The distribution of global trade imbalances: an econometric analysis

This paper builds, estimates, and simulates a world trade model to examine the distribution of global trade imbalances in response to a lower US trade deficit. A key feature of this model is that international trade imbalances add up to zero. The analysis estimates income and price elasticities for bilateral import equations, tests for the properties of the error term, for parameter constancy, and for the choice of dynamic specification. The paper finds that reliance on US income adjustments to eliminate the US external imbalance produces significant deteriorations in the trade accounts of Canada, Germany, and Japan.

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I. INTRODUCTION

That the rest of the world will absorb the reduction of the US trade deficit is a matter of accounting: because this deficit is the trade surplus of the rest of the world, eliminating one implies eliminating the other. What is not so evident is which countries will absorb this reduction, an issue of growing importance given the significant re-allocations of productive factors that are likely to emerge. Existing analyses, however, do not account for all world trade and thus cannot identify how foreign deficits respond to the reduction of the US trade deficit.¹ By focusing exclusively on US multilateral trade flows, the literature implicitly assumes that policies to reduce this deficit are independent of the distribution of countries absorbing it. Furthermore, reliance on multilateral trade flows introduces an aggregation bias in trade elasticities, implies that the cross-price elasticities are zero, and contradicts the empirical evidence against multilateral trade equations found by Thursby and Thursby [16].

This paper eliminates these restrictions by relying on an econometric trade model explaining bilateral trade flows among all trading partners in the world: Canada, Germany, Japan, the United Kingdom, the United States, other industrial countries, OPEC, non-OPEC developing countries, and centrally planned economies. The (non-diagonal) entries in the associated 9x9 trade matrix are modeled as bilateral import equations and their econometric specification is developed in section II.² Note that because this model recognizes that international trade imbalances add up to zero, it can examine the response of foreign trade accounts to a reduction of the US trade deficit.

Section III develops an analytical framework to determine the response of foreign external balances to a reduction in the US trade deficit, and section IV presents the corresponding empirical results. The main finding of the paper is that reliance on US income adjustments to reduce the US trade deficit produces significant deteriorations in the trade accounts of Canada, Germany, and Japan. Finally, section V points out the main limitations of the paper.

¹ See Krugman and Baldwin [12], Bryant and Holtham [2], Helkie and Hooper [7], Hooper and Mann [9], Hooper [10], United States Library of Congress [17].
² Previous estimates of bilateral trade elasticities include Branson [1], Houthakker and Magee [11], Hickman and Lau [8], and Marwah [15]. For more recent work, see Cushman [3], and Haynes et al [6]. See Goldstein and Khan [5] and Magee [13] for surveys of the literature.
II. ECONOMETRIC ANALYSIS OF INTERNATIONAL TRADE FLOWS

Bilateral imports of country $k$ from country $s$ behave according to the imperfect-substitute model (Goldstein and Khan, [5]):

\[
\ln M_{kst} = \alpha_{ok} + \alpha_{yk} \ln Y_{kt} + \alpha_{2ks} (\ln Y_{kt} - \ln Y_{kt'}) + \sum_j \alpha_{3kj} \ln P_{kstj} \\
+ \sum_j \alpha_{4kj} \ln P_{kstj} + \alpha_{5ks} \ln M_{ks't} + D + u_{kst},
\]

where $M_{ks't}$ is the volume of imports of country $k$ from country $s$, $Y_{kt}$ is the real income of country $k$, $Y_{kt'}$ is the potential real income of country $k$, $P_{kst}$ is the relative price for imports of country $k$ from country $s$, $P_{kstj}$ is the relative price for imports of country $k$ from country $q$, $D$ is a dummy variable for one-time events, $\alpha_{3kj} = \phi_{30} + \phi_{31} j + \phi_{32} j^2$, for $j = 0, ..., j_3$, $\alpha_{4kj} = \phi_{40} + \phi_{41} j + \phi_{42} j^2$, for $j = 0, ..., j_4$, $u_{kst} \sim N(0, \sigma_{kst}^2)$, $E(u_{kst} u_{kst+h}) = 0, \forall h$.

To explain bilateral imports of country $s$ from country $k$, the analysis uses (1) with the subscripts $k$ and $s$ replaced by $s$ and $k$, respectively.

According to (1), the response of imports to income has two components: a secular effect, measured by the parameter $\alpha_{yk}$, and a cyclical effect captured by the parameter $\alpha_{2ks}$. The own-price elasticity is $\alpha_{3}$ and the cross-price elasticity is $\alpha_{4}$. The choice of a logarithmic formulation is based on the Box-Cox tests reported in Marquez [14]. Finally, (1) assumes homogeneity of degree zero in prices and includes dummy variables to control for the effects of one-time events on imports.

