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Are the twin or triple deficits hypotheses applicable to post-communist countries?

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Hüseyin Şen and Ayşe Kaya

Are the twin or triple deficits hypotheses applicable to post-communist countries?

Abstract

This study empirically examines the validity of the twin and triple deficits hypotheses using bootstrap panel Granger causality analysis and an annual panel data set of six post-communist countries (Russia, Poland, Ukraine, Romania, the Czech Republic, and Hungary) from 1994 to 2012. Our findings, based on panel data analysis under cross-sectional dependence and country-specific heterogeneity, support neither the twin deficits hypothesis nor its extended version, the triple deficits hypothesis, for any of the countries considered. In other words, we find no Granger-causal relationship between budget deficits and trade (or current account) deficits or among budget deficits, private savings-investment deficits, and trade deficits.

JEL codes: E60, F30, F32, H62.
Keywords: macroeconomic policy, fiscal policy, twin deficits, triple deficits, post-communist countries, transition economies, bootstrap panel granger causality test.

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1 Introduction

The twin deficit hypothesis proposes that budget deficits and trade (or current account) deficits of an economy are intertwined. Deterioration in the budget balance results eventually in a corresponding deterioration of the trade (or current account) balance of an economy. Whether in the context of the recent Eurozone crisis or US Congressional wrangling over the debt ceiling, this unresolved postulate is invoked repeatedly in framing macroeconomic policy discussions.

The twin deficits hypothesis gained popularity in the US in the early 1980s at a time when large chronic current account deficits were accompanied by widening US budget deficits. In 1984, Martin Feldstein, during his chairmanship of President Ronald Reagan's Council of Economic Advisers (Frankel, 2006) termed the co-existence and tandem movement of budget deficits and trade (or current account deficits) "twin deficits." According to Feldstein (1992), side-by-side depictions of budget and trade deficits produced an image of inseparable "Siamese twins."

In the US case, the twin deficits hypothesis re-emerges in wide political discussion whenever the US is experiencing worsening trade deficits. Some of this may be ascribed to its populist appeal. As Gregory Mankiw noted in a December 2005 speech during his stint as head of George W. Bush's economics team: "*From the perspective of the Beltway mercantilists, the trade deficit is a huge national problem. They look at the trade deficit simply as lost jobs for Americans*." (Mankiw, 2006: 680). Trade deficits can be problematic for most nations, of course, so it is hardly surprising that the twin-deficits linkage has found its way into macroeconomic policy conversations around the world.

In recent years, a "triple deficits" hypothesis that includes the private savings-investment gap has emerged. Simply put, the triple deficits hypothesis proposes a linkage among government budget balance, savings-investment balance, and foreign trade (or current account) balance of an economy. Accordingly, government budget deficit along with savings-investment deficit (i.e. the economy-wide resource gap) induces trade (or current account) deficits. "Triple deficits" refers to the case where the domestic imbalance (simultaneous budget and private savings-investment deficits) is accompanied by an external imbalance (trade or current account deficits). To the best of our knowledge, Szakolczai (2006) may be credited for introducing the term "triple deficits" into wide use.

The relationship of budget deficits, private savings-investment deficits, and trade (or current account) deficits is a natural topic of interest for academics and policymakers. Understanding possible causal relationships among these variables is a pre-condition for designing robust macroeconomic policies and creating policies that promote macroeconomic stability and economic growth. It is also generally accepted that large and persistent deficits threaten macroeconomic stability and growth. Indeed, as the experiences of many countries

have shown, large and persistent budget deficits cause serious problems for future generations by leaving them with a repayment burden. Similarly, large and persistent budget and trade deficits are problematic for countries when they drain their currency reserves, cause them to take on excessive debt, or set the stage for an economic crisis.

Perhaps the largest perceived threat of dual budget and trade (or current account) deficits, however, is their ability to induce macroeconomic imbalances that damage the long-run economic development trend of a country. This concern was prominent among policy-makers in European transition economies two decades ago, when their countries faced huge initial distortions and there was great potential to run sizable trade and budget deficits for many years.

In the following analysis, we consider the validity of the twin deficits hypothesis and its cousin the triple deficits hypothesis in the context of six European transition economies (Russia, Poland, Ukraine, Romania, the Czech Republic, and Hungary). To the best of our knowledge, this is the first analysis attempting to examine the double and triple deficits hypotheses for these transition economies. We also employ bootstrap panel Granger causality analysis, a recent technique proposed by Kónya (2006) that allows for simultaneous analysis of Granger causality between two or three variables. The bootstrap panel Granger causality approach is based on a seemingly unrelated regression (SUR) estimation that considers cross-sectional dependence across countries. In practice, it means we can test Granger causality for each country by taking into account the possible contemporaneous correlation across countries. The approach is also based on a Wald test with country-specific bootstrap critical values, so it does not require a joint hypothesis for all members of the panel.

The rest of the study is divided into four parts. Section 2 briefly outlines the macroeconomic developments of the countries in our sample. Section 3 introduces the theoretical motivation and previous empirical findings on the twin and triple deficits hypotheses. Section 4 describes the data set, variables and methodology of the study, while Section 5 reports empirical results and discussion. Section 6 presents concluding remarks.

2 Macroeconomic backgrounds of six post-communist countries

In the aftermath of the collapse of the Soviet Union, a number of formerly socialist countries embarked on the long and painful transition process to market-based economies similar to their Western counterparts. The speed of the transition process has varied considerably across our six sample transition countries. In Poland and Russia, the process was quite rapid, and nearly as fast in Czechoslovakia. Hungary, a relatively more liberalized country, had less need for rapid change, so progress was slower. Romania and Ukraine faced resistance to reforms from pressure and interest groups. Nevertheless, all of these countries eventually

implemented reforms, ranging from macroeconomic stabilization to designing new market institutions and establishing new legal infrastructures. The core of reforms to increase efficiency and stimulate growth comprised macroeconomic stabilization, price and foreign trade liberalization, restructuring and privatizing state owned enterprises, and fundamental redefinition of the state's role (IMF, 2000).

During the first decade of transition, most countries struggled with high inflation and recession, which were to some extent side effects of price liberalization and the sudden collapse of economic linkages. Output fell dramatically in nearly all Eastern European transition countries. At the same time, the lifting price controls and liberalization of trade left industrial firms, in particular, facing serious liquidity problems and falling demand. In addition to poor economic performance, transition countries neglected critical reform areas such as governance, restructuring and privatizing state-owned enterprises, setting up open labor markets, and developing viable competition policies. Some of the political timidity in moving ahead with institution-building reflected opposition pressure and interest groups that rightfully or not feared change.

In any case, virtually all Eastern European countries performed poorly in their first decade of transition. Policies tended to focus on the low-hanging fruit of industrial growth revival, rather than the harder-to-reach challenge of correcting macroeconomic imbalances. Thus, monetary and fiscal policies in these countries created large demand for inadequate goods and services. With persistent excess demand, these countries encountered serious macroeconomic problems, including output gaps, unsustainable external debt, and high inflation.

Given the lack of monetary policy tools, transition countries initially adopted pegged exchange rate regimes. As time went on, they migrated to intermediate exchange rate regimes and eventually managed floats that recognized the potential destabilizing effects of international capital inflows and minimized negative effects on exports. In the initial one or two years of transition, all of our sample countries adopted conventional fixed pegs. In subsequent years, they migrated to export-oriented exchange rate regimes, such as crawling pegs, crawling bands or managed floats without pre-announced exchange rate trajectories. Although none of these arrangements provides a stable exchange rate regime, our four sample countries that joined the EU (Hungary, Poland, Romania, and the Czech Republic) all eventually adopted independent floating regimes. Russia, in contrast, employed a managed float throughout most of the observation period. Ukraine has tried several exchange rate regimes, including fixed peg and independent float.

Russia's 1998 financial crisis negatively affected all our sample countries, most notably in the form of a collapse in Russian imports. Ukraine was hit hardest, due to its close trade ties with Russia. All sample countries devalued their currencies or abandoned their existing exchange rate regime following large ruble devaluations and all experienced subsequent declines in growth.

Transition countries as a rule demonstrated much better performance in their second decade of transition. Having achieved a modicum of macroeconomic stability, they started to attract foreign capital. The EU aspirants closed the convergence gap with the EU-12 countries.

In particular, Poland, Hungary and the Czech Republic, which enjoy geographic proximity to Western European markets, benefited from investment and trade opportunities even in earliest phases of transition. UNECE (2001) reports that the share of FDI within GDP in the Czech Republic rose to 9.3 percent in 2000 from 1.9 percent in 19901992. The other sample countries, with the exception of Russia and Ukraine, also saw strong FDI inflows. In contrast, the FDI-to-GDP ratio remained relatively low for Russia and Ukraine in the first decade of transition. This ratio only increased from 0.5 percent to 1.2 percent in Russia's case, and 0.8 percent to 1.8 percent in Ukraine's. A positive trend, however, prevails throughout the rest of the sample period. Financial sector liberalization seems to have played a significant role in easing access to capital and facilitating a credit boom. A large share of external capital came to an extent in the form of FDI or cross-border bank flows (IMF, 2014).

