INFORMATION SYSTEMS IN MANAGEMENT

Information Systems in Management (2019) Vol. 8 (1) 47−56
DOI: 10.22630/ISIM.2019.8.1.5

MODELLING OF AGRICULTURAL COMMODITY PRICE EFFECTS ON THE FISCAL PERFORMANCE AND ECONOMIC GROWTH IN UKRAINE

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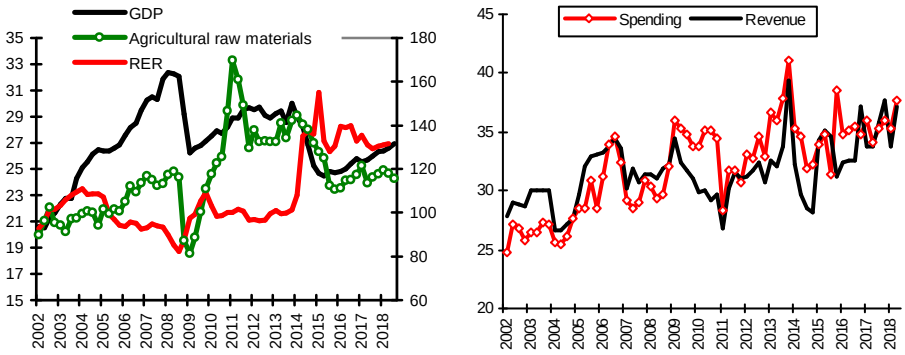
This paper analyses the effects of agricultural raw materials prices upon fiscal policy indicators and gross domestic product (GDP) output in Ukraine, on the basis of the VAR/VEC model using quarterly data for the period of 2002–2018. The results indicate a positive effect of agricultural commodity prices on GDP, with both government expenditure and revenue declining in the wake of favorable commodity price developments. As expected, higher agricultural commodity prices are associated with a real exchange rate (RER) appreciation, which in turn brings about an increase in government expenditure and revenue combined with an expansionary effect on GDP. Furthermore, agricultural commodity price and RER shocks are characterized by asymmetrical effects upon output. Among other results, there are positive output effects by both government expenditures and revenues, while the reverse causality suggests a decrease in fiscal variables following an increase in GDP. Several implications for stabilization policies are discussed.

Keywords**:** agricultural commodity prices, fiscal policy, GDP, real exchange rate, Ukraine

1. Introduction

Since the middle of 2000s, the share of agricultural commodities in Ukraine's exports has increased to 40 percent. However, it exposes the output and fiscal balance to the risk of commodity price shocks. A potential solution is anchoring fiscal policy framework in terms of rules that target the cyclically adjusted or structural (as opposed to actual) balance in an effort to overcome problems of procyclicality and fiscal volatility in the environment with large and persistent commodity shocks [6; 8]. It is assumed that the rule-based fiscal policies allow for budget surpluses in good times, thus creating pre-conditions for an expansionary fiscal stance during economic slowdown. Although several studies confirm an inverse relationship between fiscal rules and procyclicality for Latin American commodity 'republics' [9; 10; 12], opposite results are also obtained [6; 8; 13].



a) GDP (in 1994 prices), RER and agricultural raw materials prices (index, 2010=100)

b) government spending and revenues (% of GDP)

Figure 1. Ukraine: selected macroeconomic indicators, 2002–2018
Source: Ukraine's State Statistical Committee (www.ukrstat.gov.ua), Ukraine's Ministry of Finance (www.minfin.gov.ua)

Changes in the Ukraine's GDP seem to follow closely the developments in the agricultural commodity prices (Fig. 1a). In 2008-2009 and 2014-2015, agricultural commodity price shocks coincided with sharp realignments of Ukrainian currency hryvna, but any relationships between both nominal variables could be obscured by simultaneity of currency crises that started that time. However, it is not ruled out that higher agricultural prices contributed to the RER appreciation in 2002-2008, while this kind of relationship is not likely to mark post-crisis period. Fiscal variables do not reveal any connections with agricultural raw material prices, with irregular oscillations around an upward trend being visible for both government spending and revenues (Fig. 1b).

