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Terms-of-Trade Shocks and Slovak Economy

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Abstract: *Using the structural vector auto-regression analysis of the terms-of-trade, trade balance, output, consumption and investment cyclical components we show that the relationship between the terms-of-trade and trade balance is negative and that the terms-of-trade shocks explain only a small fraction of business cycles in the Slovak economy. We use quarterly data in constant prices in the period 1997-2014. The results are in line with the theoretical and empirical studies in the contemporary world economic literature. The negative relationship between the terms-of-trade and the trade balance confirms a theoretical Obstfeld-Svensson-Razin effect. The positive effect of a change in the terms-of-trade on the trade balance – so called Harberger-Laursen-Metzler effect – is the smaller, the more persistent terms-of-trade shocks are. By capital adjustment costs, the theoretical effect may be even negative. A modest contribution of the terms-of-trade shocks to the business-cycle fluctuations in Slovakia is in line with other empirical papers around the world.*

Keywords: Terms of Trade · Business Cycle · Slovak Economy · Trade Balance

JEL Classification: C32 · E32 · F14

1 Introduction

The terms-of-trade is theoretically significant source of business cycles and it causes shifts in the trade balance. However different theoretical and empirical studies lead to the different results of the short-run terms-of-trade impact on the output and on the trade balance. There are two theoretical effects of the terms-of-trade impact on the trade balance. Harberger (1950) and Laursen and Metzler (1950) used traditional Keynesian model to show that the trade balance grows with the terms-of-trade. On the contrary, the dynamic optimizing models of Obstfeld (1982) and Svensson and Razin (1983) leads to a conclusion that the positive effect of the terms-of-trade on the trade balance is the smaller the more persistent a terms-of-trade shock is. Using a small open economy real business cycle model (or a dynamic stochastic general equilibrium model) Uribe and Schmitt-Grohé (2015) showed that by capital adjustment costs the theoretical effect may be even negative. The empirical studies of Aguirre (2011), Broda (2004) and Uribe and Schmitt-Grohé (2015) surprisingly do not support a statistically significant impact of the term-of-trade on the output in poor and emerging countries. In general authors can confirm an intuition that the more open the economy is the higher effect of terms-on-trade on trade balance is. This result may be theoretically achieved by using theoretical general equilibrium models only if non-tradable goods are considered. Uribe and Schmitt-Grohé developed models with tradable and non-tradable goods to show that an existence of non-tradable goods “reduce the importance of terms-of-trade shocks”.

Slovakia is a small open transition economy. The openness of the Slovak economy is relatively high – the international-trade-output ratio is higher than 100% in Slovakia. According to Uribe and Schmitt-Grohé’s (2015) definition, Slovakia is an emerging country. Its average purchasing power parity converted GDP per capita over the last two decades is within the range 3,000-25,000. Slovakia is similarly rich as economies analysed by Aguirre (2011), Broda (2004) and Uribe and Schmitt-Grohé (2015). The question is, if in relatively highly open economy as Slovakia a contribution of the terms-of-trade to the business cycles is higher. We provide an empirical measure based on structural vector auto-regression (SVAR) econometric specification similar to one presented by Uribe and Schmitt-Grohé. We use Slovak quarterly data in the period 1997 to 2014. We compute the responses on terms-of-trade impulse and variance decompositions of terms-of-trade shocks. In result, we will

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show that a terms-of-trade shock leads to the immediate decrease in trade balance and has no impact on aggregate output in Slovakia.

2 Theoretical Background

Uribe and Schmitt-Grohé (2015) describe two theoretical effects of the terms-of-trade impact on the trade balance: Harberger-Laursen-Metzler effect and Obsfeld-Svensson-Razin effect. The Harberger-Laursen-Metzler effect comes from a traditional Keynesian theory. The national accounting identity is in the form:

$$y_t = c_t + g_t + i_t + x_t - m_t;\ \forall t \in T \tag{1}$$

where y_t denotes output, c_t denotes private consumption, g_t denotes public consumption, i_t denotes private investment, x_t denotes exports, and m_t denotes imports in the period t from the given time set T. Using a simple Keynesian concept we assume that private investment and public consumption are both exogenous (autonomous) constants:

$$i_t = \bar{i};\ \forall t \in T \tag{2}$$

and

$$g_t = \bar{g};\ \forall t \in T \tag{3}$$

where $\bar{i}$ and $\bar{g}$ are parameters. Consumption and imports are increasing functions of output:

$$c_t = c(y_t) \tag{4}$$

and

$$m_t = m(y_t);\ \forall t \in T \tag{5}$$

where marginal propensity to consume and marginal propensity to import is positive and less than 1:

$$0 < c_{yt} = \frac{\partial c(y_t)}{\partial y_t} < 1;\ \forall t \in T \tag{6}$$

and

$$0 < m_{yt} = \frac{\partial m(y_t)}{\partial y_t} < 1;\ \forall t \in T \tag{7}$$

