Bank of Israel **Research Department**

The Effect of Terms of Trade Shocks on GDP and the Real Exchange Rate[1]

Roni Frish* and Yinon Polak**

Discussion Paper 2018.09

October 2018

Bank of Israel; http://www.boi.org.il

* Roni Frish, Research Department – email: roni.frish@boi.org.il, Tel: 02-6552670

** Yinon Polak : inon51@gmail.com Tel: 054-2284384

[1] We wish to thank Yossi Yakhin for his large contribution to this study, and Avihai Rosenzaft and the participants of the Bank of Israel Research Department seminar.

חטיבת המחקר, בנק ישראל ת"ד 780 ירושלים 91007

Research Department, Bank of Israel. POB 780, 91007 Jerusalem, Israel

השפעת זעזועים בתנאי הסחר על התוצר ועל שער החליפין הריאלי

רוני פריש וינון פולק

תקציר

המחקר בוחן את ההשפעה של זעזועים בתנאי הסחר על התוצר ועל שער החליפין הריאלי באמצעות מודל SVAR (Structural Vector Auto Regression). במודל שלושה משתנים – תנאי הסחר, שער החליפין הריאלי והתוצר. מגבלות הזיהוי מתבססות על ההנחה שתנאי הסחר אקסוגניים, ושלזעזוע בשער החליפין אין השפעה פרמננטית על התוצר. המודל נאמד ל-19 מדינות מפותחות ול-34 מדינות מתפתחות לשנים 1974 עד 2015. הזעזועים בתנאי הסחר הסבירו בין 13% ל-17% מהשונות בקצב צמיחת התוצר ו-15% עד 18% מהשונות בשער החליפין הריאלי, בממוצע של כל המדינות, ללא הבדל משמעותי בין המדינות המפותחות למתפתחות. במדינות המפותחות שיפור של 5% בתנאי הסחר גרר (בממוצע) עלייה של כ-0.6% בתוצר וייסוף של כ-2.4% בשער החליפין הריאלי, ובמדינות המתפתחות – עלייה דומה של התוצר (0.5%) וייסוף מתון יותר בשער החליפין הריאלי (1.5%). השפעתם של הזעזועים בתנאי הסחר על התוצר ועל שער החליפין הייתה השפעה מתמשכת, ובכך הם פעלו בדומה לזעזועי היצע.

The Effect of Terms of Trade Shocks on GDP and the Real Exchange Rate

Roni Frish and Yinon Polak[1]

Abstract

This study use a structural vector auto regression (SVAR) model to examine the effect of terms of trade shocks on GDP and the real exchange rate. The model contains three variables—the terms of trade, the real exchange rate, and real GDP. The model's identifying restrictions are based on the assumption that the terms of trade are exogenous, and that an exchange rate shock has no permanent effect on GDP. The model was estimated for 19 advanced economies and 34 developing economies between 1974 and 2015. The terms of trade shocks account for 13 to 17 percent of the GDP variance and for 15 to 18 percent of the real exchange rate variance, with no significant difference between advanced and developing economies. On average, a 5 percent shock to the terms of trade led to an increase of 0.6 percent in GDP and an increase of 2.4 percent in the real exchange rate in advanced economies, while in developing economies, it led to similar growth of GDP (0.5 percent), and a more moderate increase in the real exchange rate (1.5 percent). The shocks to the terms of trade had a prolonged effect on GDP and on the exchange rate, thereby acting in a similar manner to supply shocks.

---

[1] The authors thank Yossi Yakhin for his large contribution to this study, and Avihai Rosenzaft and the participants of the Bank of Israel Research Department seminar.

1. Foreword

This study examines the effect of terms of trade shocks[1] on real per capita GDP (hereinafter: GDP) and the real exchange rate (hereinafter: the exchange rate or RER). In the past, fluctuating terms of trade were found to be an important factor in accounting for shocks in the business cycles of different countries. Mendoza (1995) found that these shocks account for nearly half of the fluctuations in GDP and the exchange rate of developing and advanced countries between 1960 and 1990. In contrast, Uribe & Schmitt-Grohe found that these shocks account for less than 10 percent of fluctuations in GDP in countries where per capita GDP was low (in 1980-2011).

This study uses a Structural Vector Auto Regression (SVAR) model to examine the effect of terms of trade shocks. The basic model contains three variables - terms of trade, the real exchange rate, and per capita GDP. The identification assumptions assume that the terms of trade are exogenous (so that GDP and exchange rate shocks affect the terms of trade with a lag rather than immediately). Another identification assumption is that an exchange rate shock has no permanent effect on GDP. The model was estimated for 19 advanced economies and 34 developing economies for the sample period 1974-2015. The estimations show that, on average, terms of trade shocks account for 13 to 17 percent of the GDP variance and 15 to 18 percent of the real exchange rate variance. The model shows that, on average, a 5 percent improvement in the terms of trade led to an increase of 0.6 percent in GDP and an increase of 2.4 percent in the real exchange rate in advanced economies while in developing economies it led to a similar growth of GDP (0.5 percent) and an increase of 1.5 percent in the exchange rate (after five years). The shocks to the terms of trade had a prolonged effect on GDP and on the exchange rate, thereby acting in a similar manner to supply shocks.

Once we change the identification assumptions and allow shocks originating in GDP and in the exchange rate to effect the terms of trade simultaneously (and not just at one period lag) – The terms of trade shocks account for a more significant share of the variance in GDP and the exchange rate in developing economies – 27 percent and 22 percent, respectively.

We examined the effect of the terms of trade shocks on the current account surplus. Harberger, Laursen and Metzler argued that improved terms of trade will increase saving in the economy (and as a consequence also improve the current account surplus) since an improvement of this kind is equivalent to an increase in income for the economy, and the marginal propensity to consume (from the higher income) is less than one. In contrast, Obstfeld (1982), and Razin and Svensson (1982) asserted that the effect of a terms of trade shock on consumption depends on the degree to which the shock persists, on the elasticity of the intertemporal substitution and

[1] The terms of trade are the relationship (ratio) between the export price and the import price.

elasticity of the substitution between tradable and non-tradable products. We estimated an SVAR model, which like Otto's model (2003) included the terms of trade, current account surplus and per capita GDP. The identification assumptions were that shocks in the current account surplus have no permanent effect on per capita GDP and that shocks in the current account surplus and GDP do not affect the terms of trade simultaneously (but at one period lag). We found that an improvement in the terms of trade led to an increase in the current account surplus, notwithstanding that the improvement in the terms of trade was continuous (and did not fade out).

