PRACE NAUKOWE UNIWERSYTETU EKONOMICZNEGO WE WROCŁAWIU
RESEARCH PAPERS OF WROCŁAW UNIVERSITY OF ECONOMICS **nr 509 ● 2018**

ISSN 1899-3192
e-ISSN 2392-0041

Agnieszka Żyra
Cracow University of Technology
e-mail: agazyra@gmail.com

Solomiya Shevchuk
Lviv Trade and Economics University
e-mail: solomiya@gmail.com

COMMODITY PRICE VOLATILITY, OUTPUT GROWTH AND EXCHANGE RATE DYNAMICS IN THE CENTRAL AND EASTERN EUROPEAN COUNTRIES

NIESTABILNOŚĆ CEN SUROWCÓW, WZROST GOSPODARCZY ORAZ KURS WALUTOWY W GOSPODARKACH EUROPY ŚRODKOWEJ I WSCHODNIEJ

DOI: 10.15611/pn.2018.509.43
JEL Classification: F43,C54

Summary: This paper investigates the commodity price effects upon GDP growth and nominal effective exchange rate (NEER) dynamics in several Central and Eastern European (CEE) countries (the Czech Republic, Hungary, Poland and Romania). Our main finding is that an increase in the world commodity price index is a factor behind a uniform exchange rate appreciation across all countries, with an acceleration in output growth in the Czech Republic and Hungary. Except for the Czech Republic, higher commodity price volatility is associated with exchange rate depreciation, while being neutral with respect to output growth. Among some other results, exchange rate dynamics seems to be independent of output growth in three out of four countries, while the effects of a foreign demand shock as proxied by Germany's industrial production are quite homogeneous across nations.

Keywords: commodity prices, output, exchange rate, Central and Eastern European (CEE) countries.

Streszczenie: W opracowaniu poddano analizie oddziaływanie światowych cen surowców na wzrost gospodarczy oraz nominalny efektywny kurs walutowy (NEER) dla wybranych krajów Europy Środkowej i Wschodniej (Czech, Węgier, Polski i Rumunii). Ustalono, że wzrost cen surowców powoduje aprecjację kursu walutowego we wszystkich analizowanych krajach, przy czym przyspieszenie tempa wzrostu gospodarczego występuje tylko w Czechach i na Węgrzech. Z wyłączeniem Czech, większa niestabilność cen surowców kojarzy się z deprecjacją kursu walutowego, niewpływającą na wzrost gospodarczy. Spośród innych wyników na uwagę zasługuje to, że zmiany kursu walutowego są niezależne od dynamiki wzrostu gospodarczego w większości krajów (oprócz Czech). Jednocześnie skutki zewnętrznego wstrząsu popytowego (w postaci zmian produkcji przemysłowej w Niemczech) w badanych gospodarkach są bardzo podobne.

Słowa kluczowe: światowe ceny na surowce, wzrost gospodarczy, kurs walutowy, kraje Europy Środkowej i Wschodniej (ESW).

1. Introduction

It is generally assumed that the openness of the economy affects economic growth through favourable changes in the terms of trade (TOT), measured as the relationship between export and import price indices [Kehoe, Ruhl 2005]. However, there are arguments that it is the volume of foreign trade, not the commodity prices, which is responsible for growth effects [Ekholm, Södersten 2002]. Movements in commodity prices affect different countries in various ways depending on the composition of both their exports and imports; many developing countries export non-fuel primary commodities, but import energy [Spatafora, Tytell 2009]. Booms in commodity prices do not therefore translate directly into terms-of-trade booms for all commodity exporters and busts for all commodity importers.

Despite numerous empirical studies, the estimates of commodity boom effects upon economic growth are not straightforward [Bodart, Candelon, Carpantier 2012; McGregor 2017]. Regardless of direction – expansionary, restrictionary or neutral, the impact of commodity prices upon economic growth is strong enough, not only for developing countries but for developed nations as well. As established recently for 138 countries over the period of 1960–2015, the world commodity price shocks explain on average 33% of output fluctuations in individual economies and this figure doubles when the model is estimated on post 2000 data [Fernández, Schmitt-Grohé, Uribe 2017].