Output and all consumption of aggregate demand (c_t + g_t + i_t) are expressed in terms of import goods. The quantity of goods exported in period t is denoted by q_t. Thus, the value of exports in terms of importables, x_t, is given by

$$x_t = tot_t q_t;\ \forall t \in T \tag{8}$$

where tot_t denotes the exogenous terms-of-trade. Quantity of goods exported, q_t, is assumed to be autonomous constant given by

$$q_t = \bar{q};\ \forall t \in T \tag{9}$$

A solution of the model may be expressed by multipliers. The expenditure multiplier is in the well-known Keynesian form:

$$\frac{\partial y_t}{\partial \bar{i}} = \frac{1}{1 + m_{yt} - c_{yt}} > 0;\ \forall t \in T \tag{10}$$

Harberger-Laursen-Metzler effect is described by

$$\frac{\partial tb_t}{\partial tot_t} = \frac{1 - c_{yt}}{1 + m_{yt} - c_{yt}}\bar{q} > 0;\ \forall t \in T \tag{11}$$

where $tb_t \equiv x_t - m_t$ denotes trade balance.

This effect is stronger the larger is the volume of exports, $\bar{q}$, the smaller is the marginal propensity to import, m_{yt}, and the smaller is the marginal propensity to consume c_{yt}. Intuitively, a higher value of the marginal propensity to import, m_{yt}, weakens the endogenous expansion in aggregate demand to an exogenous increase in exports, as a larger fraction of income is used to buy foreign goods. Similarly, a higher value of the marginal propensity to consume, c_{yt}, reduces the Harberger-Laursen-Metzler effect, because it exacerbates the endogenous response of aggregate demand to a terms-of-trade shock through private consumption.

A disadvantage of the traditional Keynesian model is given by a Lucas critique. The marginal propensity to consume is exogenous. However, according to Friedman permanent income hypothesis, this propensity depends on endowment shock persistence. In the result the traditional Keynesian model is independent of whether terms-of-trade shocks are permanent or temporary in nature. However, as Harberger-Laursen-Metzler effect depends on the marginal propensity to consume, we suppose that the persistence of terms-of-trade shocks is important.

Uribe and Schmitt-Grohé perform a possible modification of the model. Assume that marginal propensity to consume is increasing function of the persistence of terms-of-trade shock:

$$c_{yt} = \alpha(\rho);\ \forall t \in T \tag{12}$$

where ρ denotes the (constant) persistence of terms-of-trade shock and

$$\frac{\partial \alpha(\rho)}{\partial \rho} > 0 \tag{13}$$

After substituting (12) for the marginal propensity to consume, we can rewrite the Harberger-Laursen-Metzler effect (11) to the form:

$$\frac{\partial tb_t}{\partial tot_t} = \frac{1-\alpha(\rho)}{1+m_{yt}-\alpha(\rho)}\bar{q} > 0;\ \forall t \in T \tag{14}$$

The Harberger-Laursen-Metzler effect is the smaller the more permanent the terms-of-trade shock is.

The Obsfeld-Razin-Svensson effect is cast within a dynamic optimizing theoretical framework that differs fundamentally from the reduced-form Keynesian model we used to derive the Harberger-Laursen-Metzler effect. Consider the small open economy real business cycle model. The small open endowment economy is inhabited by infinitely-lived representative household with preferences described by intertemporal utility function in the form:

$$U = E_0\left[\sum_{t=0}^{\infty}\beta^t u(c_t)\right] \tag{15}$$

where c_t denotes private consumption, $0 < \beta < 1$ is a subjective discount factor. An operator E_t denotes expectations operator conditional on information available in the period t. The utility, u, is continuously differentiable, strictly increasing and strictly concave function of consumption, therefore marginal utility of consumption is always positive

$$u_{ct} = \frac{\partial u(c_t)}{\partial c_t} > 0;\ \forall t \in \{1,2,\ldots\} \tag{16}$$

The marginal utility of consumption is decreasing function of consumption

$$u_{cct} = \frac{\partial^2 u(c_t)}{\partial c_t^2} < 0;\ \forall t \in \{1,2,\ldots\} \tag{17}$$