2. Review of the literature

This study relies largely on the research method of Otto (2003), who examined the effect of an improvement in the terms of trade on the trade balance, using an SVAR model containing three variables – the terms of trade, GDP and the export surplus.[2] Three identification restrictions were derived from the assumption that the terms of trade are exogenous: the terms of trade are not affected by shocks in GDP or shocks in the export surplus, and a shock in the export surplus does not have any long-term effect on GDP. Otto's study (2003) examined whether an improvement in the terms of trade leads to an increase in the export surplus. We may recall that Harberger (1950) and Laursen and Metzler (1950) asserted that improved terms of trade lead to an increase in the export surplus and in saving in the economy by increasing the real income of individuals, since the marginal propensity to consume (from the higher income) is less than one. In contrast, Obstfeld (1982) and Svensson and Razin (1983) argued that a permanent, positive terms of trade shock will not necessarily increase saving and the import surplus, because the impact of such a shock on consumption depends on the extent to which it persists, on the elasticity of the intertemporal substitution and elasticity of the substitution between tradable and non-tradable products.

The main purpose of the present study is to examine the effect of terms of trade shocks on GDP and the real exchange rate (and not on the export surplus as in Otto's study (2003)), and in this sense it is similar to the study by Hoffmeister and Roldos (1997) who examined the causes of business cycles in East Asia and South America, using an SVAR model. Their study found that the principal source of GDP fluctuations is productivity shock (supply shocks), whereas terms of trade shocks account for only a small proportion of fluctuations in GDP. They used two categories of identification assumptions – that the terms of trade and global interest rate are exogenous to the economy, and that shocks in the other non-exogenous variables have no long-

[2] The difference between exports and imports in percentage GDP.

term effect on GDP. Terms of trade shocks accounted for 7 percent of the variance in GDP and 30 percent of the variance in the exchange rate in South American countries and 6 percent and 7 percent of the variance, respectively, in countries in Asia. A similar study by Hoffmeister, Roldos and Wickman (1997) found that terms of trade shocks account for 15 percent of the variance of sub-Saharan African countries.

Contrary to the aforementioned studies, scholars who examined the effects of terms of trade shocks on GDP using a calibrated Dynamic Stochastic General Equilibrium (DSGE) of small, open economies found that terms of trade shocks have a marked effect on GDP. The most prominent study is that of Mendoza (1995). Based on data for 7 large advanced economies (the G7) and 23 developing economies, this study initially found four key empirical facts: (a) terms of trade shocks are large and persistent and correlate positively, albeit weakly, with GDP growth (weak procyclicality); (b) an improvement in the terms of trade leads to a certain increase in the current account surplus; in other words: there is a positive, weak correlation between changes in the terms of trade and a change in the current account surplus; (c) GDP fluctuations in developing economies are greater than those of the advanced economies; (d) real exchange rate fluctuations are large and persistent (contrary to the theory of Purchasing Power Parity). Notably, import prices were an anchor, and all real variables were measured in terms of fixed import prices. Mendoza subsequently presented a DSGE model for a small open economy. The model assumes that individuals consume leisure as well as three products: importable products, exportable products and non-tradable goods. Firms produce the three goods using capital, which is an importable good, and labor services. To simplify matters, it was assumed that the scope of the shared labor supply for the import and export sectors is completely inflexible, as is the supply of capital to the non-tradable sector. The terms of trade are exogenous to the economy and the global markets for products and capital are competitive. Fluctuations in the business cycle are triggered by shocks in the terms of trade and manufacturing productivity in the domestic economy. The model was calibrated and estimated and it was found that the terms of trade shocks account for approximately half (45 percent to 60 percent) of fluctuations in GDP.

Kose (2002) also estimated the effect of terms of trade shocks on business cycles in small, open developing economies using a calibrated DSGE model. The model included non-tradable sector and tradable sector which produces intermediate (partly finished) goods. Non-tradable products are produced using imported intermediate inputs, labor and capital; intermediate goods are produced using imported capital, labor and land, which is fixed and inelastic in scope. The study found that the terms of trade shocks account for 88 percent of all GDP fluctuations (and 90 percent of the fluctuations in total investment in the economy). One of the reasons for the difference from the results of Mendoza's study (1995) is that in Kose's model the non-tradable

sector uses imported intermediate inputs and it therefore has greater exposure to terms of trade shocks.

Schmitt-Grohe and Uribe (2016) highlighted one possible reason for the difference between the low estimates obtained in the SVAR estimations and the high estimations obtained in the DSGE models. They first measured an SVAR model for 38 developing economies and found that the terms of trade shocks account for less than 10 percent of the GDP fluctuations (in the median economy). They then estimated a DSGE model which like Mendoza's model (1995) comprised three sectors (exportable, importable and non-tradable goods) using capital and labor. Unlike Mendoza's model (1995), the scope of employment in the export and import sectors and the volume of capital in the non-tradable sector was not determined in advance (and the investment product also included a local component). Calibration and estimation of the model showed that terms of trade shocks account for a significant share of the variance in GDP - 27 percent. This is true when GDP is measured in terms of the final product (which includes an import component). However, when GDP is measured at fixed prices, using the Paasche index, the terms of trade shocks accounted for 9 percent of the variance, similar to the estimate obtained in the SVAR model.[3]

Lubik and Teo (2005) estimated a DSGE model for five small, open economies (Australia, Canada and New Zealand, and two developing economies - Chile and Mexico). They found that world interest rate shocks are the main driving forces of business cycles (40 percent – 75 percent), whereas terms of trade shocks have a negligible effect (just 3 percent). In contrast with the DSGE studies reviewed in this paper, according to which GDP fluctuations can be largely attributed to terms of trade shocks, this model was estimated in full (namely, the structural parameters were not calibrated).

Fernandez, Schmitt-Grohe, and Uribe (2017) estimated an SVAR model for a panel of 138 countries and found that terms of trade shocks accounted for 33 percent of fluctuations in GDP in the period between 1960 and 2015 and 78 percent of fluctuations in GDP between 2000 and 2015. This contrasts with studies that estimated an SVAR model and found that terms of trade shocks account for a minor share of GDP volatility. This study covered three separate shocks in the terms of trade (rather than one single shock) – shocks in the global prices of agricultural produce, metals and fuels. The combined effect of all three shocks was found to be much greater than that of a single shock in the global price.

[3] Either way, there was a marked difference between the results obtained in the SVAR model and those of the DSGE model at economy level, even when the results for the median economy were similar.