The purpose of this article is to analyse and quantify the relationship between several commodity price indices and dynamics of both output and nominal effective exchange rate (NEER) for the Czech Republic, Hungary, Poland and Romania, which all have been practicing a floating exchange rate regime since the beginning of 2000s. It is important for the assessment of the exchange rate shock-absorbing properties, i.e. its ability to neutralize nominal external shocks. Our research hypothesis is that fluctuations in the world commodity prices are neutralized with nominal exchange rate realignments, while there are no any significant output effects. The contribution of the article is the application of a simultaneous equation statistical model that accounts for a two-way causality between output and exchange rate, in the presence of commodity price effects, for selected four CEECs.

The remainder of the paper is organized as follows: section 2 provides a review of relevant literature, section 3 presents the data and explains the estimation methodology, section 4 discusses the results and section 5 comprises conclusions.

2. Commodity prices and macroeconomic developments

The behaviour of commodity prices, in terms of both their trend and their volatility, remains a subject of considerable controversy in academic research and policy circles [Spatafora, Tytell 2009]. The only feature not to be contested is that price shocks and world commodity markets are persistent and volatile at the same time [Cashin, McDermott, Soon 1999]. At first glance, standard open economy models do not imply causality running from commodity prices to real GDP (output) and productivity, although a decrease in private consumption and aggregate demand are expected in the case of worsening of the TOT [Diewert, Morrison 1986]. However, empirical studies demonstrate macroeconomic effects of commodity prices on all kinds of economies, even those of the G-7. For instance, it is found that commodity price shocks are an important driving force of macroeconomic fluctuations in the USA – second only to investment-specific technology shocks – particularly with respect to inflation [Gubler, Hertweck 2013]. In the long run, shocks to commodity prices account for 11.9% and 25.1% of the variation in US output and consumer prices [Kang, Ratti, Vespignani 2017]. A direct link between commodity prices and productivity is confirmed for such heterogeneous economies as USA and Mexico [Kehoe, Ruhl 2008].

Another aspect refers to macroeconomic effects of commodity price volatility, even around a relatively stable long-term trend. Assuming a causality running from commodity price volatility to the real exchange rate (RER) volatility, there is a significant impact on productivity growth, especially in the economies with undeveloped financial markets [Aghion et al. 2009] or institutional problems [Arezki, Gylfason 2011]. Nevertheless, there are many other factors behind RER volatility, such as highly volatile productivity shocks, sharp oscillations in monetary and fiscal policy shocks or capital flows [Calderón, Kubota 2009]. Regardless of the country-specific features and RER effects, an inverse relationship between commodity price volatility and output growth seems to prevail [Mendoza 1997; Bleaney, Greenaway 2001; Blattman, Hwang, Williamson 2003], even though examples of an opposite direct link are not lacking either [Jawaid, Waheed 2011]. As argued by E. Mendoza [1997], the effect of volatility of TOT could be negative or positive depending on the degree of risk aversion. If the risk aversion is low, volatility of commodity prices diminishes welfare and economic growth. Conversely, if the risk aversion is high, a higher volatility of TOT sustains economic growth but still reduces social welfare. In many cases, a positive relationship between commodity prices and output growth is combined with a negative impact of price volatility, for example see [Blattman, Hwang, Williamson 2003; Bleaney, Greenaway 2001; Mendoza 1997].

Macroeconomic responses to commodity price shocks could be related to their impact upon the trade balance which could be country-specific [Otto 2003; Bouakez, Kano 2008] and related to inflationary developments, especially for the countries with a large share of foodstuff in the consumption basket and high energy use per unit of output [Gelos, Ustyugova 2017].

On the other hand, the impact of the commodity price shock could be weakened (or amplified) by domestic policy responses. Higher growth during the latest commodity-price cycle of 1990s and 2000s was not at least partially due to global factors, but rather to such aspects as lower real appreciations than in the past or stronger initial fiscal positions [Spatafora, Tytell 2009]. An exchange rate appreciation can be an element of anti-inflationary policy [Muhanji, Ojah 2011], but this argument is not plausible enough. For example, the effect of the presence of inflation targeting regimes appears modest and not evident during the 2008 food price shock [Gelos, Ustyugova 2017]. Nonetheless, the exchange rate flexibility played an important buffering role during booms, but less so during busts, as well as in advanced and emerging market economies [Adler, Magud, Werner 2018].

