\frac{H}{P} = l(y, R), \quad (4)$$

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<sup>4)</sup> The presence of network trade can lead to overstatement of the volatility of trade volumes. If trade flows are measured in terms of the full value of exports and imports every time they cross a border, then there will be double-counting, the seriousness of which will rise with the frequency of the number of crossings during the manufacturing process. In the presence of production sharing, trade flows are better viewed in terms of value-added. See, for example, Wynne and Kersting (2009).



where  $H$  is high-powered money,  $P$  is the (constant) price level,  $y$  is real GDP, and  $R$  is the nominal rate of interest. With zero inflation, real and nominal interest rates are identical.

For goods-market equilibrium we incorporate direct linkages between imports and exports through network trade along the lines developed in equation (1):

$$i(r) + x[y^*, e; m(y, e)] - s(y) - m[y, e; x(y^*, e)] = g, \quad (5)$$

where  $i$  is real investment,  $r$  is the real interest rate,  $s$  is real saving and  $g$  is the real budget surplus.

The balance-of-payments equilibrium condition of the benchmark model is also amended to include equation (1) as the specification of the current account:

$$x[y^*, e; m(y, e)] - m[y, e; x(y^*, e)] + K(R, R^*) = 0, \quad (6)$$

where  $K$  represents net capital inflows, which are positive and negative functions, respectively, of domestic and foreign interest rates. As in the basic model, the assumption of stable prices allows us to ignore distinctions between nominal ( $R$ ) and real ( $r$ ) interest rates and nominal ( $K$ ) and real ( $k$ ) capital flows.

### 3.1. Direct Links: Exports to Imports

For countries in which the direct link runs from exports to imports only, the relevant expression for exports in equations (5) and (6) is  $x(y^*, e)$ . In that set-up, the main effect of vertical intra-industry trade is on the behavior of the exchange rate under floating rates.<sup>5)</sup> When, for example, a monetary expansion lowers the interest rate and raises domestic income, causing both the current account and the financial account to deteriorate, the depreciation

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<sup>5)</sup> In other words, the slopes of the three curves are unaltered relative to the benchmark model.

needed to return the economy to equilibrium is larger in the presence of vertical intra-industry trade. This is evident in equations (5) and (6), where the depreciation increases both network and non-network exports, as expected. But while it reduces non-network imports, it raises network imports.

Another way to see this is to note that network trade tends to make the demand for foreign exchange less elastic with respect to the exchange rate than in the benchmark model. This results from the previously discussed fact that while a currency depreciation reduces the volume of imports, its positive effect on exports tends to raise processing imports, so that the net effect of a given exchange rate change on overall imports is smaller.

Hence, when a rise in domestic income raises the demand for foreign exchange, the lower exchange-rate elasticity of demand requires a larger adjustment in the exchange rate. The adjustments are  $dE/dy = m_y / (x_e - m_e)$  in the benchmark model and  $dE/dy = m_y / [(1 - m_x)x_e - m_e]$  for production networking, when the direct linkage runs from exports to imports. The exchange-rate adjustment required to compensate for a change in domestic output on the trade balance is clearly larger. Hence, while the effect of disturbances like this on the trade balance is attenuated as the importance of network trade rises, the exchange rate must work harder in order to achieve a desired change in the trade balance.

This reduced sensitivity of the trade balance to the exchange rate suggests further that the critical values of the Marshall-Lerner condition will be harder to achieve as the importance of network imports in total imports rises.

A similar story applies to the response of the exchange rate to a fiscal expansion. The currency appreciates in both cases under high capital mobility, but the degree of appreciation is greater in the presence of network trade.

### 3.1.1. Foreign Shocks

A rise in foreign income affects the home trade balance less, because the rise in home exports is mitigated by the rise in imports through the direct link

between exports and imports in processing trade. Under floating rates, the currency must appreciate in both models in order to offset the expansionary effect of the rise in foreign income on the domestic economy.<sup>6)</sup> However, the appreciation necessary to return the open economy to full equilibrium is smaller with vertical intra-industry trade than without. This is due to the fact that the foreign shock generates a smaller improvement in the home country's trade balance, which in spite of the reduced influence of exchange-rate changes on trade reduces the needed appreciation.