The aim of this article is to provide an empirical assessment of agricultural raw materials prices upon the RER, output and fiscal variables in Ukraine. The remainder of this paper is organized as follows. The next section reviews the relevant literature on the relationship between commodity prices and fiscal performance. Section 3 presents data and econometric methodology. In Section 4 empirical results are discussed. The last section concludes.

2. Commodity prices and fiscal performance

Assuming a high volatility of commodity prices, it is quite natural to perform an anti-cyclical fiscal policy, with the real (nominal) exchange rate serving as a shock absorber. During a period of high commodity prices, it is expedient to improve the budget balance thus creating a greater fiscal space, which gives more room for accommodating terms-of-trade (TOT) shocks. For example, such an approach is established for Chile and Peru [14]. Among Latin American countries, only Chile targets cyclically adjusted indicators although Colombia is going the "Chilean way" and the Mexican rule offers some stabilization properties. Argentina, Brazil and Peru apply numerical rules targeting the overall/primary public balance and/or the public spending [7]. Limited exchange rate flexibility, weak external position, and loose fiscal policy tend to amplify the negative effects of adverse TOT shocks on domestic output, especially if sharp drops in commodity prices are preceded by booms [1]. For Ukraine, it is of particular importance that financial dollarization is likely to act as a shock "amplifier."

The optimal windfall allocation rule between spending today and asset accumulation for low-income countries with imperfect access to world capital markets and a variety of externalities associated with public infrastructure, as well as direct complementarity effect with private investment, and reduced distribution costs, are studied by Agenor [2]. It is established that an optimal response to commodity price shocks defined in terms of the volatility of private consumption and either the non-resource primary fiscal balance or a more general index of macroeconomic stability, which accounts for the volatility of the RER, implies a dynamic trade-off between spending now and spending later. Such a policy is considered to be better option for fiscal policy in comparison to an unconditional cash transfer policy.

Alternative fiscal rules imply targeting of a structural budget balance, in connection to commodity prices, as it is suggested by a successful experience of Chile [7]. Familiar arguments in favor of the structural balance rule are found for Mexico [3], Brazil [5] and Colombia [11], important commodity exporters. During the recent commodity boom of 2002-2012 the impact of increases in commodity prices tends to be higher for the Latin American countries with low fiscal procyclicality [4]. However, a procyclical fiscal policy pattern still dominates in

the region. For 20 countries of Latin America and the Caribbean over the period of 1990–2013 period, it is found that 1 percent increase in the output gap is associated with up to 0.66 percentage point deterioration in the structural primary balance, with the inverse relationship being stronger in countries that face large TOT shocks [6]. Analysing a dataset of 48 non-renewable commodity exporters for the period 1970–2014, it is stated that fiscal policy tends to have a procyclical bias (mainly via expenditures of the public sector), with no sign of declining in recent years despite adopting the fiscal rules [8]. Such an outcome can be explained by non-linearity of budget balance with respect to public debt stock. Based on a panel of developed and emerging economies over the period of 1990-2011, it is found that when the public debt-to-GDP ratio exceeds threshold of 86 percent, fiscal policy becomes rather procyclical [9].

As the procyclical fiscal policy promises larger gains in the short run, it can be difficult to implement prudent solutions because of political reasons. For example, it is established for Chile with a Dynamic Stochastic General Equilibrium (DSGE) model that if the government saves most of the extra revenues from the higher commodity price; an increase of a copper price by 10 percent leads to an expansion of output below 0.2 percent and a RER appreciation of 0.5 percent [13]. Although an expansionary fiscal stance is associated with a stronger output expansion above 0.5 percent and a RER appreciation of 0.8 percent, such a policy can create substantial difficulties in the intertemporal context. Argentina is a good example of such a case.