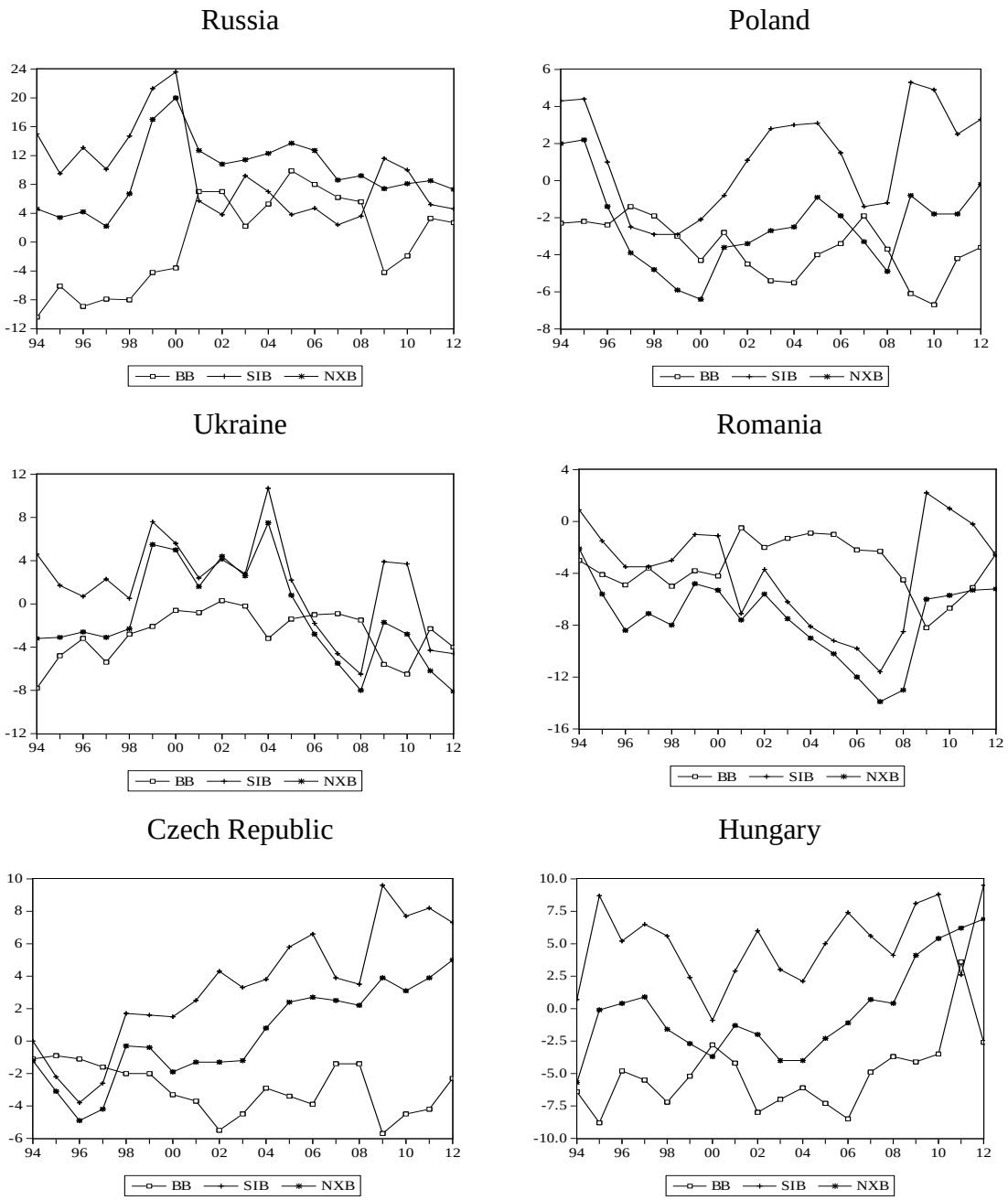
The four countries that joined the EU all experienced large and persistent external deficits. Figure 1 summarizes some key economic variables in these countries. It depicts budget balance (BD), private savings-investment balance (SIB), and trade balance (NXB) as a percentage of GDP for our six post-communist countries. Notably, Russia's budget balance and trade balance moves counter to the trends of the other countries throughout the observation period (with exceptions of 2005 and 2007). Based on visual inspection, it may be said that there were no co-movements between the two balances for the sample period. Accordingly, the budget balance trends up as the trade balance trends down and vice versa. With the exception of Russia and Romania for a couple years, this holds true for all our sample countries for the entire observation period. In Russia's case, however, the budget balance and trade balance show parallel trends only in 2005 and 2007, whereas for Romania the parallel trends in the two balances are rare. A glance at Figure 1 suggests that there were no parallel movements in the budget and trade balances, evidence that argues against the validity of the twin deficits hypothesis.

Considering budget, private savings-investment, and trade balances as a whole, we still find no parallel movements among them. Figure 1 generally gives no clear picture with regard to linkages of budget, private savings-investment or trade balances that supports the validity of the triple deficits hypothesis.

During the early stages of the transition, virtually all the countries received substantial financial and technical assistance from the IMF and World Bank. Hungary, Romania, Poland, and the Czech Republic also received substantial support from the EU as part of the accession process. Indeed, EU financial and technical support (often provided via the EBRD,

ECB, and EIB) played a crucial role in reforming these countries. IMF estimates show that in the first three years of the EU membership, financial inflows from the other members increased from below 1 percent of GDP on average to almost 2.5 percent of GDP on the provision of structural funds, agricultural support, and other subsidies (IMF, 2014: 40).

Figure 1 Budget balance (BB), private savings-investment balance (SIB), and trade balance (NXB).



Source: World Bank World Development Indicators Database, IMF Staff Country Reports, UN National Accounts Main Aggregates Database and Our Own Calculations.

Although these new EU members posted varied macroeconomic performances over their first two decades of transition (due e.g. to different initial conditions, policies during transition, and impacts of global crises), they all successfully completed their transition processes (IMF, 2014). All faced high budget and trade deficits, high external debt, and sharp output declines along the way.

3 Theoretical and empirical backgrounds to the study

3.1 Theoretical background

The literature offers two explanations of the twin deficits hypothesis. The Keynesian view, sometimes characterized as the "conventional" approach to twin deficits, argues that a worsening budget balance fuels a worsening trade (or current account) balance. The Ricardian view, in contrast, sees no systematic association between budget and trade (or current account) balances.[1]

The twin deficits hypothesis implies a close relationship between budget deficits and trade (or current account) deficits in an economy. Even as discussion continues as to whether the twin deficits hypothesis is even valid, the past decade has witnessed the rollout of a "triple deficits" hypothesis. This new hypothesis claims a linkage of government budget balance, private savings-investment balance, and trade (current account) balance. Under the Keynesian approach, an increase in the government budget deficit increases interest rates because domestic funds are insufficient to cover profitable investment opportunities and government borrowing. With the attraction of foreign capital inflows, the domestic currency appreciates, putting domestic goods at a competitive disadvantage against foreign goods and driving the current account balance into deficit.

This view has spawned two corollaries: the "Keynesian income-spending" and "Feldstein chain" approaches. The Keynesian income-spending approach takes the simple Keynesian model of the national income and establishes a direct link between budget deficits and trade (or current account) deficits. The Feldstein chain approach proposes an indirect association between budget deficits and external deficits, whereby, under the assumption of an open economy with flexible exchange rate regime and free movements of capital, budget deficits put an upward pressure on domestic interest rates through the deficit financing mechanism. An increase in interest rates attracts foreign capital to the home country, creating a net inflow of foreign capital. Appreciation in the domestic currency, in turn, hurts the international competitiveness of the home country by making its goods and services more costly

[1] Ricardian view refers to the Ricardian equivalence hypothesis, developed for our purposes in the seminal works of Barro (1974, 1989). This view sometimes referred to in the literature as the "neo-classical" view.

than imported goods and services. Thus, increased budget deficits eventually result in increased trade (or current account) deficits. In stylized form, the Feldstein chain could be describe as: Budget deficit $\uparrow\rightarrow$ Government's deficit financing requirement $\uparrow\rightarrow$ Domestic interest rates $\uparrow\rightarrow$ Foreign capital inflows $\uparrow\rightarrow$ Real value of domestic currency against foreign currencies (appreciation in exchange rate) $\uparrow\rightarrow$ X$\downarrow$M$\uparrow$ $\rightarrow$NX$\downarrow$.[2]

The Ricardian approach, in contrast, asserts that increased budget deficits (regardless of whether they stem from tax cuts, higher spending or both) cause forward-looking economic agents to increase their savings in anticipation that the government will increase taxes in the future to meet rising deficits and pay off accumulated debt. These economic agents respond to budget deficits by accumulating wealth further rather than increasing their spending. Thus, a reduction in public savings (i.e. increase in budget deficits) is balanced by a corresponding increase in private savings. As a result, the trade (or current account) deficit does not respond to changes in budget deficits.[3]

The simple Keynesian model of the national income identity for an open economy is the starting point of our theoretical analysis of the twin and triple deficits hypotheses. For an open economy, GDP for the period "t" is expressed as follows:[4]

$$GDP = C + I + G + X - M \quad (1)$$

Where

GDP : Gross domestic product

C : Consumption

I : Investment

G : Government spending

X –M : Net export (NX)

Equation (1) represents the national income from the perspective of total expenditure. National income can also be expressed in terms of total income as in Equation (2). By definition, nations dispose of their income (GDP) for the period "t" as consumption (C), savings (S), or taxes (T). Accordingly,

$$GDP = C + S + T \quad (2)$$

As total expenditure in the economy equals total income, we obtain Equation (3).