The estimation of (1) involves testing whether the conditioning variables (income, prices, and exchange rates) are super exogenous with respect to trade elasticities and examining whether the import-supply, import-demand system is recursive. After finding support for both of these propositions, the paper applies ordinary least squares to (1) using quarterly data for 1973Q1 - 1985Q2. Given the relatively large number of parameter estimates, reporting all of them would exceed space limitations. Thus the paper summarizes the main features exhibited by these estimates (see Marquez [14] for a complete description of each of the estimating equations).

Marquez [14] describes the data. Testing for super exogeneity (Engle, Hendry, and Richard, [4]), involves applying sequential Chow tests to both the conditional model (equation (1)) and the marginal processes (the
First, the elasticities exhibit a large range of variation, a dispersion that weakens the case for aggregate import demand equations. Second, income elasticities are generally greater than one and at least twice as large as their standard errors. Third, countries fall into one of two categories depending on whether their income elasticity is below or above one. The "low" income elasticity countries are Japan and LDCs; the "high" income elasticity countries are Canada, Germany, the United Kingdom, the United States, and other industrial countries; the income elasticities for OPEC's bilateral imports are near unity. Fourth, the estimates of the own-price elasticity are negative, but many of them are not statistically significant (27 out of 56) at the 1% significance level, a finding noted also in the literature.\(^4\)

The results from the Jarque-Bera test indicate that the residuals do not violate the normality assumption for any of the 56 bilateral trade equations considered here. The F-tests for serial correlation support the assumption of serial independence for the residuals in 54 out of 56 cases. Finally, the results from the ARCH-tests support the assumption of homoskedastic errors for all 56 trade equations. For the equations in which they were used (30 in total), the Almon restrictions are supported by the data. F-tests comparing the dynamic specification of (1) against an unrestricted dynamic specification indicate that the data do not reject the dynamic specification of (1) for any of the 56 cases considered here. Finally, the hypothesis of parameter constancy is not rejected in 53 out of 56 trade equations.\(^5\) On the whole, the failure to reject either the conditions for classical inference, the dynamic specification of (1), or the assumption of parameter constancy are reassuring.

III. THE DISTRIBUTION OF GLOBAL TRADE IMBALANCES

1. Model formulation

The world trade model consists of estimated bilateral trade equations and identities defining each country's total exports, exogenous variables. The latter are modeled as function of lagged policy variables (Marquez [14], appendix B). The conditional processes exhibit parameter stability whereas the marginal processes do not. To examine recursiveness, Marquez ([14], appendix B) estimates an export (relative) price equation for each bilateral trade equation and tests both whether the coefficient for bilateral imports is zero and whether the residual is uncorrelated with the residual of the associated bilateral trade equation. In 45 out of 56 price equations, bilateral imports have no significant influence on the relative price and the residuals of the price and import equation are uncorrelated.


\(^5\) The equations failing the Chow test are UK imports from OPEC, and US imports from both other industrial countries and OPEC.
total imports, and the corresponding trade account. Multilateral exports of country \( k \), that is \( X'_{kt} \), are determined as the sum of its 8 bilateral exports, 7 of which are explained with export demand equations:

(2) \[ X_{kt} = \sum_{s=1}^{7} P_{kt} X_{s,t} + \overline{X}_{kt} = \sum_{s=1}^{7} P_{ks} M_{sk} [y_{kt}, P_{skt}, P_{sqt}, k_s, (L)] + \overline{X}_{kt}, \]

where \( \alpha_{sk}(L) \) is a vector of estimated trade elasticities, \( \overline{X}_{kt} \) is the exogenously given value of exports to centrally planned economies, and it is assumed that \( X'_{kt} = M_{sk} \) for expository reasons.\(^6\)

Multilateral imports of country \( k \), \( M_{kt} \), are determined as the sum of its 8 bilateral imports, 7 of which are explained with import demand equations:

(3) \[ M_{kt} = \sum_{s=1}^{7} e_{st} P_{st} M_{sk} + \overline{M}_{kt} = \sum_{s=1}^{7} e_{st} P_{st} M_{sk} [y_{kt}, P_{kt}, P_{sqt}, k_t, (L)] + \overline{M}_{kt}, \]

where \( \alpha_{kt}(L) \) is the vector of estimated trade elasticities, and \( M_{kt} \) is the exogenously given value of imports from centrally planned economies.