A foreign financial shock, such as a tightening of global credit conditions, reflected in higher foreign interest rates,  $R^* = r^*$ , tightens domestic credit conditions as capital flows out, causing domestic interest rates to rise and to dampen economic activity. The home country's financial account deteriorates to the same extent in the two scenarios. The home currency depreciates, which tends to stimulate economic activity. The net effect of these pressures is a permanently higher rate of interest and higher level of output. These results are identical to those in the basic model, except that the depreciation needed to bring the result about rises as the importance of vertical intra-industry trade in total trade rises.

### 3.1.2. Fixed Exchange Rates

Under fixed rates, there is no change from the benchmark model regarding the efficacy of monetary and fiscal policies. Monetary policy continues to be completely ineffective in the absence of sterilization, while the potency of fiscal policy as a tool of macroeconomic stabilization depends on the degree of capital mobility. High capital mobility enhances the power of fiscal expansion to close an existing output gap, because the strong reaction of capital inflows relative to the rise in goods and services imports puts pressure on the currency to appreciate. The central bank intervenes by purchasing foreign exchange and thereby raises domestic money supply. Low capital

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<sup>6)</sup> Much has been said about the relative immunity of the home economy to external output shocks in the Mundell-Fleming model. Our focus here, however, is to examine the consequences of production networks for the adjustment process. For a general assessment of Mundell-Fleming and alternative macro models, see de Grauwe (1997).

mobility has the opposite effect. The complete coincidence of outcomes derives from the fact that the elements of distinction between the two scenarios do not come into play.

The repercussions due to foreign income shocks, on the other hand, depend on the importance of the direct link between imports and exports. A positive foreign GDP shock causes a smaller improvement in the home country's trade balance than would be the case in the benchmark model, implying that the intervention-induced increase in the home country's money supply will be smaller and with it the expansionary effect associated with the foreign shock. A foreign liquidity shock, on the other hand, has identical reactions in the two models, once again because the elements of distinction between the two scenarios do not come into play.

### **3.2. Direct Links: Imports to Exports**

Direct linkages may also run from imports to exports. As noted earlier, U.S. trade with Mexico in motor vehicles is an obvious example in which a rise in U.S. demand for imported automobiles directly increases exports of U.S.-made parts and components. When direct linkages run from imports to exports, the departures from the benchmark model's results are somewhat more complex.

It is well-known that balance-of-payments adjustment depends on the degree of capital mobility.<sup>7)</sup> Capital mobility is crucial in determining whether a domestic fiscal expansion leads to appreciation or depreciation of a country's currency. Network trade with direct links from imports to exports has an analogous effect on balance of payments adjustment. In the presence of network trade, a rise in domestic GDP causes a smaller deterioration of the current account to the extent that the induced rise in imports provokes a rise in exports. Hence, a smaller increase in domestic interest rates is required in

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<sup>7)</sup> In other words, it depends on the slope of the BP schedule relative to the LM curve. High capital mobility flattens the BP curve, implying that a deterioration of the current account due to a rise in income requires a smaller increase of interest rates in order to provide the needed offset via financial account improvement.

order to offset the worsening of the current account. This means that countries with low capital mobility may nevertheless have relatively flat balance-of-payments curves if they are significantly involved in production networks.

Unlike capital mobility, however, network trade also changes adjustment in the goods-producing sector. The relevant ratio in the basic model is  $dr/dy = (s_y + m_y)/i_r$ , compared with  $dr/dy = [s_y + m_y(1 - x_m)]/i_r$  in the presence of network trade. In other words, network trade flattens the slope of the open-economy goods-market relationship.

### 3.2.1. Floating Rates

These differences, however, do not affect the efficiency of either monetary or fiscal policy in reducing an existing output gap under floating rates relative to the benchmark model. In other words, monetary and fiscal expansions of a given magnitude, respectively, have identical impacts on the home interest rate and on home income in the two scenarios. This may seem surprising, given the decreased responsiveness of the trade balance to variations in domestic income. However, under the assumption of identical money market structures in the two scenarios, the ensuing currency depreciations provoke relative adjustments in the balance of payments and the goods-producing sector that depend only on the marginal propensity to save. Given the same savings propensity across the two scenarios, the changes in interest rate and income will be identical.