[2] $\uparrow$, $\downarrow$, and $\rightarrow$ stand for increase, decrease, and represent causal direction, respectively. Additionally, where, by turns, "X", "M", and "NX" represent export, import, and net export.
[3] See Barro (1974, 1989) for details.
[4] See Bernheim (1988), Vamvoukas (1997), and Fidrmuc (2003) for similar derivations.

$$C + I + G + X - M = C + S + T \quad (3)$$

After cancelling out "C" and making necessary arrangements in Equation (3), we obtain Equation (4).

$$(T - G) + (S - I) = (X - M) \quad (4)$$

Breaking down total savings in an economy (S) into private (Sp) and government (Sg) savings yields Equation (5).

$$(T - G) + (Sp + Sg - I) = NX \quad (5)$$

Since private savings are the part of disposable income saved rather than consumed, we obtain Equation (6).

$$Sp = GDP - T - C \quad (6)$$

On the other hand, government savings are equal to the difference between government revenues and government expenditures, such that:

$$Sg = T - G \quad (7)$$

Using the decomposed forms of Sp and Sg [Equations (5) and (6)] and then substituting into Equation (5), we re-write Equation (5) in the following form:

$$(T - G) + (GDP - T - C) + (T - G) - I) = NX \quad (8)$$

After making necessary arrangements in Equation (8), we obtain Equations (9) and (10).

$$(T - G) + (GDP - C - G) - I = NX \quad (9)$$

$$(T - G) + (Sp - I) = NX \quad (10)$$

Equation (10) indicates that the trade balance (NX) equals the sum of the government budget balance (T-G) and of the excess of private savings over domestic investment (Sp – I). Equation (10) implies that if private savings roughly equals domestic investment ($Sp \cong I$)[5], the budget balance of an economy is equal to its trade balance.[6] This means (at least arithmetically) that budget balance moves together with trade (or current account) balance in same

[5] This also implies that domestic investment is financed entirely by private savings.
[6] Obviously, Equation [10] could also be written in terms of current account balance. By definition, the national income identity can be expressed in terms of the gross national product as follows: GNP = C + I + G + X – M + NFI,

direction by about the same amount, and thereby we can imply that the two balances are twinned or directly interrelated. In this case, a deterioration of budget balance leads to deterioration in the trade (or current account) balance. If private savings do not equal the investment balance, i.e. the shortfall of domestic saving as compared with domestic investments (Sp < I) and budget balance is negative (T < G), we are faced with triple deficits, where the sum of the two domestic deficits is equal to the trade deficit. From the policy perspective, this implies that if budget deficits exist along with a private savings-investment gap, triple deficits are unavoidable.

Equation (10) by itself says nothing about the causes and interconnections of the deficits. The commonly accepted view is that budget deficits are the fundamental cause of twin or triple deficits and that the cure is to reduce budget deficits [see e.g. Feldstein (1992), Ahmed and Ansari (1994), Khalid and Guan (1999), IMF (2011), Tang (2014)]. Here, twin or triple deficits are seen as a consequence of government overspending and all three deficits should cease to exist when the government cuts spending.

3.2 Empirical background

To our knowledge, Milne (1977) produced the earliest study of the relationship between fiscal deficits and trade deficits. Examining 38 countries, she concludes that fiscal deficits are an important factor in determining trade deficits. Several subsequent studies, including Bernheim (1988), Miller and Russek (1989), Abell (1990), and Latif-Zaman and DaCosta (1990), concentrated exclusively on the US in examining the validity of the twin deficits hypothesis. The empirical findings of these studies generated results in favor of the validity of the twin deficits hypothesis.

In 1990, notably a time of recession, work on the twin deficit hypothesis again expanded to other countries. This new wave of studies even considered the validity of the hypothesis for country groups (e.g. OECD and the EU). Studies deserving mention include Ahmed and Ansari (1994) for Canada, Magazzino (2012) for Italy, Bostancı and Tunç (2002) and Kıran (2011) for Turkey, Kim and Kim (2006) for South Korea, Baharumshah and Lau (2007) for Thailand, Sobrino (2013) for Peru, Mudassar et al. (2013) for Pakistan, Marinheiro (2008) and El-Baz (2014) for Egypt, Ogbonna (2014) for South Africa, Salvatore (2006) for the G-7 countries, Baharumshah et al. (2006) for the ASEAN-4 countries, Afonso et al. (2013) and Trachanas and Katrakilidis (2013) for five EU countries, and Xie and Chen (2014) for OECD countries.[7]

where NFI stands for net factor incomes from abroad. Substituting GNP for GDP, and following the same process from Equation [1] to Equation [10], the sum of last two items, (X –M) plus NFI, gives the current account balance. Here, the equation takes the form (T – G) + (Sp – I) = CAB.

[7] Details of all these studies are reported in Appendix A.

The empirical findings of the studies are mixed on support for the twin deficits hypothesis. Studies confirming the validity of the hypothesis include Rosensweig and Tallman (1993), Ahmed and Ansari (1994) for Canada, Bostancı and Tunç (2002) for Turkey, Baharumshah and Lau (2007) for Thailand, Holmes (2010) for the US, and Vamvoukas (2010) for Greece. Studies finding no supporting evidence include Dewald and Ulan (1990) and Rahman and Mishra (1992) for the US, Kaufmann et al. (2002) for Austria, Abbas et al. (2010) for 124 countries, Kıran (2011) for Turkey, Sobrino (2013) for Peru, Ogbonna (2014) for South Africa. Overall, about all that can be said is that these studies point to a very weak link or no linkage at all between budget deficits and trade (or current account) deficits, supporting our proposition based on the Ricardian equivalence hypothesis.

Notably, a few studies, including Kim and Kim (2006), Magazzino (2012), Mudassar et al. (2013) for Pakistan, El-Baz (2014) for Egypt, find a reverse relationship between government budget deficits and the trade (or current account) balance. This suggests a unidirectional causality running from trade or current account deficits to budget deficits. Most studies reveal short-run, rather than long-run, relationship.

Some studies indicate bi-directional causality. For example, the studies of Anoruo and Ramchander (1998) for five Asian countries, Islam (1998) for Brazil, Baharumshah et al. (2006) for Malaysia and the Philippines, Lau et al. (2010) for the Philippines, Kalou and Paleologou (2012) for Greece, Asrafuzzaman et al. (2013) for Bangladesh, and Xie and Chen (2014) for eleven OECD countries find bi-directional Granger causality between budget deficits and trade (or current account) deficits, especially over the short run.

Other studies find highly disparate results that change according to the statistical techniques used, the length and timing of the observation period, as well as country-specific features. For instance, Miller and Russek (1989) find different results for the same sample countries, whereas Khalid and Guan (1999) assert that the twin deficits hypothesis is only valid for developing countries. Ratha (2012) argues that, while the Keynesian proposition holds in the short run, the Ricardian equivalence proposition is present in the long run. A relatively recent study by Eldemerdash et al. (2014) found different results for Arab countries that produce oil and those that do not. Their findings suggest a positive relationship between fiscal and external balances for oil-producing countries, but no similar relationship between two non-oil countries.

Among the most interesting of all the studies here is that of Kim and Roubini (2008), who argue that in the case of the US, cuts in budget deficits increase current account deficits, resulting in *twin divergences*. In other words, budget deficit shocks in the US case tend to improve the current account and depreciate the real exchange rate in the short run.

Perhaps due to a lack of data, academic economists and other researchers have neglected the twin deficits hypothesis in case of the post-communist countries. Indeed, there are only a handful of studies analyzing the twin deficits hypothesis for these countries. To

our knowledge, with the exception of a few single-country studies, the big-picture works are limited to the studies of Fidrmuc (2003), Gurgul and Lach (2012), Aristovnik and Djurić (2013), Tosun et al. (2014), and Gabrisch (2015). In all cases except Fidrmuc (2003), these studies yield results that favor the Ricardian view.

As for the triple deficits hypothesis, the existing literature in this matter is indeed scarce. To our knowledge, the relevant studies are Szakolczai (2006), Akıncı and Yılmaz (2012), Şen et al. (2014), and Tang (2014). All offer evidence favoring the validity of the triple deficits hypothesis, but all are also single-country studies.[8] Moreover, the study of Szakolczai (2006) is not empirical.