Switching from fixed to flexible exchange rate regime and export diversification policies have often been advocated so as to minimize the negative effects resulting from international commodity price disturbances [Tornell, Velasco 2000; Broda 2004; Hoffmann 2007], reflecting arguments in favour of exchange rate shock-absorbing properties [Edwards, Yeyati 2005]. As found by C. Broda [2004], up to a third of the exchange rate volatility can be accounted for by shocks to TOT under floating exchange rate regimes. The feedback effects from the exchange rate volatility to macroeconomic and financial variables are found to be much stronger for developing countries, relative to developed economies [Grossmann, Love, Orlov 2014].

When considering the case of temporary decline in commodity prices for Australia and New Zealand, it has been established that the size of the depreciation under a floating exchange rate and the extent to which real national output is insulated from the commodity price shock depends, in the immediate terms, on the rate of pass-through and in the medium term on the openness of the economy [Makin 2013]. Hence, the more open (closed) the economy, the less (more) the national output is insulated from commodity price fluctuations. However, domestic output is not insulated at all from the commodity price shock under a pegged exchange rate.

On the other hand, countries that saw larger growth declines in the wake of the 2008–2009 world financial crisis had more flexible exchange rate regimes [Berg et al. 2011]. One of the likely explanations could be an extensive use of monetary policy under a flexible exchange rate regime [Devereux 2004]. On the whole, potential advantages of floating as a way to minimize the inflationary pass-through of the world commodity prices are not strong enough. For example, it has been discovered that the commodity price shocks may not have transitory effects when a country's currency is pegged to the U.S. dollar [Sekine, Tsuruga 2016]. However, the effect remains transitory in countries with exchange rate flexibility.

3. Data and statistical methodology

The commodity price index of both Fuel and Non-Fuel Price Indices, 2010 = 100, $PCOM_t$, has been obtained from the IMF database [www.imf.org/external]. Also, the commodity price indices of metals and crude oil are used, 2010 = 100, $PMET_t$ and $POIL_t$, respectively. The metals index includes Copper, Aluminum, Iron Ore, Tin, Nickel, Zinc, Lead, and Uranium Price Indices and the crude oil index is simple average of the three spot prices; Dated Brent, West Texas Intermediate, and the Dubai Fateh (Figure 1). The world commodity prices had been stable since the beginning of 1990s till the middle of 2000s, with a steep increase over the 2005–2008 period. In the wake of the 2008–2009 world financial crisis, commodity prices decreased by a half, but it was a short-lived phenomenon. The world commodity prices had recovered in 2010 and stood a very high plateau till the beginning of 2014. Following an abrupt correction in 2014–2015, commodity prices diminished to their 2009 level and then there has been a moderate recovery in prices since the beginning of 2016. Moreover, it is easy to spot that the latest increase in the crude oil prices had been well above the same upward trend for all commodity index in general and the metals price index in particular, especially within 2007–2008 and 2012–2013.

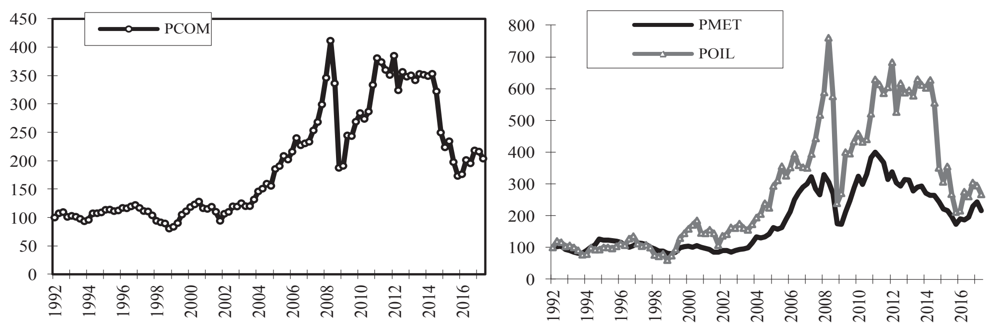


Fig. 1. World commodity prices, 1992–2017

Source: [www.imf.org/external/np/res/commod/index.aspx].

In order to study macroeconomic effects of the commodity prices, time series of output (GDP) and nominal effective exchange rate are applied. The sample comprises quarterly data for the period of 2000–2016 in the Czech Republic, Hungary, Poland and Romania. The data are from the IMF's *International Financial Statistics* online database [http://www.imf.org/en/data]. As the hypothesis of a unit root cannot be rejected for endogenous variables in all cases, regression models are estimated in the first differences (variations). Except for the world interest rate and volatility of commodity prices, all other variables are transformed into natural logarithms, as indicated by lowercase letters.