We assume that $u(c_t)$ is homogenous of degree –1, so that

$$\frac{u_{ct+1}}{u_{ct}} = \frac{c_t}{c_{t+1}};\ \forall t \in \{1,2,\ldots\} \tag{18}$$

Assume that consumption good, c_t, is imported, and that each period the household is endowed with 1 unit of exportable goods. As before tot_t denotes the international relative price of exportable goods in terms of importable goods, i.e. terms-of-trade. Then, the household's unit endowment expressed in terms of importable goods is simply tot_t. The budget constraint of the representative household in period t is in the form:

$$d_t = (1+r)d_{t-1} + c_t - tot_t;\ \forall t \in \{1,2,\ldots\} \tag{19}$$

where d_t denotes household's debt position in period t expressed in terms of import goods and $r > 0$ denotes a constant world interest rate. In terms of import goods in period t, the household's endowment, tot_t, modified by net debt income, rd_t, is used to household's consumption, c_t, and the change of household's debt position. The household and the firm is not allowed to trigger Ponzi games and therefore no-Ponzi games constraint in the form

$$\lim_{j\to\infty} \frac{1}{(1+r)E_t\left(d_{t+j}\right)} = 0;\ \forall t \in \{1,2,\ldots\} \tag{20}$$

must hold.

As the economy is small, the evolution of the terms-of-trade, tot_t is exogenous and we suppose that if follows the AR(1) process:

$$tot_t = \rho\ tot_{t-1} + \varepsilon_t^{tot};\ \forall t \in \{1,2,\ldots\} \tag{21}$$

where $0 < \rho < 1$ is a serial correlation parameter describing a persistence of the terms-of-trade shocks and ε_t^{tot} is a normally distributed stochastic term with zero mean and constant variance.

Markets clear when the trade balance of import goods equals endowment (exports) minus consumption (imports)

$$tb_t = tot_t - c_t;\ \forall t \in \{1,2,\ldots\} \tag{22}$$

The household's debt position equals to the net international investment position (i.e. household borrows/lends from/to abroad). The representative household is in a small open economy so insignificant agent in the international markets that it takes the world prices $\{tot_t, r\}_{t=0}^{\infty}$ as given.

Equilibrium is an allocation $\{c_t\}_{t=0}^{\infty}$ so that all markets clear and representative household takes prices $\{tot_t, r\}_{t=0}^{\infty}$ as given. We can solve the equilibrium as the household problem of choosing allocation $\{c_t\}_{t=0}^{\infty}$ to maximise utility U subject to the budget constraint (19) in each period t and subject to the no-Ponzi games constraint (20). The first order condition of the problem is an Euler equation in the form:

$$u_{ct} = \beta(1+r)E_t\left(u_{ct+1}\right);\ \forall t \in \{1,2,\ldots\} \tag{23}$$

We do not need to form second-order conditions as the utility function is concave in c_t and the constraint function is linear in c_t. Define a deterministic steady state consumption $c_t = E_t(c_{t+1})$ so that $u_{ct} = E_t(u_{ct+1})$ in each period t, as $u(c_t)$ is homogenous of degree –1, therefore $\beta\,(1+r) = 1$.

Considering the no-Ponzi games condition the present value of the real live-time household budget in period t is:

$$\sum_{s=t}^{\infty} E_t\left[\frac{c_s}{(1+r)^s}\right] = \sum_{s=t}^{\infty} E_t\left[\frac{tot_s}{(1+r)^s}\right] - (1+r)d_{t-1};\ \forall t \in \{1,2,\ldots\} \tag{24}$$

Let us substitute the steady state Euler equation and AR(1) into the live-time household budget (24) for consumption and terms-of-trade, respectively, in each period s. Then, by solving for consumption, we yield:

$$c_t = \frac{r}{1+r-\rho} tot_t - rd_{t-1};\ \forall t \in \{1,2,\ldots\} \tag{25}$$

By substituting (25) into the trade balance (22) for consumption, we yield:

$$tb_t = \frac{1-\rho}{1+r-\rho} tot_t + rd_{t-1};\ \forall t \in \{1, 2, \ldots\} \tag{26}$$

The Obsfeld-Razin-Svensson effect is:

$$\frac{\partial tb_t}{\partial tot_t} = \frac{1-\rho}{1+r-\rho};\ \forall t \in \{1, 2, \ldots\} \tag{27}$$

An increase in the terms-of-trade in the period t produces an improvement in the trade balance in the period t. In response to a mean-reverting increase export income stemming from an improvement in the terms-of-trade households consume only part of the additional income and save the rest to smooth consumption over time. Consumption increases be less than income leading to an improvement in the trade balance. The Obsfeld-Razin-Svensson effect states that the effect of terms-of-trade shocks on the trade balance is decreasing in shock persistency ρ. Moreover it is decreasing in interest rate r. Households have more incentive to save more in response to temporary shocks than in response to persistent shock. Analogically households the more save, the higher interest rate is.