A study by Fernandez, Gonzales and Rodriguez (2015) focused on the effect of fluctuating export prices of commodities from emerging market economies in which raw materials account for a substantial share of total exports. They exposed three important facts: the share of commodities in total exports in the average emerging market economy is more than double that of advanced economies (25 percent compared with 11 percent, respectively). Second, in emerging market economies, the development of the export prices of natural resources is procyclical, correlating with and even driving the GDP business cycle, as well as the consumption and investment cycle.[4] Third, there are common factors in the development of the prices of all raw materials (agricultural, fuel and metals) and a common factor was also found in the development of GDP for all emerging markets. The authors presented a model of a small, open economy which also includes a sector commodity exporting firms that is owned by households. An increase in the global price of the commodity will increase household income, triggering an increase in demand for the final consumer product, which also includes a non-tradable element; as a result, the price of the non-tradable product will rise, the rental rate of the capital owners in GDP will increase, and the demand for investment (which includes the local component) will increase. The increase in the global price of the export-targeted commodity will therefore cause an upsurge in the emerging market's business cycle. The model was calibrated and estimated using a Bayesian estimation. The results show that terms of trade shocks account for almost half (42 percent) of GDP fluctuations, a substantial share of which has its origins in the factor common to the development of raw materials prices around the world. The study also found a correlation between an increase in export prices and a decrease in the economy's risk premium.

A study by Shousha (2016) focused on the effect of commodity export prices on small, open economies. A separate SVAR model was estimated for developing economies and advanced economies. The model included two exogenous variables – the rate of interest in the USA and commodity export prices – and endogenous variables: GDP, investment (real gross fixed capital formation), trade balance (to output ratio), credit to the non-financial private sector, real interest rate and real exchange rate. Shocks in the export prices of raw materials account for 23 percent of the variance in the GDP of the developing economies (Argentina, Brazil, Chile, Colombia, Peru and South Africa) and 7 percent of the variance in the GDP of the advanced economies (Australia, Canada, New Zealand and Norway). Later on, the study presented a DSGE model for a small, open economy that includes a financial sector. The model emphasizes the path through which shocks in export prices affect the volume of credit. The results of the model

[4] The simultaneous correlation between the index of commodity export prices and GDP was 0.5, increasing to 0.6 when the increase in GDP is calculated according to the index of private consumption prices (rather than GDP prices).

estimation correspond with the results obtained in the SVAR model, and in particular it was found that an export price shock affects the GDP of developing economies more than that of advanced economies. The model shows that export price shocks affect developing and advanced economies differently, and that this difference is due to the varying strength of the impact on interest rate through a lower country risk.

3. Effect of terms of trade shocks on GDP in the short and long term

Let us assume that the output of the tradable sector (Y_T) and the non-tradable sector (Y_N) is produced by means of standard Cobb-Douglas production functions with two production inputs – capital (K) and labor (L) – and a productivity factor (A):

$$Y_N = A_N L_N^{\alpha} K_N^{1-\alpha}; Y_T = A_T L_T^{\beta} K_T^{1-\beta}$$

Where capital is a tradable production input and labor is a non-tradable production input, while workers moving freely between the two sectors. The real exchange rate is the ratio of price level in the economy to price level abroad (with both measured in the same currency); without considering taxes and transportation costs, the price of the tradable product is identical in all countries (and specifically in country *i* and country *j*). The price ratio of the non-tradable product (P_N) between country *i* and country *j* (i, j) is:

$$\frac{P_{N,i}^t}{P_{N,j}^t} = \varpi \frac{P_{X,i}^t A_{X,i}^t A_{N,j}^t}{P_{X,j}^t A_{X,j}^t A_{N,i}^t} \qquad , \left(\varpi \equiv \left(\frac{(1-\beta_i)}{\beta_i} \frac{\alpha_i}{1-\alpha_i} \right)^{1-\beta_i} \Bigg/ \left(\frac{(1-\beta_j)}{\beta_j} \frac{\alpha_j}{1-\alpha_j} \right)^{1-\beta_j} \right)$$

This solution assumes that the foreign economy has close to zero surplus assets. One result emerging from the model is that improved terms of trade have the same effect on the real exchange rate as an improvement in the relative productivity of the tradable sector vis-à-vis foreign economies

$$\left(\frac{A_{X,i}^t}{A_{N,i}^t} : \frac{A_{X,j}^t}{A_{N,j}^t} \right)$$

Improved terms of trade could affect GDP through a number of channels:

1. **Demand:** Improved terms of trade due to a drop in import prices will increase the economy's disposable income, thus increasing domestic demand. In economies with full employment, increased domestic demand will not increase output (the demand channel will be off). But in economies without full employment (cyclical unemployment), increased domestic demand

will lead to greater utilization of the production and output inputs; the increased output will almost certainly be temporary, since according to accepted convention, the economy will converge, sooner or later, into full employment production.

2. **Supply:** In an economy with full employment, improved terms of trade (higher export prices) will continuously increase GDP: An improvement in the terms of trade raises the real wage (in terms of imported goods) and as a result individuals will increase their working hours (by reducing the number of leisure hours).[5] Improved terms of trade could also lead to an increase in the inventory of capital (which in turn increases output).
3. Improved terms of trade affects the composition of output: an increase in export prices worldwide will incentivize local exporters to increase production. This entails a shift of production inputs to the tradable sector, at the expense of the other sector (assuming that the economy is in full employment).[6]

The model's estimations make it possible to distinguish whether the terms of trade effect operates through the demand channel or through the supply channel. In the first instance, any terms of trade shock will have only temporary effect on output, whereas in the second instance (the supply channel), the effect will be prolonged.

4. The statistical model:

An SVAR model was estimated with three basic variables – terms of trade, real exchange rate and real GDP per capita (at fixed prices) – and one exogenous variable: global output (at fixed prices). We chose to use the first difference for each of the variables given that the actual variables have a unit root (I(1)), whereas the first differences are stationary.

An SVAR model was chosen since for the vast majority of OECD countries, no cointegration relationship was found between the three endogenous variables – terms of trade, exchange rate and per capita GDP.[7] Specifically, no significant cointegration relationship was found between per capita GDP and the two other endogenous variables,[8] and in most economies no

[5] This is assuming that the substitution effect (which operates to limit leisure) is greater than the effect of income (which operates to increase leisure).

[6] Since the change in the composition of output only became worthwhile following a change in the relative price; and the change in output (in fixed prices) was measured in the previous year's prices and not at current prices), the change in the composition of output is not expected to significantly contribute to increasing total output at fixed prices.

[7] This cointegration test referred to the following OECD countries: Australia, Canada, Denmark, Finland, France, Germany, Great Britain, Greece, Hungary, Iceland, Israel, Italy, Japan, Netherlands, Norway, Poland, Spain, Sweden and Switzerland.