To sum up, many studies have attempted to establish a nexus between the budget balance and the trade (or current account) balance, but no clear consensus has emerged. While some studies such as Latif-Zaman and DaCosta (1990), Baharumshah and Lau (2007), and Xie and Chen (2014) assert that budget deficits and current account deficits are "twins", "identical twins", or even "reverse twins" [Anoruo and Ramchander (1998), Kim and Kim (2006), El-Baz (2014)], others such as Enders and Lee (1990), and Kim and Roubini (2008), find they less twins than distant cousins. Some even claim they were "separated at birth" [IMF (2011)].

Despite a vast number of studies attempting to test the validity of the twin deficits hypothesis for advanced and developing countries, the empirical findings have produced no clear-cut results. Hence, further empirical studies focusing on different economies with modern econometric techniques, as in the case of this study, may help in better understanding the nature and underlying mechanisms of the twin and triple deficits issue.

4 Data set, variables, and methodology

4.1 Data set and variables

We employ annual data on budget balance, private savings-investment balance, and trade balance to construct our three variables used in bootstrap panel Granger causality analysis. Our data set is restricted by the availability of comparable data, especially at the onset of transition; we limit the scope of our data to the period 1994 to 2012 and six of the larger post-communist economies (Russia, Poland, Ukraine, Romania, the Czech Republic, and Hungary).

All the data related to the variables have been directly taken from the relevant sources in proportion to GDP. The data on budget balance (cash surplus/deficit basis and at general government level) are taken from the World Bank World Development Indicators Database. The data for Poland and Russia 1994–2000, Ukraine 1994–1998, Romania 1994–2001, and Hungary 1994 are extracted from the respective IMF country reports. As can be

[8] See Appendix A for details.

seen in column 1 of the Table 1 below, most of our sample countries ran sizable budget deficits during the observation period.

Table 1 Descriptive statistics for variables of six post-communist countries, 1994–2012

Country	Budget balance to GDP		Private savings-investment balance to GDP		Trade balance to GDP	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Russia	0.11	6.42	9.41	5.84	9.52	4.48
Poland	–3.64	1.47	1.23	2.71	–2.41	2.27
Ukraine	–2.83	2.25	1.63	4.32	–1.15	4.43
Romania	–3.47	1.99	–4.02	3.96	–7.49	2.96
Czech Republic	–2.92	1.49	3.28	3.65	0.36	2.78
Hungary	–5.09	2.74	4.50	2.82	–0.19	3.49

Sources: The World Bank and IMF data for budget balance, data from UN and own calculations for private savings-investment balance, and the World Bank for trade balance.

The data on trade balance, which refers to the difference between exports and imports of goods and services, are also obtained from the World Development Indicators Database of the World Bank. To obtain trade balance as a percentage of GDP, we deduct the imports-of-goods-and-services-to-GDP from exports-of-goods-and-services-to-GDP. Again, as seen in column 3 of Table 1, most countries under consideration ran trade deficits during the observation period.

To construct data series on private savings-investment balance, we draw on the UN National Accounts Main Aggregates Database to obtain data on both domestic savings and gross capital formation (a proxy for gross domestic investment). We proxy government savings by government general budget balance on a cash surplus/deficit basis and deducted government savings from the figures for total domestic savings obtained from above UN sources to arrive at our private savings figure. The balance of private savings over gross domestic investment describes private savings-investment balance.

4.2 Methodology: bootstrap panel Granger causality test

There are three commonly used approaches for testing the direction of Granger causality in panel data. The first approach is based on estimating a panel vector error correction model by means of a generalized method of moments (GMM) estimator that estimates a panel model by eliminating the fixed effect. This approach does not account for heterogeneity or cross-sectional dependence. The second approach, proposed by Hurlin (2008), is a panel data causality test that allows for slope heterogeneity. This approach does not take into account

cross-sectional dependence, which, if it exists, creates substantial biases and size distortions. The third approach, proposed by Kónya (2006), allows both heterogeneity and cross-sectional dependence to be taken into account.

This study employs the approach proposed by Konya (2006), which has three advantages over the first two approaches. First, this approach is based on a SUR estimation that allows us take into account cross-sectional dependence across countries. Second, it does not require the joint hypothesis for all members of the panel because it is based on a Wald test with country-specific bootstrap critical values. Finally, it requires no pre-testing for panel unit roots or co-integrating relationships. A general drawback of the unit root test is its low testing power, which can lead to incorrect judgments with regard to co-integrating relationships.

Here, we take into account the possible existence of direct relationship between budget deficits and trade deficits, and/or among budget deficits, private savings-investment deficits, and trade deficits. For this purpose, we employ the bootstrap Granger causality approach developed by Kónya (2006), based on bi-variate [budget balance (BB) and private savings-investment balance (SIB)] and tri-variate [(BB), (SIB), and trade balance (NXB)] finite-order vector autoregressive models. In our opinion, the bootstrap panel causality approach is superior to the first two techniques mentioned above in terms of accounting for cross-sectional dependency and country-specific heterogeneity. In detecting Granger causal relationships, the bootstrap panel causality approach is based on seemingly unrelated regressions (SUR) estimation of the set of equations and Wald statistics with country-specific bootstrap critical values. Notably, Kónya (2006) indicated that this approach does not require any pre-testing for the panel unit root and cointegration. Since country-specific bootstrap critical values are used, the model variables need not be stationary. The variables can be used in level form regardless of their unit root and cointegration properties.

The panel causality approach of Kónya (2006) can be formulated for the twin and triple deficits hypotheses as follows:

$$NXB_{1t} = \alpha_{11} + \sum_{l=1}^{p_1} \beta_{11l} NXB_{1t-l} + \sum_{l=1}^{p_1} \delta_{11l} BB_{1t-l} + \sum_{l=1}^{p_1} \varphi_{11l} SIB_{1t-l} + \varepsilon_{11t}$$

$$\vdots\ NXB_{Nt} = \alpha_{1N} + \sum_{l=1}^{p_1} \beta_{1Nl} NXB_{Nt-l} + \sum_{l=1}^{p_1} \delta_{1Nl} BB_{Nt-1} + \sum_{l=1}^{p_1} \varphi_{1Nl} SIB_{Nt-l} + \varepsilon_{1Nt} \quad (1)$$

$$BB_{1t} = \alpha_{21} + \sum_{l=1}^{p_2} \beta_{21l} NXB_{1t-l} + \sum_{l=1}^{p_2} \delta_{21l} BB_{1t-l} + \sum_{l=1}^{p_2} \varphi_{21l} SIB_{1t-l} + \varepsilon_{21t}$$

$$\vdots\ BB_{Nt} = \alpha_{2N} + \sum_{l=1}^{p_2} \beta_{2Nl} NXB_{Nt-l} + \sum_{l=1}^{p_2} \delta_{2Nl} BB_{Nt-l} + \sum_{l=1}^{p_2} \varphi_{2Nl} SIB_{Nt-l} + \varepsilon_{2Nt} \quad (2)$$

$$SIB_{1t} = \alpha_{31} + \sum_{l=1}^{p_3} \beta_{31l} NXB_{1t-l} + \sum_{l=1}^{p_3} \delta_{31l}\, BB_{1t-l} + \sum_{l=1}^{p_3} \varphi_{31l} SIB_{1t-l} + \varepsilon_{31t}$$

$$\vdots\ SIB_{Nt} = \alpha_{3N} + \sum_{l=1}^{p_3} \beta_{3Nl} NXB_{Nt-l} + \sum_{l=1}^{p_3} \delta_{3Nl}\, BB_{Nt-l} + \sum_{l=1}^{p_3} \varphi_{3Nl} SIB_{Nt-l} + \varepsilon_{3Nt}\ , \qquad (3)$$

where NXB, BB, and SIB denote trade balance, budget balance, and private savings-investment balance, respectively. N is the number of countries of panel (I = 1, 2, 3,…, N), t is the time period (t = 1, 2, 3, …, T), and "l" is the lag length. The error terms, ε_{1Nt}, ε_{2Nt} and ε_{3Nt}, are supposed to be white-noises (i.e. they have zero means, constant variances and are individually serially uncorrelated) and may be correlated with each other for a given country.

We assume that NXB, BB and SIB are stationary or cointegrated so, depending on the time-series properties of the data, they may denote the level, first difference or some higher difference. To test for the panel Granger causality in this system, alternative causal relations for a country are likely to be found. For example, there is one-way Granger causality from BB to NXB if not all $\delta_{1,I}$ are zero, but all $\beta_{2,I}$ are zero; there is one-way Granger causality from NXB to BB if all $\delta_{1,I}$ are zero, but not all $\beta_{2,I}$ are zero; there is two-way Granger causality between BB and NXB if neither $\delta_{1,I}$ nor $\beta_{2,I}$ is zero; there is no Granger causality between BB and NXB if all $\delta_{1,I}$ and $\beta_{2,I}$ are zero. This definition can easily be extended to causal relations among budget balance, private savings-investment balance, and trade balance. To determine the direction of causality, the Wald statistics for Granger causality are compared with country-specific critical values obtained from the bootstrap sampling procedure.