Intuitively, in countries with high capital costs (i.e. with high country interest rate spread), the effect of terms-of-trade shocks on the trade balance is very small. This intuition can be theoretically verified using the small open real business cycle model of the production economy. This economy consists of representative household and firm. The output is produced by firm using inputs capital and labour. The output is supposed to be the exports of the economy while the sum of the investment, consumption and capital costs is supposed to be exports of the economy. An effectiveness of the production is given by the terms-of-trade (instead of the total factor productivity).

Uribe and Schmitt-Grohé present the model. Because in the model terms-of-trade shocks are identical to productivity shocks, a persistent increase in the terms of trade induces firms to increase the stock of capital to take advantage of the persistent expected increase of the marginal product of capital in terms of imports. The increase in the desired stock of capital induces a surge in the demand for (imported) investment goods, which tends to deteriorate the trade balance. This negative effect is stronger if imported capital costs are larger. The final effect of terms-of-trade shocks on the trade balance can be negative, if both the persistency of the terms of trade shock, and the capital costs are sufficiently high.

Using this simple concept in with the terms-of-trade instead of the total factor productivity in the production function, the effect of terms-of-trade on the output is clearly positive. This theoretical result is confirmed in the extended small open real business cycle model considering firms producing both importable and exportable goods presented by Uribe and Schmitt-Grohé. Model is more realistic as only a fraction of GDP is exported. However, as we stated in the introduction, empirical observations do not confirm this theory. Empirically the effect of the terms-of-trade on the output is negligible.

Uribe and Schmitt-Grohé extended model by non-tradable goods. The non-tradable goods cannot be exported or imported. Their prices are not equalized across countries because, for various reasons, such as transportation costs and trade barriers, trading them across borders is economically inviable. By calibrating the model, Uribe and Schmitt-Grohé showed that a model presence of non-tradable goods decreases the theoretical effect of the terms-of-trade on the output. However this effect is still too high in comparison with the terms-of-trade effect predicted by the empirical studies.

3 Methods and Data

We used vector autoregressive (VAR) models for our analysis. It is well known that in VAR models every endogenous variable is a function of all lagged endogenous variables in the system. See Lütkepohl (2005) for more details about VAR models.

The mathematical representation of the unrestricted VAR model of order p is:

$$\mathbf{y_t} = \mathbf{A_1 y_{t-1}} + \mathbf{A_2 y_{t-2}} + \ldots + \mathbf{A_p y_{t-p}} + \mathbf{e_t} \tag{28}$$

where $\mathbf{y_t}$ is a k vector of endogenous variables; $\mathbf{A_1}$, $\mathbf{A_2}$, …, $\mathbf{A_p}$ are matrices of coefficients to be estimated; and $\mathbf{e_t}$ is a vector of innovations that may be contemporaneously correlated but are uncorrelated with their own lagged values.

The VAR model (28) can be interpreted as a reduced form model. A structural vector autoregressive (SVAR) model is structural form of VAR model and is defined as:

$$\mathbf{A}\mathbf{y_t} = \mathbf{B_1}\mathbf{y_{t-1}} + \mathbf{B_2}\mathbf{y_{t-2}} + \ldots + \mathbf{B_p}\mathbf{y_{t-p}} + \mathbf{B}\mathbf{u_t} \tag{29}$$

It is assumed that the structural errors, $\mathbf{u_t}$ are white noise and the coefficient matrices $\mathbf{B_1}$, $\mathbf{B_2}$, …, $\mathbf{B_p}$ are structural coefficients that in general differ from their reduced form counterparts and $\mathbf{B}$ is matrix of restrictions on $\mathbf{u_t}$.