3. Empirical methodology

We use quarterly series of the following variables for the period of 2002Q1:2018Q2: agricultural raw materials prices, $praw_t$ (index, 2010=100), real effective exchange rate, rer_t (index, 2010 = 100), government revenue and spending, rev_t and g_t respectively (percent of GDP), gross domestic product, y_t (in 1994 prices). Fiscal variables are taken from the National Bank of Ukraine (www.bank.gov.ua), GDP from the Ukraine's State Statistical Office (www.ukrstat.gov.ua), while the time series for agricultural raw materials prices and RER are obtained from the IMF's databases (www.img.org). All variables enter in logs, with GDP, government revenue and spending series being seasonally adjusted.

Except for the government revenues, all other variables are integrated of order 1, or simply I(1), as indicated by the unit root tests (Table 1). However, it is possible to assume that weak stationarity of rev_t does not affect statistical properties of the relationship between our variables, especially when accounting for the fact that stationarity of rev_t is not confirmed for a shorter 2006-2018

sample. As suggested by the Johansen test (Table 2), there is at least one cointegrating equation between endogenous variables.

Table 1. Unit Root Tests for endogenous variables

	ADF		PP	
	L	FD	L	FD
$praw_t$	–2,88*	–6,34***	–2,39	–6,14***
rer_t	–1,23	–7,82***	–1,33	–7,81***
rev_t	–3,38**	–9,54***	–3,38**	–13,53***
g_t	–2,49	–10,78***	–2,29	–12,08***
y_t	–2,14	–5,51**	–2,04	–5,50*

Note: ***, **, * null hypothesis of a unit root can be rejected at 1, 5 an 10 percent level of confidence, respectively; L and FD stand for levels and first differences, respectively

Table 2. Johansen Test Statistics for $praw_t$, rer_t, rev_t, g_t, and y_t

Number of cointegrating equations		Trace statistic	0.05 Critical value	Prob.	Max-Eigen Statistic	0.05 Critical value	Prob.
H_0: $r = r_0$	$r = 0$	89.67***	76.97	0.0	36.30**	34.80	0.03
	$r = 1$	53.37*	54.07	0.06	25.55	28.58	0.11
	$r = 2$	27.81	35.19	0.24	16.57	22.29	0.25
	$r = 3$	11.24	20.26	0.51	7.78	15.89	0.57
	$r = 4$	3.46	9.16	0.4974	3.46	9.16	0.49

Assuming that endogenous variables are $I(1)$ and cointegrated with rank r ($0 < r < n$), the Vector Error-Correction Model (VECM) representation with structural restrictions presents as follows:

$$B(L)\Delta z_t = -\alpha\beta z_{t-1} + \xi_t, \tag{1}$$

where $B(L)$ is the matrix polynomial with degree k, α and β are $n \times r$ matrices of rank r, z_t is the vector of endogenous variables, Δ is the operator of first differences, ξ_t is the vector of stochastic innovations. Exact identification of β requires r restrictions on each of the r cointegrating vectors.

The vectors of endogenous variables and stochastic innovations are chosen as follows: $z_t = (\Delta praw_t, \Delta rer, \Delta rev, \Delta g, \Delta y)$, $\xi_t = (\xi_t^{praw}, \xi_t^{rer}, \xi_t^{rev}, \xi_t^{g}, \xi_t^{y})$, where ξ_t^{praw}, ξ_t^{rer}, , ξ_t^{rev}, ξ_t^{g} and ξ_t^{y} are stochastic innovations for respective endogenous variables. It is assumed that the agricultural raw materials prices affect RER, with fiscal variables and output in the third, fourth and fifth places, implying that innovations to government revenue and spending or output do not influence relative prices in the very same period they occur.

For computational purposes, EViews 6.1 program is used. We include two lags into the VECM, as suggested by the Akaike criterion for a VAR model with same endogenous variables.

4. Empirical results and discussion

The selected impulse responses of endogenous variables are presented in Fig. 2. Table 3 reports the portion of the forecast error variance decomposition (FEVD) in the endogenous variable at different forecast horizons, which is attributable to innovations in other variables (the dominant shock is in bold type).