As the results from our Granger causality test may be sensitive to lag structure, determining optimal lag length(s) is crucial as to the robustness of the findings. To determine optimal lag structure, we follow Kónya's approach, whereby maximal lags are allowed to vary across variables, but remain the same across equations. We estimate the system for each possible trinity of $p_1p_1p_1$, $p_2p_2p_2$ and $p_3p_3p_3$ by assuming from one to four lags, and then choose the combinations which minimize the Akaike Information Criterion (AIC) and Schwartz Information Criterion (SIC).

5 Empirical results and discussion

Taking into account cross-sectional dependence and country-specific heterogeneity in empirical analyses is essential as our sample countries are highly integrated and highly globalized in their economic relations. If cross-sectional dependency does exist, the use of the seemingly unrelated regressions (SUR) approach should be more efficient than an ordinary

least-squares (OLS) approach in estimating panel data causality. Moreover, the causality results obtained from the SUR estimator developed by Zellner (1962) should be more reliable than those obtained from county-specific OLS estimations. The Monte Carlo experiment by Pesaran (2006) emphasizes the importance of testing for the cross-sectional dependence in a panel data study. It also illustrates the substantial bias and size distortions that arise when cross-sectional dependence is ignored.

A further issue to decide is whether to treat slope coefficients as homogenous to impose the causality restriction on the estimated parameters. The causality from one variable to another variable by imposing the joint restriction for the panel is the strong null hypothesis and the homogeneity assumption for the parameters is unable to capture heterogeneity due to country-specific characteristics.

Thus, we start our empirical analysis with testing for cross-sectional dependency, followed by slope homogeneity across countries. We then select the appropriate panel causality method for determining the direction of causality between budget balance, private savings-investment balance, and trade balance in our six post-communist countries.

To investigate the existence of cross-sectional dependence, we implement four tests: the LM, CD_{lm}, CD and LM_{adj} tests.[9] The test results are presented below in Table 2. As shown from the table, the null hypothesis of no cross-sectional dependence across the countries is strongly rejected at 1% level of significance, implying that the SUR method is more appropriate than country-by-country OLS estimation. The findings in Table 2 indicate that a shock in one sample country is transmitted to the other countries under consideration. The same table also reports the results of two slope homogeneity tests ($\tilde{\Delta}$, $\tilde{\Delta}_{adj}$).[10] The test findings of both tests reject the null hypothesis of slope homogeneity for each group of countries, thus supporting country-specific heterogeneity. The rejection of slope homogeneity implies that the panel causality analysis imposing homogeneity restriction on the variable of interest results in misleading inferences.

[9] See Appendix B for a detailed description of the cross-sectional dependence tests.
[10] See Appendix B for details of the slope homogeneity tests.

Table 2 Cross-sectional dependence and homogeneous tests for six post-communist countries

	Statistic	p-value
LM	33.8000*	0.000
CD_{LM}	14.242*	0.000
CD	7.326*	0.000
LM_{adj}	4.931*	0.000
$\tilde{\Delta}$	4.355*	0.000
$\tilde{\Delta}_{adj}$	2.103*	0.000

Note: (*) indicates rejection of the null hypothesis at 1% level of significance. The data covers the whole sample period from 1994 to 2012.
Source: Authors' calculations

The existence of cross-sectional dependence and heterogeneity across countries supports the suitability of the bootstrap panel causality approach. The results from bootstrap panel Granger causality analysis are presented in Tables 3 and 4.[11,12]

The results reported in Table 3 suggest that there exists a significant, but negative, Granger causality running from budget deficits to trade deficits at 10% level of significance only for Poland and Romania. We do not find any significant relationship from budget deficit to trade deficit for Russia, Ukraine, the Czech Republic or Hungary.

On the other hand, Table 3 indicates that there is a significant and positive Granger causality running from trade deficit to budget deficit at 10% level of significance for three countries (Russia, Romania, and Hungary).

The possible explanation of these findings might be that widening trade deficits may have decreased aggregate demand in these countries, resulting in a reduction in output and an increase in unemployment. To overcome this issue, their governments may have attempted to boost their economies through expansionary fiscal and monetary policies such as allowing budget deficits, increasing reliance on foreign borrowing, or injecting money into the economy to eliminate the loss of exports. Thus, these trade deficits may reflect budget deficits financed by foreign borrowing.

Overall, the empirical findings reject the twin deficits hypothesis for all six post-communist countries. However, we find reverse causality, i.e. that trade deficits Granger-cause budget deficits, for Russia, Romania, and Hungary.

[11] See Kónya (2006) for the bootstrap procedure on how the country-specific critical values are generated.
[12] See Appendix C for more results.

Table 3 Panel Granger causality between budget balance (BB) and trade balance (NXB)

Country	Estimated coefficient	Wald test	Bootstrap critical values			Granger causality
			10%	**5%**	**1%**	Yes/No
			H_0 : Budget deficits do not cause trade deficits			
Russia	–0.01338	0.42347	7.47146	10.48650	18.09132	No
Poland	**–0.40196**	**8.43258*** **	**6.15855**	**10.14831**	**19.55460**	**Yes**
Ukraine	0.23545	0.97061	6.65941	9.95018	16.42223	No
Romania	**–0.92404**	**20.20951*** **	**7.25294**	**11.68645**	**22.02894**	**Yes**
Czech Republic	–0.13205	0.42753	6.50894	9.31977	18.09772	No
Hungary	0.15658	1.90532	5.93777	9.32404	17.52335	No
			H_0 : Trade deficits do not cause budget deficits			
Russia	**0.76100**	**11.36284*** **	**6.98460**	**10.02295**	**17.03960**	**Yes**
Poland	0.17234	3.26816	7.34377	10.49350	20.58291	No
Ukraine	0.21855	6.33932	6.90682	9.83193	21.95872	No
Romania	**0.16497**	**6.87736*** **	**6.84733**	**10.70928**	**16.54435**	**Yes**
Czech Republic	–0.023962	0.35011	7.60660	11.41818	20.16391	No
Hungary	**0.63851**	**9.06185*** **	**7.46853**	**10.96797**	**18.97539**	**Yes**

Note: The data covers the whole sample period from 1994 to 2012. (***) indicates statistical significance at 10%.
Source: Authors' calculations

The results of our tri-variate model where NXB is the independent variable, BB and SIB are the dependent variables are reported in Table 4. As the table shows, the bootstrap critical values considerably higher than the chi-square critical values usually applied with the Wald test, and that they vary considerably from country to country. The Granger causality test results for the null hypothesis show that BB and SIB do not Granger cause NXB as indicated in the Wald test column of Table 4. In other words, the null hypothesis of non-causality is accepted for all the countries under consideration. We do not find empirical support for the validity of triple deficits hypothesis for these countries.

Table 4 Panel Granger causality from budget balance (BB) and private savings-investment balance (SIB) to trade balance (NXB)

Country	Estimated coefficient	Wald test	Bootstrap critical values			Granger causality
			10%	**5%**	**1%**	
H_0 : Budget deficits and savings-investment deficits do not cause trade deficits						Yes/No
Russia	–17.78857	0.81986	9.40823	16.11821	54.14434	No
Poland	93.97035	3.83792	6.48852	8.13023	12.97103	No
Ukraine	14.07559	4.66484	8.36666	10.91874	18.57224	No
Romania	225.71975	3.48975	11.06174	13.79216	23.27718	No
Czech Republic	–24.59393	0.10745	7.73098	9.13379	17.55371	No
Hungary	–160.52930	4.81681	5.23574	8.89057	20.13321	No

Note: The data cover the whole sample period from 1994 to 2012.
Source: Authors' calculations

Overall, Table 5 summarizes our results of the direction of panel Granger causality among the three variables for all the countries examined. As can be seen from the table, the empirical results do not support the validity of the twin or triple deficits hypotheses for any of our sample countries. Specifically, their budget deficits do not Granger-cause trade deficits and the existence of dual domestic deficits (budget plus savings-investment deficits) does not lead to external deficits.

Table 5 Direction of panel Granger causality for post-communist countries

Possible direction of Granger causality	**Country**	**Granger causality exists**	
BB ⟶ NXB	Poland and Romania	Yes	*Significant and negative*
	Russia, Ukraine, Czech Republic, and Hungary	No	*Insignificant*
NXB ⟶ BB	Russia, Romania, and Hungary	Yes	*Significant and positive*
	Poland, Ukraine, and Czech Republic	No	*Insignificant*
BB ⟶ SIB	Poland and Romania	Yes	*Significant and negative*
	Russia, Ukraine, Czech Republic, and Hungary	No	*Insignificant*
SIB ⟶ BB	Russia, Ukraine, and Hungary	Yes	*Significant and positive*
	Poland, Romania, and Czech Republic	No	*Insignificant*
SIB ⟶ NXB	Poland and Romania	Yes	*Significant and positive*
	Russia, Ukraine, Czech Republic, and Hungary	No	*Insignificant*
NXB ⟶ SIB	Poland and Romania	Yes	*Significant and negative*
	Russia, Ukraine, Czech Republic, and Hungary	No	*Insignificant*
BB, SIB ⟶ NXB	Russia, Poland, Ukraine, Romania, Czech Republic, and Hungary	No	*Insignificant*

Notes: BB, SIB, NX denote budget balance, private savings-investment balance, and trade balance, respectively.
"⟶" represents Granger causal direction.
Source: Authors' summary

6 Concluding remarks

In this study, we tested for evidence of the twin and triple deficits hypotheses in six post-communist countries (Russia, Poland, Ukraine, Romania, the Czech Republic, and Hungary) over the period 1994–2012. We first examined the existence of possible Granger causalities between budget and trade balance, and then tri-variate Granger causalities among the budget balance, private savings-investment balance, and trade balance. Our analysis was based on the bootstrap panel Granger causality technique, which allows us to capture cross-sectional dependence and heterogeneity across countries.