A SVAR model can be used to identify shocks and trace these out by employing impulse response analysis and forecast error variance decomposition through imposing restrictions on used matrices. Uribe and Schmitt-Grohé proposed a specification of the SVAR, through which we can determine responses on terms-of-trade impulse:

$$\mathbf{A}\begin{pmatrix} tot_t \\ tb_t \\ y_t \\ c_t \\ i_t \end{pmatrix} = \mathbf{B_1}\begin{pmatrix} tot_{t-1} \\ tb_{t-1} \\ y_{t-1} \\ c_{t-1} \\ i_{t-1} \end{pmatrix} + \mathbf{B}\begin{pmatrix} u_t^{tot} \\ u_t^{tb} \\ u_t^{y} \\ u_t^{c} \\ u_t^{i} \end{pmatrix} \tag{30}$$

where:

tot relative cyclical component of the terms of trade
tb relative cyclical component of the trade balance to output ratio
y relative cyclical component of output
c relative cyclical component of consumption
i relative cyclical component of investment

The u_t^{tb}, u_t^{tot}, u_t^{y}, u_t^{c} and u_t^{i} are structural shocks of given variables. Data are gathered from the portal of Statistical Office of the Slovak republic. The terms-of-trade is computed as the ratio of export and import deflators. The trade balance is computed as the difference between exports and imports. The output is considered to be GDP, the consumption is considered to be the final consumption of households and the investment is considered to be the gross capital formation. The last four variables are in constant prices with reference year 2010. The Cyclical components may be obtained by log-quadratic trend or Hodrick-Prescott (HP) filter with different λ wages. In experiments, we used all these methods and we state that results are qualitatively the same in all cases. The published results are obtained using HP filter with $\lambda = 1600$.

We estimated the parameters of the SVAR specification (30) using the Amisano and Giannini (1997) approach. The class of commonly used models may be written as:

$$\mathbf{A}\mathbf{e_t} = \mathbf{B}\mathbf{u_t} \tag{31}$$

The structural innovations $\mathbf{u_t}$ are assumed to be orthonormal, i.e. its covariance matrix is an identity matrix $\mathbf{\Sigma_u} = \mathbf{I}$. The assumption of orthonormal innovations imposes the following identifying restrictions on $\mathbf{A}$ and $\mathbf{B}$:

$$\mathbf{A}\mathbf{\Sigma_e}\mathbf{A}^\mathbf{T} = \mathbf{B}\mathbf{B}^\mathbf{T} \tag{32}$$

Noting that the expressions on both sides of (32) are symmetric, this imposes $k(k+1)/2 = 15$ restrictions on the $2k^2 = 50$ unknown elements in $\mathbf{A}$ and $\mathbf{B}$. Therefore, in order to identify $\mathbf{A}$ and $\mathbf{B}$, we need to impose $(3k^2–k)/2 = 35$ additional restrictions. The matrix $\mathbf{A}$ of unrestricted specification is a lower triangular matrix with unit diagonal (10 zero and 5 unity restrictions) and matrix $\mathbf{B}$ is a diagonal matrix (20 zero restrictions) in this just-identified specification. Other tested restrictions are imposed on elements of matrix $\mathbf{A}$ (matrix of contemporary effects between endogenous variables), which means that our specification becomes over-identified and also testable.

The selected lag of model (30) is validated by sequential modified likelihood ratio test statistic and information criteria and by the LM test for autocorrelations. We present them in the Table 1 and 2. Significant values of serial correlation for lower lags could be a reason to increase the lag order of an unrestricted VAR, but this is not our case. We verified the stability of a VAR model (i.e. whether all roots have modulus less than one and lie inside the unit circle). The result of this computation is in the Table 3. We estimated the parameters of restricted and unrestricted specifications. Using the logarithm of the maximum likelihood functions of both specifications we calculated the likelihood ratio statistics and verified the significance of restrictions in the Table 4. All tests are explained in Greene (2003) for example.

Using matrix polynomial in lag operator $\mathbf{A}(L) = \mathbf{B_1}L + \mathbf{B_2}L^2 + \ldots + \mathbf{B_p}L^p$ we can rewrite (29) as SMA representation:

$$\mathbf{y_t} = \left[\mathbf{A} - \mathbf{A}(L)\right]^{-1} \mathbf{Bu_t} = \mathbf{C}(L)\mathbf{u_t} = \mathbf{C}(0)\mathbf{u_t} + \mathbf{C}(1)\mathbf{u_{t-1}} + \mathbf{C}(2)\mathbf{u_{t-2}} + ... + \mathbf{C}(h)\mathbf{u_{t-h}} + ... \quad (33)$$