Our statistical model presents as follows:

$$\Delta y_t = a_0 + a_1 \Delta y_{t-1} + a_2 \Delta e_t + a_3 \Delta pcom_t + a_4 \sigma_t^{pcom} + a_5 r_t^* + a_6 y_t^* + \varepsilon, \tag{1}$$

$$\Delta e_t = b_0 + b_1 \Delta y_t + b_2 \Delta e_{t-1} + b_3 \Delta pcom_t + b_4 \sigma_t^{pcom} + \upsilon_t, \tag{2}$$

where: y_t – domestic output (index, 2010 = 100); e_t – a nominal effective exchange rate (index, 2010 = 100); $pcom_t$ – the commodity price index (2010 = 100); σ_t^{pcom} – the volatility of commodity prices; r_t^* – the world interest rate; y_t^* – the foreign output index, 2010 = 100; ε_t and υ_t – stochastic factors; Δ – the operator of the first differences.

It is assumed that there is a two-way causality between domestic output and NEER. Commodity prices and their volatility are supposed to affect both endogenous variables. If exchange rate acts as an absorber, there should an asymmetry between NEER and commodity prices ($b_3 < 0$), with no effect of the latter upon output ($a_3 \approx 0$). Besides all commodity price index, price indices for metals and crude oil are also employed. The world interest rate is proxied with the London Inter-Bank Offer Rate (LIBOR). As a proxy for foreign output, y_t^*, the industrial production in Germany is used. It is asserted that both interest rate and output abroad have real effects, but no nominal effects. Time series for output are seasonally adjusted.
The volatility applied is the estimated conditional variance of the commodity price indices from a univariate GARCH(1,1) model:

$$\begin{aligned} &\Delta pcom_t = \eta + AR(1) + MA(1) + \lambda CRISIS + \xi_t,\ \xi_t / \Omega_{t-1} \approx N(0, \sigma_t), \\ &\sigma_t = \omega + \alpha \xi_{t-1}^2 + \beta \sigma_{t-1},\ \omega > 0,\ \alpha > 0,\ \beta > 0, \end{aligned} \tag{3}$$

where: η – the mean of $\Delta pcom$ conditional on past information (Ω_{t-1}); $AR(1)$ and $MA(1)$ – components, respectively; $CRISIS_t$ – the dummy (1 for 2008Q1 to 2009Q4 and 0 otherwise); ξ_t – the stochastic factor.

It is presumed that the commodity price index is dependent upon its auto-regressive and moving average components, with controlling for crisis developments as well. The estimated σ_t (conditional variance) from the GARCH(1,1) model is applied in the estimation of the commodity price index. Table 1 presents the results from the GARCH(1,1) model for all commodity price indices, indicating a significant ARCH process for $PCOM_t$ and $POIL_t$, but not for $PMET_t$.

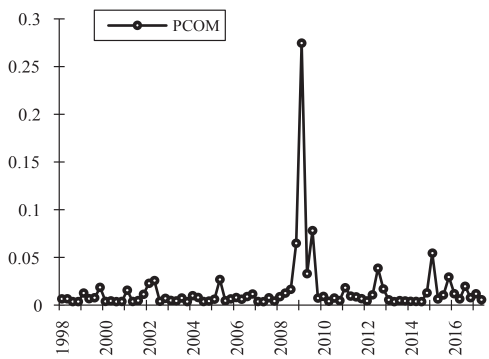
Table 1. Model GARCH estimates for commodity indices

	Δ	*AR*(1)	*MA*(1)	Δ	Δ	Δ	Δ
$\Delta pcom_t$	0,015 (1.04)	0.602 (2.38**)	Δ0.352 (Δ1.14)	Δ0.007 (Δ0.22)	0.004 (2.23**)	0.861 (2.80**)	0.016 (0.09)
$\Delta pmet_t$	0.003 (0.21)	0.235 (0.79)	0.130 (0.37)	0.012 (0.34)	0.001 (0.65)	0.186 (1.29)	0.741 (2.94***)
$\Delta poil_t$	0.028 (1.26)	0.575 (Δ2.33**)	Δ0.437 (Δ1.50)	Δ0,008 (Δ0.17)	0.011 (2.09**)	0.934 (2.61***)	0.014 (0.12)

Note: *z*-statistic in parenthesis; ***, **, * imply statistical significance at the 1, 5 and 10% level.