We find no evidence in favor of the twin/triple deficits hypothesis for the countries considered. This means that there is no Granger causality running from budget deficits to trade deficits, and no Granger causality was found running from budget deficits and private

savings-investment deficits to trade deficits. Based on these findings, we conclude that the Ricardian equivalence proposition of the twin and triple deficits hypotheses holds for these six post-communist countries over the observation period.

Overall, it appears that budget deficits and trade deficits are causally independent variables in our sample. It is worth mentioning that our findings are broadly parallel to the empirical findings of several earlier studies, including Dewald and Ulan (1990) and Rahmann and Mishra (1992) for the US, Kaufmann et al. (2002) for Austria, Abbas et al. (2010) for 124 countries, Kıran (2011) for Turkey, and Ogbonna (2014) for South Africa. Further, our findings are consistent with all but a limited number of studies on post-communist transitions countries, specifically Gurgul and Lach (2012), Aristovnik and Djurić (2013), and Gabrisch (2015).

There may be several explanations for these findings. First, the existence of an output gap may be a factor. With some minor exceptions, all sample countries in the first decade of the transition displayed actual output levels in proportion to potential GDP well below their potential levels. This suggests the existence of an output gap. If so, increases in aggregate demand following expansionary fiscal policies may have been masked by increases in domestically produced goods and services, rather than through imports. The second plausible explanation may be a substantial exogenous increase in investment. These investment booms might have been generated through foreign technical assistance, technological innovation, successful market-oriented reforms, or a combination of all three. Successfully implemented free-market reforms, in particular, would have conferred the economic benefits of growth, enhanced trade competitiveness, and inflows of much-needed foreign capital. Third, there was the external assistance these countries received at the earlier stages of transition from international financial organizations such as the IMF, World Bank, as well as bilateral donors. Moreover, the countries that have already joined the EU all received substantial financial and technical supports from the EU throughout their accession processes. Finally, Russia and Ukraine are commodity-exporting countries[13] and so their export earnings and demand depend mostly on external factors. Over the observation period, there were several currency devaluations that effectively restrained imports to Russia and Ukraine.

This study broadly relates to possible explanations for the divergent results among the many empirical papers. The different findings may largely arise from the differences in methodology and data. In some previous studies, the possibility of structural breaks was ignored in the series. In others, the variables considered were treated as integrated of order "one", referring to the existence of a unit root. Further, analysis of data sets that focus on a short period of time may not yield reliable evidence. Lack of longer-term data for countries, as in the case of this study, limits the possibility for clear-cut, differentiated results. Not to put a fine point on

[13] Both are resource-rich countries, with iron and steel playing particularly large export roles. For Russia, of course, oil and oil- related products are dominant export products.

it, but differences in econometric techniques, data measures, samples employed, etc. yield different results. To overcome such differences, future studies should concentrate on comparison of various estimation techniques on a common data set. The same holds for country-specific features. Country-specific features such as exchange rate regime differences, deficit financing strategies, economy structure, institutional arrangements, etc. similarly affect the findings of various papers.

All in all, based on our empirical findings, it could be argued that if the Ricardian proposition holds true, fiscal policy is limited in its ability to influence trade (or current account) deficits. From a policy standpoint, such an evidence implies that the causes of large and persistent external deficits must be sought somewhere else than the budget side of the economy. Behind this, there might be several reasons, such as the structure of foreign trade, the exchange rate regime pursued, and the international competitiveness of the particular country in question, the degree of capital mobility, and the Feldstein-Horioka puzzle. Nevertheless, it is obvious that the case for the twin or triple deficits hypotheses is more likely to be seen in countries with economies that are highly integrated with international markets, open to capital movements, and experience intensive international competitiveness.

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Appendix A Selected empirical studies on twin and triple deficits hypotheses*, 1988–2015

	Empirical study	Period and country specification		Method or/and model	Empirical findings
		Period	Country		
Triple deficits hypothesis	Tang (2014)	1960:Q1–2013:Q1	US	Autoregressive distributed lag (ARLD) model	US data supports triple-deficits link, i.e. fiscal, current account, and capital and financial account balances move together over the long run.
	Şen et al. (2014)	1980–2010	Turkey	Dolado-Lütkepohl Granger causality analysis and VAR model	Triple deficits hypothesis valid for Turkey.
	Akıncı and Yılmaz (2012)	1975–2010	Turkey	Bounds testing approach	Budget and saving deficits positively and significantly affect current account deficits over the short and long run. Triple deficits hypothesis valid for Turkey.
← Twin deficits hypothesis	Gabrisch (2015)	1995: Q1–2010:Q4	Three post-transition countries: Poland, Czech Republic, and Hungary.	Cointegration and VECM for Poland; Granger causality test for the Czech Republic and Hungary	Twin deficits hypothesis rejected.
	Ahmad et al. (2015)	1980–2009	Nine African countries: Botswana, Cameroon, Egypt, Morocco, Nigeria, Tanzania, Ethiopia, Kenya, and Uganda.	Threshold cointegration technique	Positive cointegrating relationship between fiscal balance and current account balance for six of the nine countries considered (Botswana, Cameroon, Egypt, Morocco, Nigeria, and Tanzania). For Ethiopia, Kenya, and Uganda, a negative cointegrating relationship is found between the fiscal balance and current account balance.

	Eldemerdash et al. (2014)	1970–2010	Group of Arab countries: Bahrain, Egypt, Jordan, Kuwait, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, and United Arab Emirates.	Panel data Granger causality test	Positive relationship between fiscal and external balances for oil-producing countries, but no such relationship for non-oil countries. Findings support conventional view for oil-producing countries only. Accordingly, a 1% increase in the ratio of government fiscal balance (surplus/deficit) to GDP tends to (improve/deteriorate) the current account balance to GDP by 0.44–0.89% in oil-producing countries.
	El-Baz (2014)	1990–2012	Egypt	Granger causality test and vector error correction model (VECM)	Reverse causal relationship between budget deficit and current account deficit that runs from current account deficit to budget deficit.
	Ogbonna (2014)	1960–2012	South Africa	Bi-variate and multi-variate (VAR) models based on cointegration analysis and the error correction model (ECM).	No evidence of the twin deficits hypothesis over the short run. Findings suggest that the Ricardian equivalence proposition holds for South Africa within a short time horizon.
	Xie and Chen (2014)	1980–2010	Eleven OECD countries: Belgium, France, Finland, Greece, Iceland, Ireland, Norway, Spain, Sweden, UK, and Switzerland.	Bootstrap panel Granger causality	Bi-directional causality between the current account deficit and the government budget deficit for all countries studied. Twin deficits hypothesis supported through Keynesian hypothesis or current account targeting hypothesis.
	Aristovnik and Djurić (2013)	1995–2008	Twelve new EU members and three candidate countries.	Dynamic panel data model	Budget deficits of EU members and candidate countries signal relatively high levels of substitutability between private and public saving, implying a low correlation between fiscal and external imbalances. Empirical results usually reject the validity of the twin deficits hypothesis.
	Asrafuzzaman et al. (2013)	1972–2012	Bangladesh	VAR and Granger causality test	Bi-directional Granger causality between budget deficit and trade deficit in short run, *but* no relationship over long run.

	Mudassar et al. (2013)	1980–2011	Pakistan	ARDL cointegration methodology and error–correction estimation	Trade deficits determine budget deficits.
	Trachanas and Katrakilidis (2013)	1971–2009 (Italy) 1975–2009 (Ireland) 1977–2009 (Portugal, Italy, and Greece)	Five EU countries: Portugal, Ireland, Italy, Greece, and Spain.	Gregory and Hansen cointegration analysis	Long-run relationship between fiscal and current account imbalances. Findings support validity of twin deficits hypothesis.
	Sobrino (2013)	1990:Q1–2012:Q1	Peru	Toda and Yamamoto's Granger causality test	Empirical findings reject the twin deficits hypothesis. Evidence instead points strongly to reverse causality, i.e. current account balance affects fiscal account.
	Gurgul and Lach (2012)	2000–2009	CEE countries in transition: Bulgaria, Estonia, Czech Republic, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia.	Evaluating panel dataset by Granger and Huang	Twin deficits hypothesis does not hold for all countries under consideration.
	Kalou and Paleologou (2012)	1960–2007	Greece	Vector error correction model (VECM)	Budget deficits and trade deficits positively linked. Causality runs from current account deficits to budget deficits.
	Magazzino (2012)	1970–2010	Italy	Granger causality tests	Trade balance Granger causes budget deficit, while there is no long-run relationship between these two variables.
	Ratha (2012)	1998:Q1–2009:Q1	India	Bounds-testing approach	The Keynesian proposition is only valid in the short run. In the long run, Ricardian equivalence controls.