Hence, **C**(0) is the coefficient matrix on impact, **C**(1) at a one period lag, **C**(2) at a two period lag, and so on. Generally, $\mathbf{C}_{i,j}(h)$ element is the impulse response of variable *i* to shock *j* at horizon *h*. The forecast error of **y** at horizon *s* is:

$$\mathbf{y_{t+h}} - \mathbf{\hat{y}_{t+h}} = \mathbf{C}(0)\mathbf{u_{t+h}} + \mathbf{C}(1)\mathbf{u_{t+h-1}} + \mathbf{C}(2)\mathbf{u_{t+h-2}} + ... + \mathbf{C}(h)\mathbf{u_t} \quad (34)$$

Variance of the forecast error (assuming orthogonality) is expressed as sum of the individual variances of shocks:

$$\mathrm{var}\left(\mathbf{y_{t+h}} - \mathbf{\hat{y}_{t+h}}\right) = \mathbf{C}(0)\mathbf{IC}(0)^{\mathbf{T}} + \mathbf{C}(1)\mathbf{IC}(1)^{\mathbf{T}} + \mathbf{C}(2)\mathbf{IC}(2)^{\mathbf{T}} + ... + \mathbf{C}(h)\mathbf{IC}(h)^{\mathbf{T}} \quad (35)$$

The fraction of the forecast error variance of variable *i* due to shock *j* at horizon *h*, is then the (*i*,*j*) element of expression (35) divided by the total forecast error variance and is expressed as a percentage. We calculated the impulse response functions and realized variance decomposition to quantify the short-term impact of shocks. Generally, the impulse response function traces the effect of a one-time shock in one of the innovations on current and future values of the endogenous variables and variance decomposition is a way to quantify how important each shock is in explaining the variation of each of the variables in the system.

Table 1 VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	849.7127	NA	7.70e-18	-25.21530	-25.05077	-25.15020
1	940.1206	164.6234*	1.10e-18*	-27.16778*	-26.18060*	-26.77715*
2	958.0665	29.99913	1.37e-18	-26.95721	-25.14739	-26.24106
3	978.6379	31.31768	1.61e-18	-26.82501	-24.19254	-25.78334
4	1003.496	34.13345	1.73e-18	-26.82077	-23.36566	-25.45358
5	1023.302	24.24063	2.24e-18	-26.66574	-22.38798	-24.97302

Source: Own processing – output from the econometric software EViews
Note: Asterisk indicates lag order selected by the criterion.

Table 1 shows the VAR lag order selection criteria. All criteria: sequential modified likelihood ratio test statistic (LR), Akaike information criterion (AIC), Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ) confirmed lag order 1 (asterisk nearby extreme value).

Table 2 VAR Residual Serial Correlation LM Tests

Lags	LM-Stat	Prob
1	37.42832	0.0525
2	25.41611	0.4393
3	20.92892	0.6966
4	28.83195	0.2710
5	30.50831	0.2058
6	31.12115	0.1850
7	30.88250	0.1929
8	33.16054	0.1271
Probs from chi-square with 25 df.		

Source: Own processing – output from the econometric software EViews

We realized the autocorrelation test in order to eliminate possible wrong VAR lag order decision. Table 2 shows the results of the tests. The LM tests for autocorrelations did not reject the null hypothesis of any residual autocorrelations up to lag *h*. Even if there was no autocorrelation of residuals, we made experiments with different lag orders. Obtained results practically did not differ from the published results.

Table 3 VAR Stability Condition Check

Root	Modulus
0.681944	0.681944
0.539852 - 0.256891i	0.597857
0.539852 + 0.256891i	0.597857
0.270690	0.270690
-0.121938	0.121938

No root lies outside the unit circle.
VAR satisfies the stability condition.

Source: Own processing – output from the econometric software EViews

Table 3 shows the verification of the stability of a VAR model. All roots have modulus less than one and lie inside the unit circle. The estimated VAR satisfies the stability condition.

Table 4 Test of Over-Identification Restrictions

Log likelihood	959.5133		
LR test for over-identification:			
Chi-square(3)	4.807380	Probability	0.1865