Source: authors' calculations.

The estimated values of σ_t are presented in Figure 2. The volatility of metals and crude oil prices follow the same pattern, with a marked increase over the period of 2007–2009, but the amplitude is much smaller for the former. The volatility of all commodities price index is somewhat in the middle, being well above that for metals but much smaller in comparison to crude oil.



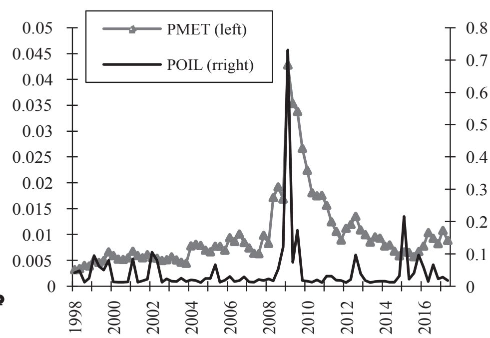


Fig. 2. The estimated σ_t (conditional variance) for selected commodity price indices, 1980–2017

Source: authors' calculations.

4. Empirical estimates

Table 2 presents estimation results for the baseline specification with all commodities price index, while estimates for specifications with metals and crude oil prices are presented in Tables 3 and 4, respectively. Dependent on a particular specification, exogenous variables explain between 10% (Poland) and 50% (Hungary) of changes in the output growth rate, and between about 10% (Poland) and 30% (Romania) of changes in the NEER. In all specifications, the ADF test suggests stability of residuals, thus validating statistical properties of regression models.

There is no difference between country estimates regarding all commodity price effects upon the NEER. In all of the presented cases, higher commodity prices are followed by an exchange rate appreciation (coefficients on $\Delta pcom_t$ are statistically significant at the level of 1%). A simultaneous acceleration of output growth is observed only for the Czech Republic and Hungary. As there is no commodity price effect on output in Poland and Romania, both countries provide a support of exchange rate absorbing properties. Such an assumption is further strengthened by a reaction of both output and exchange rate to the volatility of commodity prices. A higher value of σ_t^{pcom} brings about an exchange rate depreciation, with no effect upon output growth. The same result is found for Hungary. As for the Czech Republic, both output and NEER are not affected by commodity price volatility.

Except for Poland, both output and exchange rate dynamics are inertial, as indicated by statistically significant coefficients on Δy_{t-1} and Δe_{t-1}, respectively. It is worth noting that the exchange rate does not affect output growth in all CEE countries, thus running counter to one of standard assumptions of the Keynesian open economy models. Being in accordance with the monetary model of exchange rate determination, a higher demand for money as implied by a higher output growth rate brings about an exchange rate appreciation in the Czech Republic, but it is not the case for other countries. There is no surprise that industrial production in Germany contributes to output growth across all CEE countries, while importance of LIBOR is found only for Romania.

Table 2. Determinants of GDP growth and exchange rate dynamics (all commodities price index)

Variable	Czech Republic		Hungary		Poland		Romania	
	Δy_t	Δe_t	Δy_t	Δe_t	Δy_t	Δe_t	Δy_t	Δe_t
Δy_t	—	–0.624 (–2.10**)	—	0.362 (0.88)	—	–0.228 (–0.31)	—	0.413 (1.43)
Δy_{t-1}	0.419 (2.95***)	—	0.368 (2.55**)	—	—	—	0.233 (2.01**)	—
Δe_t	0.028 (0.41)	—	–0.010 (–0.15)	—	0.083 (0.73)	—	0.135 (1.10)	—
Δe_{t-1}	—	0.271 (2.34**)	—	0.294 (3.12***)	—	0.045 (0.35)	—	0.433 (4.07***)
$\Delta pcom_t$	0.018 (1.80*)	–0.059 (–2.81***)	0.020 (1.99*)	–0.129 (–4.08***)	0.012 (1.06)	–0.110 (–3.05***)	0.010 (0.56)	–0.098 (–2.97***)
σ_t^{pcom}	–0.072 (–1.36)	0.070 (1.02)	–0.056 (–1.16)	0.333 (2.10**)	–0.016 (–0.28)	0.540 (3.78***)	–0.114 (–1.27)	0.386 (2.82***)
Δr_t^*	0.0003 (0.81)	—	0.0001 (0.27)	—	0.0006 (1.16)	—	0.0016 (1.72*)	—
Δy_t^*	0.077 (1.24)	—	0.097 (1.72*)	—	0.016 (2.03**)	—	0.212 (1.90*)	—
R^2	0.30	0.26	0.44	0.25	0.11	0.29	0.17	0.30
ADF	–8.39***	–7.72***	–8.67***	–8.36***	–8.09***	–8.42***	–7.60***	–7.52***