[8] It is fair to assume that the development of GDP in the long term has a cointegration relationship with the development of other variables – capital inventory, education, technology, etc.

cointegration relationship was found between the terms of trade and the real exchange rate. Since no cointegration relationship was found between the three variable, we chose to estimate a model that only includes the first difference of the variables, and not their levels.[9]

To estimate an SVAR model with three endogenous variables, three identification assumptions must be made. The first two assumptions are that shocks in GDP and the exchange rate do not immediately affect the terms of trade. These assumptions were confirmed by the Granger test that we performed, and they are also generally accepted in other studies, given that import and export prices are set in the world market. However, the third identification assumption, according to which a shock in the relative price (real exchange rate) has no long-term effect on GDP, is, in our opinion, preferable to each of the other possible identification assumptions: the assumption that exchange rate shocks do not affect GDP in the short term, or that GDP shocks do not affect the exchange rate in the short term are both unacceptable as those two variables are correlated. As demonstrated by Balassa and Samuelson, changes in GDP have a long-term effect on the real exchange rate. Therefore we will assume that shocks to exchange rate do not affect GDP in the long term. The assumption that a shock in the relative price has no long-term effect on GDP is widely accepted. From this, we derive that the source of a shock that simultaneously affected both the exchange rate and GDP, and left its mark on GDP in the long-term, is not in the exchange rate but rather in GDP.[10]

The SVAR model is

$$A_0 Y_t = \sum A_i Y_{t-1} + \beta u_t$$

u_t and Y_t are vectors of length n of structural shocks and endogenous variables, respectively.

The specific model is:

$$Y_t = \begin{bmatrix} \Delta \ln(tot_t) \\ \Delta \ln(reer_t) \\ \Delta \ln(gdp\_pc_t) \end{bmatrix}; u_t = \begin{bmatrix} u_{tot,t} \\ u_{reer,t} \\ u_{gdp\_pc,t} \end{bmatrix}$$

where Δ is the symbol for the first difference

$(\Delta \ln y_t = \ln y_t - \ln y_{t-1})$

[9] If there is a stable cointegration relationship between the three variables, there is an advantage to estimating the variables using the error correction model, which includes the levels as well as the first difference.

[10] Studies that examined currency crisis events found that they occurred mostly in economies with a large, prolonged current account deficit. Nonetheless, there are also models of multiple equilibrium, including coincidental shocks in the nominal exchange rate that might lead to a real crisis.

The reduced form: $Y_t = \sum \phi_i Y_{t-1} + e_t$

Where $\phi_i = A_0^{-1} A_i$; $e_t = A_0^{-1} B u_t$

The identifying restrictions for the short term are:

$A_{1,2}^0 = A_{1,3}^0 = 0$

The short term identifying restriction are imposed according to the development of Yakhin and Presman (2015),[11] in which short and long-term restrictions can be cointegrated in a standard SVAR model for the short term. This is because the aggregate effect of the structural shocks (u_t) on the endogenous variables (Y_t) is:

1. $Y_t - \overline{Y} = (I - \sum_{i=1}^{P} \phi_i)^{-1} A_0^{-1} B u_t \equiv D A_0^{-1} B u_t \equiv C u_t$

2. $Y_t = \varphi + \phi_1(L) Y_t + \phi_2(L^2) Y_t + ... + \phi_p(L^p) Y_t + \varepsilon_t$

In our case, we estimated the three reduced form regressions for p=2, which is the number of lags. We extracted from them coefficients for the matrix $(I - \sum_{i=1}^{2} \phi_i)$, we reversed the matrix and obtained matrix *D*. [12]

5. Data sources:

Our principal data source was the International Financial Statistics published by the International Monetary Fund and an additional source is World Development Indicators published by the World Bank.

Terms of Trade for the advanced economies: The IMF publishes a series of Unit Value Indices (value divided by quantity) for the import and export of commodities (UV_t^m and UV_t^x), from which we derived the terms of trade $tot\_imf_t = UV_t^x / UV_t^m$.

Terms of Trade for the developing economies: the Terms of Trade index published by the World Bank – net barter terms of trade index (tot_wb_t), that includes data for a much larger number of developing economies (but for shorter time periods).

---

[11] Yakhin and Presman (2015).

[12] In Matrix A (STATA 14), we placed restriction $A_{3,2} = D_{3,2} / D_{3,3}$ thus imposing the long-term constraint: $C_{3,2} = [DA^{-1}B]_{3,2} = 0$

Real Exchange Rate(RER): provided by the IMF. The real effective exchange rate measure the consumer price of each country relative to its trading partners.

Per-capita GDP at fixed prices (for 2010) provided by the World Bank.

Current account surplus as a percentage of GDP: provided by the IMF.

6. Estimation results:

6.1 The benchmark SVAR model estimation results for the advanced and developing economies:

We estimated an SVAR model for countries for which data is available for at least 20 consecutive years.[13] Table 1 summarizes the impulse-response functions obtained from the model estimation for 19 advanced economies (OECD members).[14] The impulse response was calibrated to a terms of trade shock of a uniform size for all countries: a 5 percent increase in the terms of trade index. The table presents the average and median response[15] of per capita GDP, the real exchange rate (RER) and the terms of trade (ToT) one year (step 1), two years (step 2), three, five and ten years after the date of the shock. The estimates obtained for each economy are detailed in the Appendix.

The results of the average estimations obtained for the OECD countries are as follows: a 5 percent improvement in the terms of trade index led to an immediate increase of 0.2 percent in GDP (step 0), GDP increased by 0.5 percent (in aggregate) one year later (step 1), and thereafter it stabilized at a level 0.5 percent to 0.7 percent higher (compared with a scenario without any terms of trade shock). The real exchange rate appreciated immediately by 1.5 percent, one year later there was an aggregate appreciation of 2.6 percent, and thereafter the RER stabilized at an appreciated level of between 2.3 percent and 2.4 percent (compared with a scenario without any terms of trade shock). The responses of GDP and the RER to the terms of trade shocks fade only slightly over time, and in this they resemble the typical responses to supply shocks; and not the typical responses to demand shocks that tend to fade over time. As noted, these results refer to the average response in 19 OECD countries. The median response of the real exchange rate was

[13] The study begins in the period following the collapse of the Bretton-Woods Agreement, which established the exchange rates among the advanced economies. The maximum estimation period is from 1973 through 2015, subject to data limitations.

[14] The 19 OECD members included in the estimation are: Australia, Belgium, Canada, Denmark, Finland, Germany, Great Britain, Greece, Iceland, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Spain, Sweden, and USA.

[15] We wish to clarify that the median was calculated for each column separately so that it is possible that, for example, the median response of the exchange rate to a terms of trade shock refers to one country, and the median response of GDP to a terms of trade shock refers to another country.

similar to the average response, though the median response of per capita GDP was more moderate.

Table 1: Aggregate response of GDP, RER and ToT to a 5% increase in the ToT Index 19 advanced economies, basic model, percent.