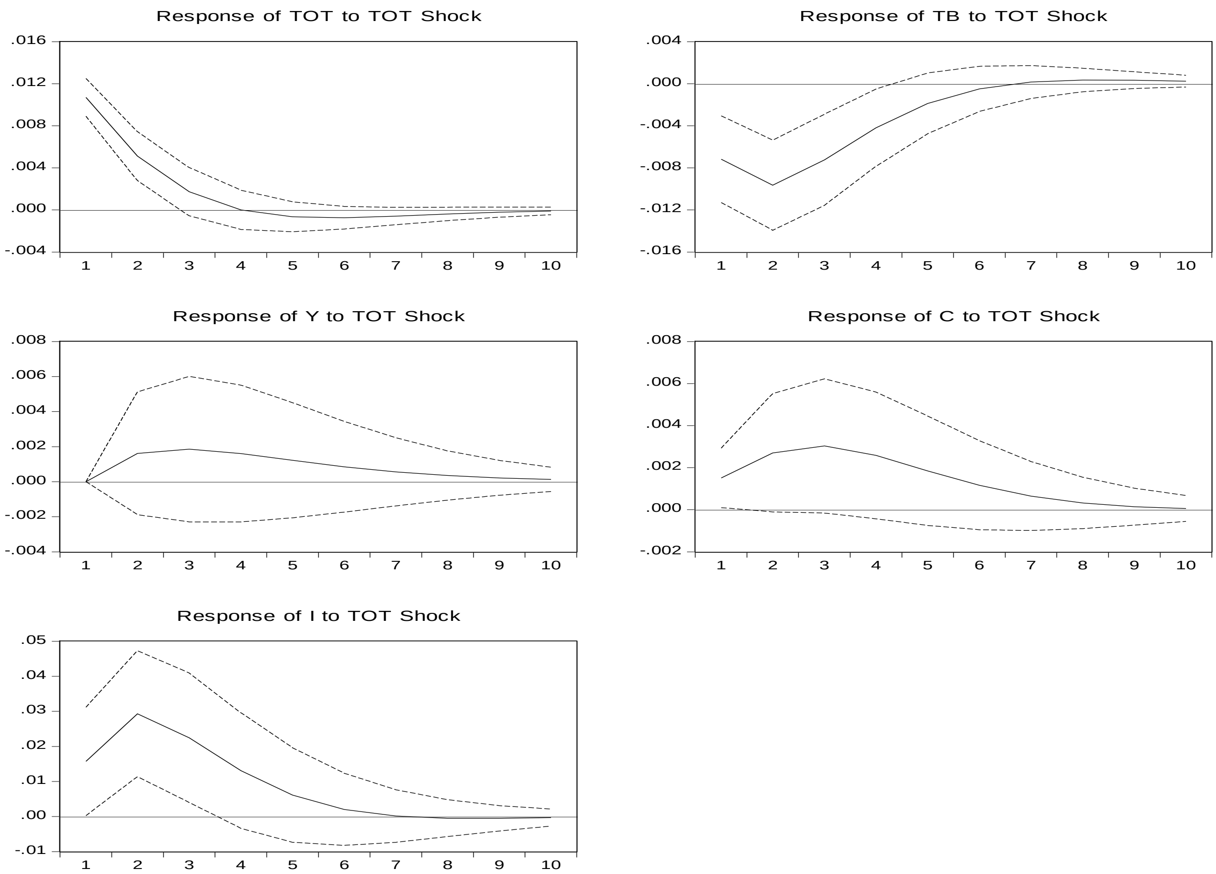
Source: Own processing – output from the econometric software EViews

The final specification of SVAR model is over-identified, so we can test it using likelihood ratio statistics. The logarithm of the maximum likelihood function of unrestricted SVAR model is 961.917. We did not reject the null hypothesis, likelihood test ratio equals to 4.8074 is less than critical value $\chi^2(3) = 7.8147$. The tested over-identifying restrictions are valid.

4 Research results

The responses to the terms-of-trade shock are in the Figure 1. As the output shock elasticity coefficient is not statistically significant, the improvement in terms-of-trade has no impact on the aggregate activity and the one-quarter delayed output expansion is statistically insignificant. Investment displays a somewhat larger expansion, albeit with a one-quarter delay. Consumption expansion is slightly over the limit of statistical significance. The 10% increase in the terms-of-trade causes an increase of 1.41% in consumption. On the other hand, the impact of the terms-of-trade shock on trade balance is statistically significant. The 10% increase in the terms of trade causes a decrease of 6.7% in trade balance. A huger contraction is delayed by one quarter. The result suggests confirmation of Obstfeld-Svensson-Razin effect.

Figure 1 Impulse Response Functions to Terms-of-Trade (TOT) Shock



Source: Own processing – output from the econometric software EViews

Note: The solid line shows the impulse response function and the dotted lines are two standard deviation bands.