Given (2) and (3), the trade account of country \( k \) is

(4) \[ NX_{kt} = X_{kt} - M_{kt} = NX_k [y_{kt}, y_{kt}, P_{kt}, P_{sqt}, \alpha_{kt}(L), \alpha_{kt}(L)], \forall k. \]

According to (4), the trade account of country \( k \) depends on the income level of all trading countries, the terms of trade of country \( k \), and trade elasticities. The model uses (4) to determine the trade account of 8 countries and relies on the adding-up constraint to explain the trade account of the bloc of other OECD countries (\( k=i \)):

(5) \[ X_{it} = M_{it} + \sum_k M_{kt} - \sum_k X_{kt}, \forall k \neq i. \]

Equation (5) ensures equality between world exports and world imports, and thus guarantees that a reduction in the US trade deficit is absorbed by the rest of the world. However, (5) does not determine the extent to which a given country absorbs this deficit reduction, a task that requires model simulations.\(^7\)

\(^6\) Differences in reporting practices across countries, shipment delays, and CIF/FOB differentials introduce a discrepancy between the value of exports of country \( k \) to country \( s \) and the value of imports of country \( s \) from country \( k \). See Marquez ([14], section 4) for details on how to take into account these measurement problems.

\(^7\) To measure the adequacy of the model against historical observations, Marquez [14] uses residual-based stochastic simulations to compute mean absolute percentage errors and to estimate regressions of the actual on the (mean of) predicted values. The results (Marquez [14], table 13) indicate a fairly tight fit of the data.
2. The absorption of the US trade deficit

Given prices and foreign income, (4) implies a relation between the level of income and net exports which the paper expresses as

\[ y_\nu = NX_1^{-1} [NX_\nu, y_2, \ldots, y_9], \]

where the United States is denoted as country 1 for notational convenience. Thus the level of US income associated with a zero trade deficit is given by

\[ y'_\nu = NX_1^{-1} [0, y_2, \ldots, y_9]. \]

The repercussions of this level of US income for the distribution of foreign balances are given by

\[ NX'_{k\nu} = NX_k [y'_\nu, y_2, \ldots, y_9], \forall k \neq 1. \]

Taken together, equations (7) and (8) imply that if the United States adjusts the trade deficit on its own, then foreign economies experience a deterioration of their external accounts \(NX'_k < NX_1\) because the contraction in US income \(y'_1 < y_1\) lowers the demand for their products.

To examine the sensitivity of this result, the analysis shocks foreign income with income in the United States adjusting to maintain external balance. Under this scenario, equations (7) and (8) become

\[ y''_\nu = NX_1^{-1} [0, y''_2, \ldots, y''_9] \]

\[ NX''_{k\nu} = NX_k [y''_\nu, y''_2, \ldots, y''_9], \forall k \neq 1, \]

where \(y''_2, y''_3, \ldots, y''_9\) for all \(t\). By expanding their economic activity, foreign economies increase their demand for US products and thus reduce the degree of adjustment needed by the United States. In other words, \(y'_1 < y''_1 < y_1\). This expansion in foreign income also increases trade among foreign countries, but the associated trade-account effects vary across non-US countries because of differences in income elasticities across countries. On the whole, the trade account improves for some but deteriorates for others - that is, \(NX''_k \geq NX'_k\).

IV. EMPIRICAL RESULTS

To study how foreign trade accounts respond to the elimination of the US trade deficit, the paper endogenizes the level of real
income in the United States and exogenizes the US trade deficit, which is then set to zero at once and permanently (see equation 7).

Because the resulting pattern of foreign trade balances depends on both the associated change in US real income and the assumed level of foreign income, the analysis simulates the trade model under two scenarios: no foreign-income response (Case 1) and a foreign-income response (Case 2). These simulations are performed over 1980Q1-1984Q4, and, by construction, they guarantee that the improvement in the US trade account is equal to the historical trade deficit.

The results for Case 1 (Table 1) exhibit several features of interest. First, reliance on US income alone to eliminate the US trade deficit requires a 15% fall in US real GNP after five years. Even this sizeable reduction in income is unrealistic because it assumes that prices, exchange rates, and real income in other countries remain unchanged in the face of contraction in US real income—that is, these are partial equilibrium results. To the extent that income in the United States does not adjust to such a level, the model predicts that the process of eliminating the US trade deficit will require a combination of further dollar depreciation, further expansion abroad, higher foreign prices, and lower US prices.

Second, the model indicates that the countries absorbing most of this reduction in the US trade deficit are Japan (29%), Canada (24%), the bloc of other OECD countries (15%), and Germany (11 percent).

The case of a foreign-income response (Case 2) is modeled as an increase of 1% per year in the growth rate of all non-US countries while US real income adjusts in order to support a zero trade deficit (see equations 10 and 11). Based on the simulation results (Table 1), this foreign expansion raises the level of US real income consistent with balanced trade by 4.5% after five years. Intuitively, a foreign expansion raises US exports and improves the US trade account. To avoid that surplus, US imports have to increase, which implies an increase in US real income. Note that, because income elasticities differ across countries, the trade account effects of faster foreign growth are not the same for all non-US countries: the trade account improves for some countries but deteriorates for other. On balance, however, the non-US

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8 Although the assumption of an immediate return to external balance is extreme, it is adopted here because it avoids the ambiguities associated with selecting any other target path for the trade account. The framework could also be used to determine the change in the exchange rate required to eliminate the trade deficit, but it is not presented here because of space considerations.