		Immediate	After 1 year	After 2 years	After 3 years	After 5 years	After 10 years
Average	Terms of trade	5.0	5.5	5.2	5.2	5.5	5.6
	GDP	0.2	0.5	0.5	0.4	0.6	0.7
	Exchange rate	1.5	2.6	2.4	2.3	2.4	2.4
Median	Terms of trade	5.0	5.5	4.9	4.6	4.5	4.5
	GDP	0.1	0.5	0.2	0.0	0.3	0.2
	Exchange rate	1.8	2.3	2.2	1.4	2.3	2.3

Average number of observations (years) for each country is 38. The basic model is an SVAR model containing three endogenous variables - first difference (log) Terms of Trade Index, first difference (log) real exchange rate and the first difference (log) per capita GDP, as well as an additional, exogenous variable: first difference in global per capita GDP at fixed prices. The identification assumptions are that shocks in per capita GDP and in the real exchange rate do not affect the terms of trade, and the effect of an exchange rate shock on GDP fade out over the long term.

Table 2 presents a summary of the results obtained from an estimation of 34 developing economies[16] (countries that are not OECD members as well as Chile and Mexico[17]). In the developing economies, a 5 percent improvement in the terms of trade led to an aggregate increase of 0.5 percent in GDP, and an increase of 1.5 percent in the real exchange rate (after 5 years, compared with a situation in which there had been no shock). The terms of trade shock was prolonged and did not taper off. The median effect of the shock on the RER was generally lower than the average effect (the effect on GDP was similar for measurement according to the average and the median).

[16] The 34 countries are: Algeria, Bolivia, Brazil, Cameroon, Central African Republic, Chile, Colombia, Congo, Costa Rica, Dominican Republic, Ecuador, Equatorial Guinea, Fiji, Gabon, Gambia, Ghana, Ivory Coast, Lesotho, Malaysia, Mexico, Morocco, Nicaragua, Nigeria, Pakistan, Paraguay, Philippines, Singapore, South Africa, Togo, Trinidad and Tobago, Tunisia, Uganda, Uruguay, Zambia.

[17] As noted above, the source of the data for the terms of trade index for the developing economies is the World Bank, and the source of the data for the terms of trade index for the advanced economies is the International Monetary Fund.

Table 2: Aggregate response of GDP, RER and ToT to a 5% increase in the ToT Index
34 developing economies, basic model, percent

		Immediate	After 1 year	After 2 years	After 3 years	After 5 years	After 10 years
Average	Terms of trade	5.0	4.9	5.0	5.2	5.2	5.5
	GDP	0.2	0.4	0.5	0.5	0.5	0.5
	Exchange rate	0.5	0.8	1.0	1.3	1.5	1.5
Median	Terms of trade	5.0	4.8	5.2	5.2	5.5	5.5
	GDP	0.3	0.4	0.4	0.4	0.5	0.6
	Exchange rate	0.0	0.4	0.3	0.7	0.8	0.7

Average number of observations (years) for each country is 33. The basic model is an SVAR model containing three variables – first difference in log Terms of Trade Index, first difference (log) real exchange rate and the first difference in (log) per capita GDP, as well as an additional, exogenous variable: first difference in global (log) per capita GDP (at fixed prices). The identification assumptions are that shocks in per capita GDP and in the real exchange rate do not affect the terms of trade, and the effect of an exchange rate shock on GDP dissipates in the long term.

Table 3 presents a summary of the results of the Structural Forecast Error Variance Decomposition obtained from separate estimations for each country. The table presents the average for the advanced economies and for the developing economies. On average, terms of trade shocks account for 15 percent of the variance in GDP and 16 percent of the variance in the real exchange rate in the advanced economies (after 5 years), and for a slightly higher share of GDP and RER variance in the developing economies.

Table 3: Structural Forecast Error Variance Decomposition –
for the Advanced and Developing Economies.
Percentage of the variation that results from ToT shocks, on average

	After 1 year	After 2 years	After 3 years	After 5 years	After 10 years
19 advanced economies					
GDP	5	9	13	15	16
Exchange rate	9	12	15	16	16
34 developing economies					
GDP	8	13	15	17	17
Exchange rate	10	14	17	18	18

Average number of observations (years) is 38 for the advanced economies and 33 for the developing economies. The basic model is an SVAR model containing three endogenous variables: change (log) in the Terms of Trade Index, change (log) in the real exchange rate and the change (log) in per capita GDP, as well as an additional, exogenous variable: percentage change in global per capita GDP at fixed prices. The identification assumptions are that shocks in per capita GDP and in the real exchange rate do not affect the terms of trade, and the effect of an exchange rate shock on GDP dissipates in the long term.

6.2 Tests of sensitivity to the basic model

Tables 4 and 5 present tests of sensitivity to the basic model. Model 1 is the benchmark SVAR model, the results of which appear in detail in Table 1, while the other three models are differentiated from it:

Model 2 is estimated without the exogenous variable - global per-capita GDP.

Model 3 is a standard long-term SVAR model with the following identification assumptions: GDP shocks and RER shocks do not affect the terms of trade in the long run, and a shock in the real exchange rate does not affect GDP in the long run.

Model 4 is a standard long-term SVAR model with two endogenous variables – GDP and real exchange rate – and two exogenous variables: growth of global GDP and terms of trade; the identification assumption in Model 4 is that shocks in the real exchange rate do not have a prolonged effect on GDP.

Tables 4 and 5 detail the average response to a 5 percent improvement in the terms of trade in the advanced economies and the developing economies, respectively.

Table 4: Aggregate response of GDP, the RER and ToT to a 5 percent increase in the Terms of Trade Index
19 advanced economies, average, percent

		Immediate	After 1 year	After 2 years	After 3 years	After 5 years	After 10 years
Model 1	Terms of trade	5.0	5.5	5.2	5.2	5.5	5.6
	GDP	0.2	0.5	0.5	0.4	0.6	0.7
	Exchange rate	1.5	2.6	2.4	2.3	2.4	2.4
Model 2	Terms of trade	5.0	5.3	4.9	5.0	5.3	5.4
	GDP	0.1	0.6	0.7	0.8	0.9	1.0
	Exchange rate	1.7	2.6	2.5	2.5	2.6	2.6
Model 3	Terms of trade	5.0	5.7	5.7	5.9	6.1	6.3
	GDP	0.0	0.2	0.2	0.2	0.3	0.4
	Exchange rate	1.7	2.9	2.9	2.8	2.7	2.8
Model 4	Terms of trade	5.0	5.0	5.0	5.0	5.0	5.0
	GDP	0.2	0.5	0.5	0.5	0.6	0.6
	Exchange rate	1.4	2.3	2.3	2.2	2.2	2.2

Model 1 is an SVAR model containing three endogenous variables (terms of trade, per capita GDP and real exchange rate) and one exogenous variable - global GDP. The identification assumptions are: shocks in GDP and the exchange rate do not immediately affect the terms of trade, and terms of trade shocks do not have a permanent effect on GDP. Model 2 differs from Model 1 in that it is estimated without the exogenous variable (global per capita GDP). Model 3 is a standard long-run SVAR model

with three endogenous variables (terms of trade, per capita GDP and real exchange rate) and one exogenous variable (global GDP). Identification assumptions: shocks in GDP and the exchange rate do not affect the terms of trade in the long run, and a shock in the RER does not affect GDP in the long run. Model 4 is a standard long-run SVAR model with two endogenous variables - per capita GDP and the RER, and two exogenous variables - global per capita GDP and the terms of trade. The identification assumption is that shocks in the real exchange rate do not affect GDP in the long run.