Source: authors' calculations.

Table 3. Determinants of GDP growth and exchange rate dynamics (world metals price index)

Variable	Czech Republic		Hungary		Poland		Romania	
	Δy_t	Δe_t	Δy_t	Δe_t	Δy_t	Δe_t	Δy_t	Δe_t
Δy_t	—	–0.697 (–2.25**)	—	–0.002 (–0.03)	—	–0.703 (–0.64)	—	0.117 (0.45)
Δy_{t-1}	0.371 (2.67***)	—	0.252 (1.97***)	—	—	—	0.250 (1.35)	—
Δe_t	0.030 (0.46)	—	–0.016 (–0.29)	—	0.123 (1.19)	—	0.078 (0.97)	—
Δe_{t-1}	—	0.271 (2.34**)	—	0.284 (3.01***)	—	0.271 (2.32**)	—	0.443 (3.91***)
$\Delta pmet_t$	0.023 (2.27**)	–0.064 (–2.73***)	0.027 (2.82***)	–0.130 (–3.62***)	0.023 (1.87*)	–0.150 (–3.51***)	0.012 (0.69)	–0.107 (–2.89***)
σ_t^{pmet}	–0.227 (–2.23**)	0.106 (0.62)	–0.403 (–3.67***)	0.356 (1.42)	–0.039 (–0.33)	0.878 (1.55)	–0.520 (–2.23**)	0.381 (1.44)
Δr_t^*	0.0002 (0.57)	—	–0.000 (–0.86)	—	0.0006 (1.34)	—	0.0012 (1.14)	—
Δy_t^*	0.140 (2.91***)	—	0.138 (3.36***)	—	0.151 (1.98**)	—	0.302 (4.02***)	—
R^2	0.34	0.23	0.53	0.18	0.09	0.13	0.45	0.21
ADF	–9.02***	–7.26***	–8.92***	–7.61***	–8.03***	–8.32***	–7.72***	–9.15***

Source: authors' calculations.

Table 4. Determinants of GDP growth and exchange rate dynamics (world crude oil price index)

Variable	Czech Republic		Hungary		Poland		Romania	
	Δy_t	Δe_t	Δy_t	Δe_t	Δy_t	Δe_t	Δy_t	Δe_t
Δy_t	—	–0.737 (–2.40**)	—	–0.390 (–0.86)	—	–0.358 (–0.48)	—	0.341 (1.39)
Δy_{t-1}	0.587 (5.22***)	—	0.464 (3.25*(*))	—	—	—	0.125 (0.98)	—
Δe_t	–0.025 (–0.46)	—	–0.041 (–0.58)	—	0.080 (0.70)	—	0.274 (2.78***)	—
Δe_{t-1}	—	0.278 (2.29**)	—	0.192 (1.48)	—	0.057 (0.49)	—	0.362 (3.29***)
$\Delta poil_t$	0.008 (0.40)	–0.037 (–2.65***)	0.010 (1.55)	–0.074 (–2.70***)	0.004 (0.55)	–0.068 (–2.87***)	0.008 (0.73)	–0.055 (–2.86***)
σ_t^{poil}	0.020 (1.27)	0.046 (1.39)	–0.001 (–0.03)	0.112 (2.01**)	–0.003 (–0.19)	0.175 (3.72***)	–0.064 (–2.07**)	0.119 (3.30***)
Δr_t^*	0.0003 (0.76)	—	–0.0001 (–0.39)	—	0.0004 (1.10)	—	0.0016 (1.72*)	—
Δy_t^*	0.151 (2.93***)	—	0.122 (2.13**)	—	0.123 (2.06**)	—	0.274 (2.78***)	—
R^2	0.38	0.26	0.46	0.20	0.09	0.25	0.21	0.33
ADF	–8.46***	–7.14***	–7.56***	–6.44***	–8.09***	–8.58***	–6.82***	–7.46***

Source: authors' calculations.