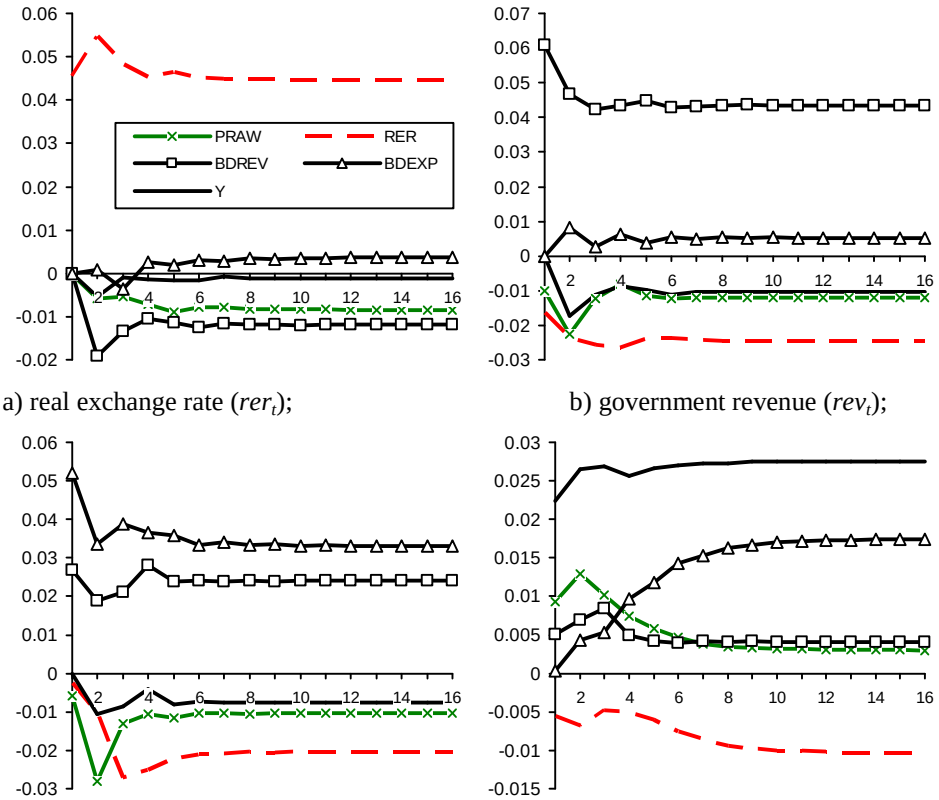
As expected, it is likely that higher prices of agricultural raw materials bring about appreciation of the RER, similar to the impact of an increase in the government revenue on the relative prices (Fig. 2a). Such similarity is observed for the expansionary effects of both variables upon output (Fig. 2d). Potentially an increase in agricultural raw materials prices can contribute to the RER appreciation through either strengthening of a nominal exchange rate or an increase in the domestic food prices. Higher government revenue is likely to bring about appreciation of the RER mainly through the mechanism of a nominal exchange rate appreciation, as any efforts to improve tax collection are associated with higher demand for money and downward pressure on domestic prices.

Following an increase in the agricultural raw materials prices, there is a decrease in either government revenue (Fig. 2b), or government spending (Fig. 2c). However, the fraction of $praw_t$ in the FEVD of rer_t is marginal, meaning that prices of agricultural raw materials do not have a significant impact upon the RER (Table 1). For other endogenous variables, the fraction of $praw_t$ in the FEVD is somewhat higher, but still below 10 percent (the only exception is a short-term impact of $praw_t$ upon output with a horizon of 4 quarters). To the same extent, the RER is not affected significantly by any of the endogenous variables.

Both government revenue and spending do not react to output, which is bad news in the former case and good news in the latter case. Depreciation of the RER is associated with a decrease in both government revenue and spending, with both outcomes being consistent with a clear restrictionary effect upon output. The fraction of rer_t in the FEVD of fiscal variables gradually increases up to 20 percent, reflecting the importance of relative prices in shaping both government revenues and expenditures. Government revenues seem to be independent of spending decisions, but there is significant causality running from rev_t to g_t. The fraction of rev_t in the FEVD of g_t is between 20 and 24 percent.