	Abbas et al. (2010)	1985–2007	124 countries	Panel regressions and panel VARs	The association between fiscal balance and current account balance is limited. Accordingly, an improvement in the fiscal balance of 1% of GDP is found to improve the current account balance by 0.2–0.3 percentage point of GDP. The association between the two is as strong in emerging and low-income economies as in advanced countries; significantly stronger in country-years where output is above potential than in cases where below potential.
	Kıran (2011)	1975–2009	Turkey	Fractional cointegration approach	Weak evidence for validity of twin deficit hypothesis. In other word; little evidence to suggest the presence of fractional cointegration relationship between the budget deficit and trade deficit.
	Lau et al. (2010)	1976:Q1–1997:Q2 (Pre-crisis period) and 1997:Q3–2008:Q1 (Post-crisis period)	Five countries hit by the Asian crisis: Malaysia, Indonesia, Korea, Philippines, and Thailand.	Standard time series estimation	Causality runs from budget deficit to current account deficit for Malaysia, the Philippines (pre-crisis), and Thailand, which fits well with the Keynesian view. For Indonesia and Korea, causality runs in the opposite direction. A bi-directional causality exists for the Philippines in the post-crisis era.
	Vamvoukas (2010)	1948–1993	Greece	Cointegration analysis, error-correction model, and Granger tri-variate causality.	Empirical findings support Keynesian proposition in short and long run. Empirical evidence shows one-way causality from budget deficit to trade deficit.
	Holmes (2010)	1960:Q1–2007:Q4	US	Nonparametric cointegration analysis	Budget and current account deficits appear to be stationarity around nonlinear trends, but can be regarded as twin deficits insofar as they share a common nonlinear deterministic time trend.

	Kim and Roubini (2008)	1973:Q1–2004:Q1	US	Recursive VAR models	Empirical results suggest that *twin divergence*, rather than twin deficits, i.e. government deficit shocks improve the current account and depreciate the real exchange rate in the short run.
	Marinheiro (2008)	1974–2002	Egypt	VAR model	Weak long-run relationship between budget deficit and current account deficit. The Ricardian equivalence proposition of twin deficits valid, but reverse Granger causality runs from current account to budget deficits.
	Baharumshah and Lau (2007)	1976:1–2001:4	Thailand	Granger causality test	Causal relationship between twin deficits runs from fiscal deficit to current account deficit; supports the validity of the twin deficits hypothesis.
	Salvatore (2006)	1973–2005	G-7 countries: US, UK, France, Italy, Canada, Japan, and Germany.	Regression analysis	Strong empirical evidence showing direct relationship between budget and current account deficits of all of the seven largest, most important industrial countries. The relationship is lagged, however, with budget deficits leading to current account deficits after one or more years.
	Kim and Kim (2006)	1970–2003	South Korea	Toda and Yamamoto's modified Wald test	Unidirectional causal relation running from current account deficit to budget deficit.
	Baharumshah et al. (2006)	1974:Q1–2000:Q4 (Thailand, Indonesia, and Philippines) 1974:Q1–2000:Q4 (Malaysia)	ASEAN-4 countries: Thailand, Indonesia, Malaysia, and Philippines.	VAR model	Keynesian view fits for Thailand over short run. For Indonesia, reverse Granger causality running from current account deficit to budget deficit. For Malaysia and Philippines, bi-directional causality between current account and budget deficit is found.

	Saleh (2005)	1970–2003	Sri Lanka	Autoregressive distributed lag (ARDL) model and the bounds test for cointegration	Empirical findings support the Keynesian view, i.e. there is a long-run relationship between current account imbalances and budget deficit. Empirical results also show that the direction of causality runs from budget deficit to current account deficit.
	Bostancı and Tunç (2002)	1987–2001	Turkey	Cointegration and error-correction model (ECM)	Long-run relationship between the budget deficits and trade deficits. Worsening budget balance negatively affects the trade balance in the short run.
	Kaufmann et al. (2002)	1976:Q1–1998:Q4	Austria	Vector error correction model (VECM)	Twin deficits hypothesis not valid.
	Normandin (1999)	1950:Q1–1992:Q3	Canada and US	Overlapping generations model	Evidence from Canadian and the US economies suggest that, although the birth rates are low, the large persistence of budget deficits yields responses that are numerically large and statistically positive.
	Khalid and Guan (1999)	1950–1994 (Developed countries) 1955–1993 (Developing countries)	Five developed countries: US, UK, France, Canada, and Australia. Five developing countries: India, Indonesia, Pakistan, Egypt, and Mexico.	Cointegration techniques	Secular relationship between budget deficit and current account deficit in four of five developing countries surveyed; no developed country exhibits similar relationship.
	Islam (1998)	1973:Q1–1991:Q4	Brazil	Granger causality test	Bilateral causality between the trade and budget deficit imbalances.

	Anoruo and Ramchander (1998)	1957–1993 (India and Philippines), 1960–1993 (Malaysia) 1967–1993 (Korea) 1970–1993 (Indonesia)	Five Southeast Asian countries: India, Indonesia, Korea, Malaysia, and Philippines.	Granger causality test based on a vector autoregressive (VAR) model	Trade deficits cause fiscal deficits, not vice versa.
	Ahmed and Ansari (1994)	1973:Q1–1991:Q4	Canada	Cointegration analysis and error correction model	Current account deficit seems related to both fiscal deficit and savings-investment gap.
	Rosensweig and Tallman (1993)	1961:Q1–1989:Q4	US	VAR	Increased US government deficits contributed to dollar appreciation and large US trade deficits in the 1980s.
	Rahman and Mishra (1992)	1946–1988	US	Cointegration approach	US budget deficits and current account deficits have no possibility of reverting to a long-run equilibrium relationship.
	Latif-Zaman and DaCosta (1990)	1971:Q1–1989:Q3	US	Bi-variate Granger causality approach	Budget deficits and trade deficits are related, but evidence supports conventional proposition that high budget deficits cause high trade deficits.
	Dewald and Ulan (1990)	1954–1987	US	Time series analysis	No significant linkage between fiscal and current account balances.
	Abell (1990)	1979–1985	US	Multivariate time series analysis	Reducing size of budget deficit may be *at least* as effective as exchange rate intervention in reducing size of merchandise trade deficit.

	Miller and Russek (1989)	1946:Q1–1971:Q2 (Fixed exchange rate period) 1971:Q3–1987:Q3 (Flexible exchange period)	US	Three different statistical techniques: Deterministic technique, stochastic technique, and cointegration analysis	Empirical findings depend on the statistical techniques used. The deterministic and stochastic approaches show a positive secular relationship between budget deficit and trade deficit (although relationship is valid only under flexible exchange rates). The relationship is fairly robust: a $1 change in fiscal deficit leads to a roughly $1 change in trade deficit. In contrast, cointegration analysis shows no long-run equilibrium relationship between fiscal and trade deficits.
	Bernheim (1988)	1960–1984	US and five major trading partners: Japan, Mexico, Canada, UK, and West Germany.	OLS	Fiscal deficits significantly contribute to deterioration in the current account deficit. More specifically, one-third or more of US current account deficits and four out of its five trading partners are driven by fiscal deficits. However, there is no discernible relationship for Japan.

* Reported according to reverse chronological order.
Source: Prepared by the author

Appendix B Cross-sectional dependence and slope homogeneity tests[14]

Three tests are available to investigate the existence of cross-sectional dependence: the Lagrange multiplier test statistic of Breusch and Pagan (1980) for cross-sectional dependence, and the cross-sectional dependence test statistics of Pesaran (2004), which are based either on Lagrange multiplier or pair-wise correlation coefficients.

The Lagrange Multiplier (LM) test developed by Breusch and Pagan (1980) requires estimation of the following panel data model:

$$Y_{it} = \alpha_I + \beta_i X_{it} + \mu_{it} \quad (1)$$

for I = 1,2, 3, …, N; t = 1,2, 3, …, T ,

where I is the cross section dimension; t is the time dimension; X_{it} is kx1 vector of explanatory variables, and α_I and β_I are the individual intercepts and slope coefficients allowed to differ across states.

In the LM test, the null hypothesis of no cross-sectional dependence H_0 : Cov (μ_{it}, μ_{jt}) = 0 for all t and I ≠ j is tested against the alternative hypothesis of cross-sectional dependence H_1 : Cov (μ_{it}, μ_{jt}) ≠ 0 for at least one pair of i≠ j.