Using alternative specifications, it has been confirmed that higher commodity prices (metals) lead to an exchange rate appreciation, but the metals price volatility is not associated with the alterations in the exchange rate at a statistically significant level (Table 3). Although higher metals prices contribute positively to output growth (except Romania), their volatility is of an opposite negative effect (except for Poland). In specifications with the metals and crude oil prices, a positive relationship between domestic growth rate and industrial output growth in Germany becomes more pronounced.

Regarding reaction of the exchange rate dynamics to the crude oil prices (Table 4), it is similar to that of all commodities price index (Table 2). However, regression coefficients on both $\Delta poil_t$ and σ_t^{poil} are smaller, suggesting a weaker response to the crude oil prices. In contrast to the estimates for $\Delta pcom_t$, higher crude oil prices do not contribute to output growth in the Czech Republic and Hungary, with their higher volatility being detrimental to output growth only in Romania.

5. Conclusions

Our results support the hypothesis concerning the exchange rate shock-absorbing properties for Poland and Romania, that the NEER strong response to the commodity price shocks is combined with the neutrality of output growth to changes in both commodity prices and their volatility. Similar evidence proves somewhat weaker for Hungary. The economy of the Czech Republic is more exposed to the commodity shocks, thus implying much weaker shock-absorbing properties of its flexible exchange rate regime (following arguments by Devereux [2004], an extensive use of monetary policy could be among explanations of such an outcome). As there is a strong inverse relationship between commodity price volatility and output growth across all four CEE countries, similar to many other empirical studies, for example [Mendoza 1997; Bleaney, Greenaway 2001; Blattman, Hwang, Williamson 2003], it implies that the risk aversion is low, as it is established by E. Mendoza [1997].

Among other results, the exchange rate dynamics seems to be independent of output growth in three out of four CEE countries (except the Czech Republic), while there is no sign of any strong exchange rate effects upon output growth either. In general, such findings do not contradict an empirically-supported assumption that the exchange rate effects are weaker in developed economies (see [Grossmann, Love, Orlov 2014]). As expected, the effects of Germany's industrial production shock are positive and quite homogeneous across nations. On the other hand, the world interest rate as proxied by the LIBOR is related to output growth in Romania only.

References

Adler G., Magud N., Werner A., 2018, *Terms-of-trade cycles and external adjustment*, International Review of Economics and Finance, vol. 54, no. 1, pp. 103–122.

Aghion P., Bacchetta P., Rancie R., Rogoff K., 2009, *Exchange rate volatility and productivity growth: The role of financial development*, Journal of Monetary Economics, vol. 56, pp. 494–513.

Arezki R., Gylfason T., 2011, *Commodity price volatility*, *democracy and economic growth*, CESifo Working Paper Series, no. 3619, CESifo Group, Munich.

Berg A., Papageorgiou C., Pattillo C., Schindler M., Spatafora N., Weisfeld H., 2011, *Global shocks and their impact on low-income countries: Lessons from the global financial crisis*, DIIS Working Paper 2011:07, Danish Institute for International Studies, Copenhagen.

Blattman C., Hwang J., Williamson J.G., 2003, *The terms of trade and economic growth in the periphery 1870–1983*, NBER Working Paper, no. 9940, National Bureau Economic Research, Washington, DC.

Bleaney M., Greenaway D., 2001, *The impact of terms of trade and real exchange rate volatility on investment and growth in Sub-Saharan Africa*, Journal of Development Economics, vol. 65, pp. 491–500.

Bodart V., Candelon B., Carpantier J.-F., 2012, *Real exchanges rates in commodity producing countries: A reappraisal*, Journal of International Money and Finance, vol. 31, pp. 1482–1502.

Bouakez H., Kano T., 2008, *Terms of trade and current account fluctuations: The Harberger–Laursen–Metzler effect revisited*, Journal of Macroeconomics, vol. 30, pp. 260–281.

Broda C., 2004, *Terms of trade and exchange rate regimes in developing countries*, Journal of International Economy, vol. 63, no. 1, pp. 31–58.