Results of the estimations for the advanced economies:

Model 2: The average response of GDP from period 3 onwards was significantly stronger than in Model 1. The average response of the exchange rate was similar to that obtained in Model 1.

Model 3: The average response of per capita GDP to a terms of trade shock was significantly weaker than that obtained in Model 1, and the response of the exchange rate was slightly stronger.

Model 4 (in which we imposed a permanent improvement of 5 percent in the terms of trade): The response of per capita GDP and the real exchange rate to a permanent improvement of 5 percent in the terms of trade was similar to the response obtained in Model 1.[18]

Table 5 presents a test of sensitivity to the results obtained for the 34 developing economies. The results of the estimation obtained from Model 2 (SVAR without the exogenous variable – global GDP) and Model 4 (in which the terms of trade are an exogenous variable) are similar to those obtained in Model 1. In Model 3 – standard long-term SVAR model – a shock in the terms of trade was found to trigger a stronger response in GDP and the real exchange rate: GDP and the RER increase in Period 5 by 1.3 percent and 2.1 percent (compared with 0.5 percent and 1.4 percent, respectively in the basic model).

[18] In all four models the average response of GDP was greater than in the median response, and particularly in Model 1 in which there was a substantial difference between the two.

Table 5: Test of sensitivity to the aggregate response of GDP, the RER and ToT to a 5 percent increase in the terms of trade index, according to different models
Average for 34 developing economies, percent

		Immediate	After 1 year	After 2 years	After 3 years	After 5 years	After 10 years
Model 1	Terms of trade	5.0	4.9	5.0	5.2	5.2	5.5
	GDP	0.2	0.4	0.5	0.5	0.5	0.5
	Exchange rate	0.5	0.8	1.0	1.3	1.5	1.5
Model 2	Terms of trade	5.0	4.9	4.9	5.2	5.2	5.4
	GDP	0.3	0.5	0.6	0.6	0.6	0.6
	Exchange rate	0.3	0.7	0.9	1.1	1.3	1.4
Model 3	Terms of trade	5.0	5.2	5.8	6.2	6.3	6.7
	GDP	0.8	1.0	1.2	1.2	1.3	1.3
	Exchange rate	0.9	1.5	1.7	2.0	2.2	2.3
Model 4	Terms of trade	5.0	5.0	5.0	5.0	5.0	5.0
	GDP	0.2	0.4	0.4	0.4	0.4	0.4
	Exchange rate	0.6	0.9	0.9	1.0	1.1	1.2

Average number of observations (years) for each country is 33. Model 1 is an SVAR model containing three endogenous variables (terms of trade, per capita GDP and real exchange rate) and one exogenous variable (global GDP). The identification assumptions are: shocks in GDP and the exchange rate do not immediately affect the terms of trade, and terms of trade shocks do not have a permanent effect on GDP. Model 2 differs from Model 1 in that it is estimated without the exogenous variable (global per capita GDP). Model 3 is a standard long-run SVAR model with three endogenous variables (terms of trade, per capita GDP and real exchange rate) and one exogenous variable (global GDP). Identification assumptions: shocks in GDP and the exchange rate do not affect the terms of trade in the long run, and a shock in the exchange rate does not affect GDP in the long run. Model 4 is a standard long-run SVAR model with two endogenous variables - per capita GDP and the real exchange rate, and two exogenous variables - growth of global per capita GDP and the terms of trade. The identification assumption is that shocks in the real exchange rate do not have a prolonged effect on GDP.

Table 6 presents Error Variance Decomposition of three different structural models for the advanced economies and for developing economies. Model 1 is the basic SVAR which containing three endogenous variables (ToT, per capita GDP and RER) and one exogenous variable - global GDP per capita. The identification assumptions are: shocks in GDP or shock in RER do not immediately affect the ToT, and ToT shocks do not have a permanent effect on GDP. Model 2 differs from Model 1 by excluding the exogenous variable - global GDP per capita. Model 3 is a long-run SVAR model with the same endogenous and exogenous variables as model 1. The identification assumptions are: shock in GDP or shock in RER do not affects the ToT in the long run, and a shock in the RER does not affect GDP in the long run.

In the advanced economies, the variance in GDP attributable to terms of trade shocks ranges from 13 percent (in the model without the exogenous variable) to 18 percent (in the long-term model), and the variance of the exchange rate attributable to the same shocks is in a narrow range of between 15 percent and 18 percent (after 5 years).

In developing economies: the terms of trade shocks account for approximately 17 percent of the variance in GDP and 18 percent of the variance in the real exchange rate. However, in Model 3 (long-run SVAR) the terms of trade shocks were found to account for a much greater share of the variance in GDP – 27 percent.

Table 6: Structural Forecast Error Variance Decomposition

Different models, average, percent

		19 advanced economies			34 developing economies		
		After 1 year	After 3 years	After 5 years	After 1 year	After 3 years	After 5 years
Model 1	GDP	5	13	15	8	15	17
	Exchange rate	9	15	16	10	17	18
Model 2	GDP	5	12	13	9	15	16
	Exchange rate	10	15	15	10	17	18
Model 3	GDP	7	16	18	21	26	27
	Exchange rate	12	17	18	16	21	22

Model 1 is the SVAR model SVAR model containing three endogenous variables (terms of trade, per capita GDP and real exchange rate) and one exogenous variable (global per capita GDP). The identification assumptions are: shocks in GDP and the exchange rate do not immediately affect the terms of trade, and terms of trade shocks do not have a permanent effect on GDP. Model 2 differs from Model 1 in that it is estimated without the exogenous variable (global per capita GDP). Model 3 is a standard long-run SVAR model with three endogenous variables (terms of trade, per capita GDP and real exchange rate) and one exogenous variable (global GDP). Identification assumptions: shocks in GDP and the exchange rate do not affect the terms of trade in the long run, and a shock in the exchange rate does not affect GDP in the long run.