For testing the null hypothesis, the LM test statistic for cross-sectional dependence of Breusch and Pagan (CD_{BP}) is given as:

$$CD_{BP} = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}^2 \quad , \quad (2)$$

where $\widehat{\rho}_{ij}^2$ is the estimated correlation coefficient among the residuals obtained from individual OLS estimation of Equation (1). Under the null hypothesis, the LM statistic has an asymptotic chi-square distribution with N (N-1)/2 degrees of freedom.

Pesaran (2004) indicates, however, that the CD_{BP} test has a drawback when N is large, implying that it is not applicable when N→∞. To overcome this problem, the following LM statistic for cross-sectional dependence (CD_{LM}) was developed by Pesaran (2004). The CD_{LM} statistic is given as:

$$CD_{LM} = \sqrt{\frac{1}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}(T\hat{\rho}_{ij}^2\text{-}1) \quad (3)$$

Under the null hypothesis of no cross-sectional dependence with T→∞ and then N→∞, CD_{LM} asymptotically follows a normal distribution.

Unfortunately, the CD_{LM} test is likely to indicate size substantial distortions when N is large relative to T. Pesaran (2004) therefore proposes an alternative test for cross-sectional

[14] These definitional equations heavily borrow from Şen et al. (2015).

dependence (CD) that can be used where N is large and T is small. The CD statistic is calculated as follows:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \quad (4)$$

Pesaran (2004) states that under the null hypothesis of no cross-sectional dependence with $T \rightarrow \infty$ and $N \rightarrow \infty$ in any order, the CD test is asymptotically normally distributed. Pesaran et al. (2008) qualify this by noting that when the population average pair-wise correlation is zero, the CD test has less power. Therefore, they propose a bias-adjusted LM test that uses the exact mean and variance of the LM statistic. The bias-adjusted LM statistic is calculated as follows:

$$CD_{adj} = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \frac{(T-k)\hat{\rho}_{ij}^2 - u_{Tij}}{\sqrt{v_{Tij}^2}} \quad , \quad (5)$$

where u_{Tij} and v_{Tij}^2 are the exact mean and variance of (T-k) $\widehat{\rho}_{ij}^2$, which are provided by Pesaran et al. (2008). Under the null hypothesis of no cross-sectional dependence with $T \rightarrow \infty$ first followed by $N \rightarrow \infty$, the results of the CD_{adj} test follow an asymptotic standard normal distribution.

The standard F-test is the most widely used way to test the null hypothesis of slope homogeneity $H_0 : \beta_I = \beta$ for all I against the hypothesis of heterogeneity $H_1 : \beta_I \neq \beta_j$ for a non-zero fraction of pair-wise slopes for $i \neq j$. This requires that the explanatory variables are strictly exogenous and the error variances are homoscedastic. To relax the assumption of homoscedasticity in the F-test, Swamy (1970) developed a slope homogeneity test that examines the dispersion of individual slope estimates from a suitable pooled estimator.

Pesaran and Yamagata (2008) state that both the F-test and Swamy's test require panel data models where N is relatively small compared to T. Therefore, they propose a standardized version of Swamy's test (hereafter, $\tilde{\Delta}$ test) for testing slope homogeneity in large panels. The Δ test is valid when (N, T) $\rightarrow \infty$ without any restrictions on the relative expansion rates of N and T when the error terms are normally distributed. Swamy's statistic can then be modified as:

$$\tilde{S} = \sum_{i=1}^{N} \left(\hat{\beta}_i - \hat{\beta}_{WFE}\right)' \frac{X_i' M_\tau X_i}{\hat{\sigma}_i^2} \left(\hat{\beta}_i - \hat{\beta}_{WFE}\right) \quad , \quad (6)$$

where $\widehat{\beta}_I$ is the pooled OLS estimator; $\widehat{\beta}_{WFE}$ is the weighted fixed effect pooled estimator of the Equation (1); M_τ is an identity matrix of order T and $\widehat{\sigma}_i^2$ is the estimator of σ_i^2.

Pesaran and Yamagata (2008) further develop the following standardized dispersion statistic:

$$\tilde{\Delta} = \sqrt{N}\left(\frac{N^{-1}\tilde{S}-k}{\sqrt{2k}}\right) \quad (7)$$

Under the null hypothesis with the condition of (N, T) $\rightarrow \infty$ and so long as $\sqrt{N}/T \rightarrow \infty$, and when the error terms are normally distributed, the $\tilde{\Delta}$ test has an asymptotic standard normal distribution.

The small sample properties of the $\tilde{\Delta}$ test can be improved when there are normally distributed errors by using the following mean and variance bias adjusted version:

$$\tilde{\Delta}_{adj} = \sqrt{N}\left(\frac{N^{-1}\tilde{S}-E(\tilde{Z}_{it})}{\sqrt{var(\tilde{Z}_{it})}}\right) \quad , \quad (8)$$

where the mean $E(\tilde{Z}_{it}) = k$, and $var(\tilde{Z}_{it}) = 2k(T-k-1)/(T+1)$.

Appendix C Other results from bootstrap panel Granger causality analysis

Table 1 reports the results of panel Granger causality between budget balance and private savings-investment balance.

Table 1 Panel Granger causality between budget balance (BB) and private savings-investment balance (SIB)

Country	Estimated coefficient	Wald Test	Bootstrap critical values			Granger causality
			10%	**5%**	**1%**	Yes/No
H_0 : Budget deficits do not cause private savings-investment deficits						
Russia	–0.24031	4.15272	6.48159	9.26189	19.68549	No
Poland	**–0.80707**	**17.96319*** **	**6.17857**	**8.89016**	**17.64496**	**Yes**
Ukraine	0.40719	2.12450	6.51380	10.25422	23.42109	No
Romania	**–0.92178**	**11.22914*** **	**8.89024**	**12.52762**	**20.61716**	**Yes**
Czech Republic	–0.042763	0.16017	6.48803	9.43279	18.42607	No
Hungary	0.19414	2.21743	6.67243	9.46650	16.73213	No
H_0 : Private savings-investment deficits do not cause budget deficits						
Russia	**0.79907**	**13.062135*** **	**6.26030**	**9.34477**	**19.20222**	**Yes**
Poland	0.20153	3.35927	7.18930	10.81216	20.25727	No
Ukraine	**0.23854**	**6.64324*** **	**5.57397**	**8.87024**	**16.31503**	**Yes**
Romania	0.19820	6.41192	7.13433	10.90076	18.40454	No
Czech Republic	–0.061918	0.19565	8.18093	12.10320	24.55806	No
Hungary	**0.77034**	**8.88738*** **	**5.56864**	**8.39067**	**14.68569**	**Yes**

Notes: The data cover the whole sample period from 1994 to 2012. (***) indicates statistical significance at 10%.
Source: Authors' calculations

Notably, there is a significant and negative Granger causality running from budget deficits to the private savings-investment deficits of Poland and Romania. Moreover, only three (Russia, Ukraine, and Hungary) of our six countries exhibit significant and positive Granger causality running from private savings-investment deficits to budget deficits. With the exception of the Czech Republic, the null hypothesis of no Granger causality from budget deficits to private savings-investment deficits or vice versa cannot be rejected.

Table 2 indicates significant and positive Granger causality running from private savings-investment deficits to trade deficits for Poland and Romania, but not the other four

countries. On the other hand, our findings suggest the causal direction from trade deficits to private savings-investment deficits is valid for Russia, Ukraine, the Czech Republic, and Hungary, implying that the null hypothesis stands for these countries (i.e. there is no Granger causality in this direction). For Poland and Romania, however, there is significant, but negative, Granger causality running from trade deficits to private savings-investment deficits.

Table 2 Panel Granger causality between private savings-investment balance (SIB) and trade balance (NXB)

Country	Estimated coefficient	Wald Test	Bootstrap critical values			Granger causality
			10%	**5%**	**1%**	Yes/No
H_0 : Private savings-investment deficits do not cause trade deficits						
Russia	0.022719	0.54678	6.73325	10.92829	20.78984	No
Poland	**0.51413**	**8.65959*** **	**6.41573**	**8.45763**	**17.97478**	**Yes**
Ukraine	–0.23934	0.56873	6.37846	9.64867	15.51802	No
Romania	**0.92680**	**21.10031*** **	**7.90944**	**11.82749**	**23.57803**	**Yes**
Czech Republic	0.19803	0.55238	6.28098	10.14065	20.84300	No
Hungary	–0.16903	0.91966	5.86125	8.56126	19.48040	No
H_0 : Trade deficits do not cause private savings-investment deficits						
Russia	–0.34668	3.76326	6.70739	9.25943	20.20941	No
Poland	**–0.94011**	**22.18209*** **	**6.75525**	**10.10809**	**17.50172**	**Yes**
Ukraine	0.43689	1.64086	7.59905	10.83030	21.06846	No
Romania	**–0.74606**	**11.84858*** **	**7.34579**	**11.34655**	**21.12873**	**Yes**
Czech Republic	–0.12811	0.97950	6.41807	9.87203	20.66651	No
Hungary	0.22865	2.14292	6.04718	9.81700	19.71584	No

Notes: The data covers the whole sample period from 1994 to 2012. (***) indicates statistical significance at 10%.
Source: Authors' calculations

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