The exchange rate, however, behaves differently in the presence of network trade. While the financial account responds identically to a change in the home interest rate, the trade balance reaction to the rise in income is weaker in the presence of network trade. On the other hand, a depreciation of a given magnitude also has a smaller effect on the trade balance. The net effect may be more or less depreciation with network trade, depending on the relative magnitudes of the marginal propensity to import and the sensitivity of imports to the exchange rate.

### 3.2.2. Fiscal Policy

For fiscal policy, the relevant condition is:

$$\frac{dE}{dG} = \frac{[(1-x_m)l_r m_y + l_y k_r]}{[x_e - (1-x_m)m_e][l_r s_y + l_y(i_r - k_r)]}. \quad (7)$$

The first term in the numerator is negative and shows the deterioration of the current account due to the rise in GDP brought about by the fiscal expansion, while the second term in the numerator is positive and shows the improvement in the financial account due to the rise in the home interest rate brought about by the expansion. The denominator is negative. When capital mobility is high (as measured by  $k_r$ ) relative to the marginal propensity to import, then the expression is negative and the home currency appreciates.

The likelihood of appreciation is further enhanced by high values of the direct link from imports to exports (given by  $x_m$ ). The difference between the benchmark model and network trade is thus incorporated in the term  $(1-x_m)$ , where  $x_m = 0$  in the former. As the direct link from imports to exports rises, the negative term in the numerator of equation (7) becomes smaller, thus increasing the magnitude of the numerator. At the same time, the rise in  $x_m$  reduces the size of the denominator. Together, these changes increase the value of expression (7), suggesting that the home currency must appreciate by more in the presence of network trade than otherwise.

### 3.2.3. Monetary Expansion

In both models, a monetary expansion leads to the same lower rate of interest and the same higher level of income, for reasons similar to those given for the earlier case of links running from exports to imports. Thus, the current and the financial accounts both deteriorate, requiring depreciation of the domestic currency. Although the interest-rate change affects the financial account to an equal degree in the two models, the GDP increase creates a larger current account imbalance in the benchmark model. The deterioration is smaller in the network-trade scenario, because the rise in imports due to

the GDP increase induces a direct rise in exports.

Furthermore, a given change in the exchange rate has a smaller effect on the trade balance when there is vertical intra-industry trade, because the decline in imports following a depreciation induces a direct decline in exports. Thus, the depreciation needed to correct the imbalances will not be the same in the two models. It will be less under network trade if  $m_y$  is larger than  $m_e$  or if, for equal  $m_e$  and  $x_e$ , the marginal propensity to save,  $s_y$ , is small and the marginal propensity to import,  $m_y$ , is large.

#### **3.2.4. Foreign Shocks**

A recession abroad, represented as a shock to foreign income,  $y^*$ , has the same effects on domestic income and interest rates as in the benchmark model. It leaves them unchanged, meaning that the home economy is completely insulated from this type of external shock. In both cases, the home currency appreciates in order to neutralize the effect of the foreign shock. However, once again there are differences between the two cases in the workload carried by the floating exchange rate, which in this case needs to adjust more in the presence of network trade. This is consistent with our earlier finding in connection with direct links that run in the opposite direction.

A foreign credit squeeze, represented by a rise in interest rates abroad, brings about a capital outflow which causes domestic interest rates to rise. The home currency depreciates, which improves the trade balance so as to offset the deterioration in the financial account. While the interest-rate rise dampens domestic economic activity, the depreciation stimulates it. The net effect is a rise in aggregate output, as in the benchmark model. Whether the depreciation is larger or smaller than in that model is ambiguous and depends once again on the relative magnitudes of the marginal propensity to import and the exchange-rate sensitivity of imports.

#### **3.2.5. Fixed Exchange Rates**

When exchange rates are fixed, the effectiveness of monetary policy as a macroeconomic stabilization tool remains essentially unchanged from the

benchmark scenario with respect to its effects on aggregate output and domestic interest rates. A monetary expansion temporarily raises income and reduces the rate of interest, but the deterioration of both current and financial accounts leads to pressures on the currency to depreciate. The resultant foreign-exchange market intervention by the central bank brings about a monetary contraction that continues until the original values of income and rate of interest have been re-established.