Calderón C., Kubota M., 2009, *Does higher openness cause more real exchange rate volatility?*, Policy Research Working Paper, no. 4896, World Bank, Washington, DC.

Cashin P., McDermott J., Soon A., 1999, *Booms and slumps in world commodity prices*, IMF Working Paper, no. WP/99/155, International Monetary Fund, Washington, DC.

Devereux M., 2004, *Monetary policy rules and exchange rate flexibility in a simple dynamic general equilibrium model*, Journal of Macroeconomics, vol. 26, no. 2, pp. 287–308.

Diewert W.E., Morrison C.J., 1986, *Adjusting output and productivity indexes for changes in the terms of trade*, Economic Journal, vol. 96, pp. 659–679.

Edwards S., Yeyati L., 2005, *Flexible exchange rates as shock absorbers*, European Economic Review, vol. 49, no. 8, pp. 2079–2105.

Ekholm K., Södersten B., 2002, *Growth and trade vs. trade and growth*, Small Business Economics, vol. 19, no. 2, pp. 147–162.

Fernández A., Schmitt-Grohé S., Uribe M., 2017, *World shocks, world prices, and business cycles: An empirical investigation*, Journal of International Economics, vol. 108, pp. S2–S14.

Gelos G., Ustyugova Y., 2017, *Inflation responses to commodity price shocks – How and why do countries differ?*, Journal of International Money and Finance, vol. 72, no. 1, pp. 28–47.

Grossmann A., Love I., Orlov A., 2014, *The dynamics of exchange rate volatility: A panel VAR approach*, Journal of International Financial Markets, Institutions & Money, vol. 33, no. 1, pp. 1–27.

Gubler M., Hertweck M., 2013, *Commodity price shocks and the business cycle: Structural evidence for the U.S.*, Journal of International Money and Finance, vol. 37, pp. 324–352.

Hoffmann M., 2007, *Fixed versus flexible exchange rates: Evidence from developing countries*, Economica, vol.74, no. 295, pp. 425–449.

Jawaid S.T., Waheed A., 2011, *Effects of terms of trade andits volatility on economic growth: A cross country empirical investigation*, Transition Studies Review, vol. 18, no. 2, pp. 217–229.

Kang W., Ratti R., Vespignani J., 2017, *Global commodity prices and global stock volatility shocks: Effects across countries*, FRB of Dallas Working Paper, no. 311, Federal Reserve Bank of Dallas, Dallas.

Kehoe T.J., Ruhl K.J., 2005, *Is Switzerland in a great depression?*, Review of Economic Dynamics, vol. 8, no. 3, pp. 759–775.
Kehoe T.J., Ruhl K.J., 2008, *Are shocks to the terms of trade shocks to productivity?*, Review of Economic Dynamics, vol. 11, pp. 804–819.
Makin A.J., 2013, *Commodity prices and the macroeconomy: An extended dependent economy approach*, Journal of Asian Economics, vol. 24, pp. 80–88.
McGregor T., 2017, *Commodity price shocks, growth and structural transformation in low-income countries*, The Quarterly Review of Economics and Finance, vol. 65, pp. 285–303.
Mendoza E., 1997, *Terms-of-trade uncertainty and economic growth*, Journal of Development Economics, vol. 54, no. 2, pp. 323–335.
Muhanji M., Ojah K., 2011, *External shocks and persistence of external debt in open vulnerable economies: The case of Africa*, Economic Modelling, vol. 28, pp. 1615–1628.
Otto G., 2003, *Terms of trade shocks and the balance of trade: There is a Harberger–Laursen–Metzler effect*, Journal of International Money and Finance, vol. 22, pp. 155–184.
Sekine A., Tsuruga T., 2016, *Effects of commodity price shocks on inflation: A cross-country analysis*, ESRI Discussion Paper Series, no. 331, Economic and Social Research Institute, Tokyo.
Spatafora N., Tytell I., 2009, *Commodity terms of trade: The history of booms and busts*, IMF Working Paper, no. WP/09/205, International Monetary Fund, Washington, DC.
Tornell A., Velasco A., 2000, *Fixed versus flexible exchange rates: Which provides more fiscal discipline?*, Journal of Monetary Economics, vol. 45, no. 2, pp. 399–436.www.imf.org/external.

Websites

www.imf.org/external/np/res/commod/index.aspx.
http://www.imf.org/en/data.