9 This paper does not address the question of what combination of dollar depreciation and growth adjustment would be most effective or desirable for reducing the US trade deficit.
balances must weaken. Finally, the foreign expansion alters the
degree to which different countries would absorb the reduction in
the US trade deficit. Specifically, the deterioration in the combined
trade accounts of Japan, Germany, Canada and other OECD
countries would account for 89% of the improvement in the US
trade account, compared with 79% in the absence of a foreign
expansion.

V. LIMITATIONS

By being the first analysis that quantifies the response of foreign
imbalances to a reduction of the US trade deficit, it is subject to
several limitations. First, there is no allowance for the response
of income, prices, and exchange rates to changes in trade flows.
Although there is evidence that these variables might be taken as
exogenous for parameter estimation, they are not necessarily so
in model simulations.

Second, the estimated response of the distribution of global
balances is model dependent. Replication of this analysis with
other models will determine how important is this dependency.
Eliminating these limitations will, no doubt, affect the precise
trade-account effects that individual foreign countries will
experience in response to the reduction of the US trade deficit.
But eliminating them will also strengthen the point of the paper:
that policies to reduce the US trade deficit are not independent of
the countries absorbing it.
### Table 1. Trade account effects of lowering the US trade deficit to zero
(deviations from baseline, billions of US dollars)

<table>
<thead>
<tr>
<th>Years</th>
<th>80Q4</th>
<th>81Q4</th>
<th>82Q4</th>
<th>83Q4</th>
<th>84Q4</th>
</tr>
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<tbody>
<tr>
<td><strong>Case 1: Foreign income unchanged</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade account responses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>-3.76</td>
<td>-8.64</td>
<td>-11.05</td>
<td>-24.78</td>
<td>-26.18</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>-2.27</td>
<td>-4.75</td>
<td>-5.54</td>
<td>-6.98</td>
<td>-9.61</td>
</tr>
<tr>
<td>Germany</td>
<td>-2.17</td>
<td>-4.20</td>
<td>-8.15</td>
<td>-9.01</td>
<td>-19.97</td>
</tr>
<tr>
<td>Japan</td>
<td>-4.96</td>
<td>-8.22</td>
<td>-9.46</td>
<td>-12.44</td>
<td>-16.43</td>
</tr>
<tr>
<td>Industrial</td>
<td>-5.86</td>
<td>-7.87</td>
<td>-5.35</td>
<td>-10.07</td>
<td>-8.52</td>
</tr>
<tr>
<td>LDCs</td>
<td>-0.82</td>
<td>-1.45</td>
<td>-1.78</td>
<td>-3.47</td>
<td>-4.50</td>
</tr>
<tr>
<td>OPEC</td>
<td>-8.08</td>
<td>-7.87</td>
<td>-5.35</td>
<td>-10.07</td>
<td>-8.52</td>
</tr>
<tr>
<td>United States</td>
<td>26.26</td>
<td>42.78</td>
<td>47.44</td>
<td>87.14</td>
<td>108.11</td>
</tr>
<tr>
<td><strong>US real GNP</strong> (% deviation)</td>
<td>-3.01</td>
<td>-6.76</td>
<td>-9.21</td>
<td>-17.14</td>
<td>-15.90</td>
</tr>
</tbody>
</table>

| **Case 2: Higher foreign income** |      |      |      |      |      |
| Trade account responses         |      |      |      |      |      |
| Canada                             | -4.73 | -10.96 | -13.48 | -29.40 | -32.45 |
| United Kingdom                     | -3.28 | -5.83 | -7.94 | -10.57 | -14.84 |
| Japan                               | -5.15 | -10.15 | -11.71 | -23.40 | -34.41 |
| Industrial                          | -5.28 | -8.24 | -9.51 | -10.10 | -13.66 |
| LDCs                                | 0.33  | 0.61  | 1.01  | 1.26  | 2.08  |
| OPEC                                | -3.90 | -0.62 | 3.27  | -0.99 | 0.92  |
| United States                      | 26.26 | 42.78 | 47.44 | 87.14 | 108.11 |
| **US real GNP** (% deviation)      | -2.42 | -5.37 | -6.76 | -13.50 | -11.39 |

a Entries for US real GNP represent percent deviation from baseline.
BIBLIOGRAPHICAL REFERENCES