7. Effect of terms of trade shocks on the current account surplus

Harberger-Laursen-Metzler posited that improved terms of trade will lead to an increase in the current account surplus. To examine this hypothesis, we ran an SVAR model with three independent variables: the percentage change in the terms of trade index, the percentage change in per capita GDP and the **current account surplus** (in percentage GDP). The identification assumptions are that the terms of trade are exogenous, therefore GDP shocks and shocks in the current account surplus do not immediately affect the terms of trade, and that the effect of a shock in the current account surplus on GDP disappears in the long run.

The model is similar to Model 2 that we estimated in the previous section, except that we substituted the variable RER with the variable of surplus in the current account (in percentage GDP). In practice, the model estimated here is almost identical to the model estimated by Otto (2003), except that here the current account surplus replaces the surplus in the goods and services account.[19] As explained by Otto (2003), shocks in the goods and services account surplus will not affect GDP in the long term, since the surplus in the goods and services account (in terms of GDP) is stationary, whereas per capita GDP is not stationary. (The GDP growth is stationary.)

The model was estimated for 23 OECD countries[20] and 76 non-OECD countries,[21] with a sequence of data for 20 years or more (for each of the three variables: TOT, CA Surplus and GDP) for each country. We have data for the current account surplus for 1980 onwards (data from the IMF[22]), so that the maximum estimation period is from 1980 through 2015.

Tables 7 and 8 present the model results. The estimation results confirm the Harberger-Laursen-Metzler hypothesis in which an improvement in the terms of trade leads to an increase in the current account surplus. A five percent improvement in the terms of trade (in step_0) triggered an increase of 0.6 percent GDP in the current account surplus of the OECD countries (OECD average in step_1) and an increase of 0.7 percent GDP in the current account surplus of the developing economies (non-OECD in step_1). The improvement in the terms of trade led to a prolonged increase of the current account surplus and GDP in both the advanced and developing economies.

Imposing no quantitative change in imports and exports, a 5 percent improvement in the terms of trade should increases the current account surplus (as a proportion of GDP) by 5 percent

[19] Use of the current account surplus (in percentage GDP) instead of the goods and services account, increased the sample and relieved us of the need to convert the surplus in dollar terms to surplus in terms of percentage GDP. Notably, Otto's model (2003) estimated 40 developing economies between 1960 and 1997 and 15 OECD countries between 1960 and 1996 (World Bank data). Otto's per capita GDP was measured as the ratio of nominal per capita GDP to the import prices index. We used per capita GDP at fixed prices (GDP prices).

[20] Australia, Belgium, Canada, Denmark, Finland, Germany, Great Britain, Greece, Hungary, Iceland, Ireland, Israel, Japan, Netherlands, New Zealand, Norway, Poland, South Korea, Spain, Sweden, Turkey, and the USA.

[21] Algeria, Angola, Argentina, Bangladesh, Benin, Bolivia, Botswana, Brazil, Burkina Fasso, Burundi, Cape Verde, Cameroon, Central African Republic, Chad, Colombia, Comoros, Congo, Democratic Republic of the Congo, Costa Rica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Ethiopia, Fiji, Gabon, Gambia, Ghana, Guatemala, Guinea, Guinea-Bissau, Honduras, Hong Kong, India, Indonesia, Jordan, Kenya, Lesotho, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Nicaragua, Niger, Nigeria, Pakistan, Panama, Paraguay, Peru, Philippines, Ruanda, Senegal, Seychelles, Singapore, South Africa, Sri Lanka, Sudan, Swaziland, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Uganda, Uruguay, Venezuela, Zambia and Zimbabwe.

[22] BCA_NGDPD – Current account balance percent of GDP, IMF.

multiplied by half the weight of trade in GDP.[23] Trade as a percentage of GDP in the sample (between 1980 and 2015) was 69 percent on average for the OECD countries and 79 percent for the other countries. Without any quantitative change in imports and exports, the current account surplus was therefore expected to increase by 2 percent GDP in the developing economies and by 1.7 percent GDP in the advanced (OECD) economies, on average. In practice, the average increase in the current account surplus was just 0.9 percent GDP in the developing economies and 0.7 percent GDP in the advanced economies (step_2). It follows that the behavioral response of the economy to terms of trade shocks (increase of imports and decrease of exports) offset about half of the increase in the current account surplus.

Table 7A: Aggregate response of GDP and CA to a 5% increase in the ToT index
Average for 23 advanced economies and average for 76 developing economies, percent

		Immediate	After 1 year	After 2 years	After 3 years	After 5 years	After 10 years
23 advanced economies	Terms of trade	5.0	4.9	4.4	4.5	4.8	5.0
	GDP	0.1	0.6	0.9	0.9	1.0	0.8
	Current account	0.4	0.6	0.7	0.7	0.6	0.5
76 developing economies	Terms of trade	5.0	4.5	4.3	4.4	4.6	4.7
	GDP	0.2	0.4	0.5	0.5	0.6	0.6
	Current account	0.4	0.7	0.9	0.9	0.9	1.0

Table 7B: Aggregate response of GDP and CA to a 5% increase in the ToT index
Median for 23 advanced economies and median for 76 developing economies, percent

		Immediate	After 1 year	After 2 years	After 3 years	After 5 years	After 10 years
23 advanced economies	Terms of trade	5.0	4.9	4.2	4.3	4.5	4.4
	GDP	0.1	0.4	0.4	0.4	0.6	1.0
	Current account	0.3	0.6	0.5	0.4	0.3	0.2
76 developing economies	Terms of trade	5.0	4.5	4.0	4.2	4.5	4.3
	GDP	0.1	0.3	0.4	0.4	0.4	0.5
	Current account	0.3	0.4	0.6	0.6	0.6	0.6

The aggregate response from the SVAR model containing three endogenous variables - percentage change in the Terms of Trade Index, percentage change in per capita GDP and the current account surplus (in percentage GDP). The identification assumptions are that shocks in GDP and in the current account surplus do not immediately affect the terms of trade, and the effect of a shock in the current account surplus on GDP dissipates in the long term.

[23] For example, when imports and exports account for 50 percent of GDP (so that trade accounts for 100 percent of GDP), and the terms of trade increase by 5 percent, the current account surplus increases by 2.5 percent GDP (0.05x 0.5 = 0.0025). This is assuming that there is no quantitative change in imports and exports.

Table 8 shows that the terms of trade shocks accounted for 14 percent of the variance in the current account surplus in the advanced economies and 12 percent in the developing economies (average). This contrasts with 20 percent and 15 percent, respectively, according to Otto's study (2003).