To gauge the importance of the terms-of-trade shock we compute the fraction of the variance of all indicators of interest explained by it, i.e. we compute the variance decomposition. These fractions are computed in the Table 5. In the first row, the fractions of the variance are computed immediately after the term-of-trade shock realisation. In the second row these fractions are computed 40 lags (10 years) after the terms-of-trade shock realisation, when responses are stable.

Table 5 Share of Variance Explained by Terms-of-Trade Shocks in Slovakia

	tot	*tb*	*y*	*c*	*i*
immediate	100.0	15.7	0.0	1.2	3.3
after 40 lags	83.5	37.8	1.9	8.2	14.9

Source: Own processing

Results in the Table 5 are in line with the papers of Aguirre (2011), Broda (2004) and Uribe and Schmitt-Grohé (2015). The terms-of-trade shocks explain a very little fraction of the output variance in Slovakia as well as in poor and emerging countries.

5 Conclusions

The terms-of-trade has significant impact on the trade balance in Slovakia. A negative correlation of the terms-of-trade with the trade balance supports the Obstfeld-Svensson-Razin effect rather than the Harberger-Laursen-Metzler effect. As Uribe and Schmitt-Grohé (2015) showed this correlation is in average positive in the developing countries over the world. From the theoretical background it follows that the negative effect of the terms-of-trade on the trade balance comes from persistent terms-of-trade shocks or from big capital costs.

However, Szomolányi together with Lukáčik and Lukáčiková (2013) showed that capital costs are not significant source of the Slovak business cycles. Using the SVAR analysis of the output, investment, trade balance, world interest rate and domestic interest rate they showed that more than 90 % of business cycles is addressed to the output shocks. Therefore we suggest that terms-of-trade shocks are relatively highly persistent in Slovakia. Main imported goods to the Slovakia have been energy goods as natural gas and oil. On the other hand Slovakia has been exporting mainly cars. In fact prices of these goods are changing more permanently as usual.

This study along with Szomolányi, Lukáčik and Lukáčiková (2013) suggest that traditional Keynesian effects are weak in Slovakia. Demand shocks can explain only a small fraction of the Slovak business cycles. A small open economy real business cycle model can explain the impact of the terms-of-trade on the trade balance better than a traditional Keynesian model. Slovak fiscal authorities should consider weak traditional Keynesian effects (such as a fiscal multiplier for example).

Our result confirm the empirical evidence of Aguirre (2011), Broda (2004) and Uribe and Schmitt-Grohé (2015) that terms-of-trade shocks explain a very little fraction of the output variance in emerging countries. Even if Slovakia is very open economy, the terms-of-trade is not an important source of the Slovak business cycles. This evidence can be theoretically explained by an existence of non-tradable goods. A challenge is to form and solve a theoretical model explaining a contribution of the trade balance on the business cycles.

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References

Aguirre, E. (2011). *Business Cycles in Emerging Markets and Implications for the Real Exchange Rate*. Ph.D. Dissertation, New York: Columbia University.

Amisano, G., & Giannini, C. (1997). *Topics in Structural VAR Econometrics.* 2nd ed. Berlin: Springer-Verlag.

Broda, C. (2004). Terms of Trade and Exchange Rate Regimes in Developing Countries. *Journal of International Economics*, 63(1), 31-58.

Greene, W.H. (2003). *Econometric Analysis.* 5th ed. New Jersey: Prentice Hall.

Harberger, A.C (1950). Currency Depreciation, Income, and the Balance of Trade. *Journal of Political Economy*, 58(1), 47-60.

Laursen, S., & Metzler L.A. (1950). Flexible Exchange Rates and the Theory of Employment. *Review of Economics and Statistics* 32(4), 281-299.

Lütkepohl, H. (2005). *New Introduction to Multiple Time Series Analysis*. Berlin: Springer.

Obstfeld, M. (1982). Aggregate Spending and the Terms of Trade: Is There a Laursen-Metzler Effect*? Quarterly Journal of Economics,* 97(2), 251-270.
Svensson, L.E.O., & Razin, A. (1983). The Terms of Trade and the Current Account: The Harberger-Laursen-Metzler Effect. *Journal of Political Economy* 91(1), 97-125.
Szomolányi, K., & Lukáčik, M., & Lukáčiková, A. (2013). *Obmedzenia na svetových finančných trhoch a slovenská ekonomika*. *Inproforum 2013: sborník z mezinárodní vědecké konference*, 7.-8. listopadu 2013, 295-299.
Uribe, M., & Schmitt-Grohé, S. (2015). *Open Economy Macroeconomics*. New York: Columbia University.