There is no evidence for a standard textbook expansionary effect of exchange rate depreciation upon output. Just the opposite, any downward movements of the relative prices are likely to bring about a decrease in output, but the importance of this link should not be exaggerated. According to the FEVD analysis, changes in

rer_t explain up to 7 percent of changes in output. Although both government revenues and expenditures are expansionary with respect to output, the impact of the latter seems to be much stronger, with the fraction of g_t in the FEVD of y_t gradually increasing from 4 to 20 percent.



a) real exchange rate (rer_t); b) government revenue (rev_t);

c) government spending (g_t); d) gross domestic product (y_t);

Figure 2. Fiscal policy effects on exchange rates

Although changes in the agricultural raw material prices do not explain a significant portion of the FEVD of the other endogenous variables, nevertheless the impulse response functions imply a potential favourable impact of higher prices upon output, with a simultaneous appreciation of the RER. As the latter effect is also expansionary, it argues in favor of a discreet stabilization policy with fiscal instruments. For the case of a procyclical increase in prices of agricultural raw materials, our study suggests the implementation of government spending cuts, while an increase in the government revenue is recommended for the periods with lower prices. Such options are consistent with proposals by Agenor [2] of not using

cash transfers policy in response to a favourable TOT shock. Similar to other countries (Chile), it is desirable to implement a fiscal policy rule, in the way that accounts for an expansionary impact of both government revenue and spending (it runs counter to a conventional interpretation of fiscal policy with revenue and spending having asymmetric output effects).

Table 4. Forecast error variance decomposition

Impulses	Responses to	Forecast horizons			
		4	8	12	16
Real effective exchange rate (rer_t)	$praw_t$	1	2	2	3
	rer_t	**92**	**91**	**91**	**91**
	rev_t	6	6	6	6
	g_t	0	0	0	0
	y_t	0	0	0	0
Government revenue (rev_t)	$praw_t$	6	6	6	5
	rer_t	**17**	**19**	**20**	**20**
	rev_t	**73**	**71**	**70**	**70**
	g_t	1	1	1	1
	y_t	4	4	4	4
Government spending (g_t)	$praw_t$	9	7	7	6
	rer_t	**13**	**15**	**16**	**18**
	rev_t	**20**	**22**	**23**	**24**
	g_t	**57**	**54**	**52**	**51**
	y_t	2	2	2	2
Output (y_t)	$praw_t$	12	6	4	3
	rer_t	4	5	6	7
	rev_t	5	3	2	2
	g_t	**4**	**13**	**17**	**20**
	y_t	**75**	**72**	**69**	**68**

Note: results for a VAR model with variables in deviations from trend are given in brackets

6. Conclusions

Our results suggest that there is a positive effect of prices of agricultural raw materials on GDP, with both government expenditure and revenue declining in the period of a favourable price shock. However, the analysis of FEVD reveals that the importance of agricultural raw materials prices as a factor behind Ukraine's output and fiscal variables is rather low. As expected, higher agricultural raw materials prices are associated with the RER appreciation, reflecting an increase in the export receipts. On the other hand, the RER depreciation brings about a decrease in the

government expenditure and revenue combined with a strong downward pressure on output. It means that any attempts to achieve more 'competitive' RER are counterproductive in the Ukraine's economy. Also, it is worth noting that agricultural raw materials price and RER shocks are characterized by asymmetrical effects upon output. Among other results, there are positive output effects by both government expenditures and revenues, while the reverse causality suggests a decrease in both fiscal variables following an increase in GDP. For the purpose of stabilization policies, our study suggests implementation of government spending cuts in the case of an increase in the agricultural raw materials prices, while an increase in the government revenue is recommended for the periods of lower prices. Similar to other countries (Chile), it is desirable to implement the fiscal policy rule, in the way that accounts for an expansionary impact of both government revenue and spending.

Obviously, there is much room for further investigation of endogenous fiscal policy rules accounting for commodity price developments, and our results would be a useful tool for that purpose. It would seem important to recognize that volatility of commodity prices can bring about a downward pressure on the long-run growth path. Also, we did not consider the interaction between fiscal and monetary policy stances, as well as effects of large exchange rate devaluations in 2008 and 2014. Finally, structural shifts in the Ukraine's economy require consideration in the context of commodity prices.

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