We estimated an additional SVAR model that differed from the model presented in tables 7 and 8 only by adding one additional, exogenous, variable – the rate of growth of global GDP. The results of this model appear in the Appendix.

Table 8A: Structural Forecast Error Variance Decomposition
Average for 23 advanced economies and 76 developing economies, percent

		After 1 year	After 2 years	After 3 years	After 5 years	After 10 years
23 advanced economies	Terms of trade	100	96	93	91	90
	GDP	6	11	13	14	14
	Current account	10	11	12	12	12
76 developing economies	Terms of trade	100	93	88	86	86
	GDP	6	10	11	12	12
	Current account	11	14	15	16	16

Table 8B: Structural Forecast Error Variance Decomposition
Median for 23 advanced economies and 76 developing economies, percent

		After 1 year	After 2 years	After 3 years	After 5 years	After 10 years
23 advanced economies	Terms of trade	100	98	93	92	90
	GDP	4	9	11	12	12
	Current account	3	7	8	8	8
76 developing economies	Terms of trade	100	95	90	89	88
	GDP	3	7	9	10	9
	Current account	5	8	10	10	10

Variance decomposition after a 5 percent shock in the terms of trade in the SVAR model containing three endogenous variables: terms of trade, per capita GDP, and current account surplus (in percentage GDP). The identification assumptions are that shocks to GDP and to the current account surplus do not immediately affect the terms of trade, and the effect of a shock in the current account surplus on GDP dissipates in the long term.

8. Summary

This study examined the effect of terms of trade shocks on the GDP and on the real exchange rate using a Structural Vector Auto Regression (SVAR) model. The model contains three variables – the terms of trade, the real exchange rate and per capita GDP – and one additional, exogenous variable: the growth of world GDP. The basic model assumes that the terms of trade are exogenous to the economy and that a shock in the real exchange rate does not permanently affect per capita GDP. The results of the estimation show that terms of trade shocks account for a substantial share of variance in GDP and in the real exchange rate: in the advanced economies these shocks accounted for 15 percent of the variance in GDP and 16 percent of the variance in the real exchange rate, whereas in the developing economies they accounted for 17 percent of the variance in GDP and 18 percent of the variance in the RER. The terms of trade shocks had a high degree of persistence; they had a prolonged effect on GDP and on the exchange rate, and in this they more closely resemble supply shocks than demand shocks: A 5 percent improvement in the terms of trade led, after 5 years, to an aggregate 0.6 percent increase in GDP in the OECD countries, and 0.5 percent increase in the GDP of the developing economies. After 5 years the shock triggered aggregate appreciation in the real exchange rate of 2.4 percent in the advanced economies and 1.4 percent in the developing (non-OECD) economies.

We also examine somewhat different assumptions: that shocks in GDP and in the exchange rate did not affect the terms of trade in the long run and that an exchange rate shock does not affect GDP in the long run, and allowed changes in the terms of trade also simultaneously effect the GDP and the real exchange rate, we found that the terms of trade shocks account for a much larger share of variance in the GDP of the developing economies – 27 percent. For the advanced economies, the change in assumptions did not significantly change the results.

We also reviewed the effect of terms of trade shocks on the current account surplus. For this purpose, we estimated an SVAR model similar to that of Otto (2003), which contained three independent variables – the terms of trade, per capita GDP and the current account surplus (in percentage GDP), and the identification assumptions are that the terms of trade are exogenous and the effect of a shock in the current account surplus on GDP dissipates in the long term. We found support for the assertion of Harber-Laursen–Metzler according to which an improvement in the terms of trade leads to an increase in the current account surplus, notwithstanding that the terms of trade shocks were found to be persistent. The behavioral response (increase of imports and/or decrease of exports) offset about a half of the contribution made by the terms of trade shock to increasing the current account surplus.

Bibliography

Blanchard, O. J. and D. Quah (1989). “The dynamic effect of aggregate demand and supply disturbances”, American Economic Review 79(3), 665–673.

Broda, C. (2004). “Terms of trade and exchange rate regimes in developing countries”. Journal of International Economics 63, 31–58.

Fernandez, A., A. Gonzalez and D. Rodriguez (2015). Sharing a ride on the commodities roller coaster: common factor in business cycles of emerging economies. IDB-WP no. 640.

Fernandez,A., S.Schmitt-Grohe and M. Uribe (2017). “World shocks, world prices, and business cycles: An empirical investigation”, Journal of International Economics 108, S2–S14.

Harberger, A.C. (1950). “Currency depreciation, income and balance of trade”. Journal of Political Economy 58, 47–60.

Hoffmeister, A.W. and J.E. Roldos (1997). Are business cycles different in Asia and Latin America? IMF working paper 97/9.

Hoffmeister, A.W., J.E. Roldos and P. Wickman (1997). Macroeconomic fluctuations in sub–Saharan Africa. IMF working paper 97/82.

Ilzetzki E., C.M. Reinhart and K.S Rogoff "Exchange Arrangements Entering the 21ST Century: Which Anchor Will Hold"(2017), NBER Working paper 23134.

Kose, M.A. (2002). “Explaining business cycles in small open economies – how much do world prices matter?”, Journal of International Economics 56, 299–327.

Laursen, S. and L. A. Metzler (1959). “Flexible exchange rates and the theory of employment”, Review of Economic and Statistics 32, 281–299.

Lubik, T.K. and W.L. Teo (2005). Do world shocks drive domestic business Cycles? Some evidence from Structural Estimation. Johns Hopkins University.

Mendoza, E.G. (1992). The effects of macroeconomic shocks in a basic equilibrium framework. IMF Staff Papers 39 (4), 855-889.

Mendoza, E.G. (1995). “The terms of trade, the real exchange rate and economic fluctuations”. International Economic Review 36 (1), 101–137.

Obstfeld, M. (1982). “Aggregate spending and terms of trade: is there Laursen-Metzler effect?”, Quarterly Journal of Economics 97 251–270.

Otto, G. (2003). “Terms of trade shocks and balance of trade: there is a Harberger-Laursen-Metzler effect?”, Journal of international Money and Finance 22, 155–184.

Schmitt-Grohe, S. and M. Uribe (2016). “How important are terms of trade Shocks?”, International Economic Review 59 , 85-111.

Shousha, S. (2016). Macroeconomic effects of commodity booms and busts: The role of financial frictions. Unpublished manuscript.

Svensson, L.E. and A. Razin (1983). “The Terms of Trade and the Current Account: The Harberger-Laursen-Metzler Effect?”, Journal of Political Economy 91, 97–125.

Yakhin, Y. and N. Presman (2015). A Stock-Flow Accounting Model of the Labor Market: An Application to Israel. IMF working paper 15/58.