In the basic model, the efficacy of fiscal policy depends on the degree of capital mobility. Under high capital mobility, there are pressures on the home currency to appreciate. Intervention by the central bank leads to reserve accumulation and growth in the domestic money supply. This induced monetary expansion strengthens the effect on output of the fiscal policy. When capital mobility is low, on the other hand, intervention to prevent currency depreciation reduces the money supply, which tends to diminish the potency of the fiscal expansion.

In the presence of vertical network trade, the domestic interest rate tends to rise less than in the basic model, while aggregate domestic output grows by more. These results follow from the aforementioned change in slopes brought about by vertical intra-industry trade. Under high capital mobility, reserve accumulation will be larger with vertical intra-industry trade than without and reserve losses under low capital mobility will be larger as well than in the benchmark model.

The effects of foreign shocks may be summarized as follows. A rise in foreign income causes the home country's interest rate to fall and its GDP to rise and in each case the change is more pronounced than in the benchmark model. The explanation is fairly straightforward. The rise in foreign income stimulates exports to the same extent in both cases, giving rise to an improvement in the home country's current account. The resulting pressure for the home currency to appreciate is met by central bank intervention in the foreign exchange market.

This intervention gives rise to an increase in money supply, which explains the decline in the interest rate and which stimulates the economy further.



The consequent increase in home income raises imports in both cases, but the deterioration in the current account is less severe in the presence of network trade. Hence, income needs to rise more in order to complete the “automatic” adjustment under fixed rates. Overall, the foreign shock has a more pronounced impact on the home economy under conditions of vertical intra-industry trade.<sup>8)</sup> There is, of course, reserve accumulation in both cases, but the accumulation is larger in the presence of vertical intra-industry trade when linkages run from imports to exports.

Finally, a tightening of liquidity abroad, represented by a rise in foreign interest rates, raises domestic interest rates and lowers domestic income in both scenarios. The decline in income is more pronounced with vertical intra-industry trade, meaning that a foreign liquidity crisis causes more damage in the domestic economy when that economy is tied to the outside world through participation in a production network.

The foreign liquidity crisis provokes an initial outflow of capital, which puts upward pressure on domestic interest rates and reduces interest-sensitive domestic expenditures. Pressures on the domestic currency to depreciate are met by central-bank intervention, which reduces the money supply. From the point of view of domestic macro stability, this is exactly the wrong outcome and will typically be sterilized by the monetary authorities. This result is interesting in light of recent global financial disturbances, in that a country’s involvement in international production networks raises its exposure to foreign financial shocks. However, this exposure depends in part upon the nature of the linkages between its exports and its imports.

#### 4. CONCLUDING COMMENTS

In traditional trade models, exports and imports are only indirectly linked

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<sup>8)</sup> The M-F model’s ISXM and BP curves both shift out more than in Mundell-Fleming. Furthermore, since the BP curve always shifts more than the ISXM curve in response to this type of shock, the new intersection of the two curves occurs at a lower rate of interest than under Mundell-Fleming.

to each other. A rise in exports, for example, stimulates domestic economic activity and raises domestic income, which in turn raises imports. Vertical intra-industry trade introduces direct links between exports and imports and thereby alters the behavior of the trade balance. It reduces the sensitivity of the trade balance to movements in exchange rates and to shocks and disturbances associated with various other variables. These repercussions have implications for macroeconomic adjustment and for the ability of monetary and fiscal policies to achieve employment and other objectives.

The reduced sensitivity of the trade balance to exchange-rate changes is important for adjustment under floating, where rate movements play such a critical role. We find that the exchange-rate changes needed to achieve a given degree of adjustment are consequently larger with than without network trade. In other words, network trade tends to raise the volatility of floating rates.

The trade balance also becomes less responsive to movements in income and in home and foreign prices. Increases in domestic income or domestic inflation both raise imports, but when direct linkages run from imports to exports, there ensues a rise in exports, which reduces the net change in the trade balance. This change in behavior is relevant to both floating and fixed regimes. One interesting result under fixed rates is that linkages from imports to exports tend to make a country more vulnerable to foreign financial crises.

Finally, we find that when direct links run from imports to exports, network trade has an effect on the adjustment process that is analogous to capital mobility. Hence, countries with increasing involvement in network production and trade tend to experience a rise in the potency of fiscal policy.

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