Revisiting the Glick-Rogoff Current Account Model: An Application to the Current Accounts of BRICS Countries

Zhai, Weiyang and Yoshida, Yushi

Shiga University

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Weiyang Zhai
Faculty of Economics, Shiga University

and

Yushi Yoshida
Faculty of Economics, Shiga University

Abstract:

Understanding what drives the changes in current accounts is one of the most important macroeconomic issues for developing countries. Excessive surpluses in current accounts can trigger trade wars, and excessive deficits in current accounts can, on the other hand, induce currency crises. The Glick-Rogoff (1995, Journal of Monetary Economics) model, which emphasizes productivity shocks at home and in the world, fit well with developed economies in the 1970s and 1980s. However, the Glick-Rogoff model fits poorly when it is applied to fast-growing BRICS countries for the period including the global financial crisis. We conclude that different mechanisms of current accounts work for developed and developing countries.

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Keywords: BRICS Countries; Current Accounts; Glick-Rogoff Model; Global Financial Crisis; Productivity Shock.

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1. Introduction

Understanding what drives the changes in current accounts is one of the most important macroeconomic issues for developing countries. Excessive surplus in a current account can trigger trade wars, and excessive deficits in the current account can lead to currency crises. For example, Brazil's current account has frequently fallen into a deficit since the 1990s, and India experienced a current account deficit of 91 billion US dollars in 2012, whereas China's current account surplus has become the world's largest (see Figure 1).

The current trade war between the US and China began under the administration of President Trump following a decade in which the US's bilateral trade deficit with China remained large. Against the backdrop of the worldwide effort being made to reduce tariff and nontariff barriers, the US raised the tariffs for steel products and thousands of products in other industries from China in consecutive sequences starting in 2018, and China responded with retaliatory tariff increases.

Currency crises are, in many cases, preceded by a current account deficit. Obstfeld (2012) documents that many crises have been preceded by a large current account deficit, pointing out the crises of Chile in 1981, Finland in 1991, Mexico in 1994, and Thailand in 1997, which subsequently led to the outbreak of the Asian currency crisis. It should be noted that current account deficits are not a prerequisite for currency crises. However, as shown in previous studies, a current account deficit is considered an important warning signal of consequent crises. Roy and Kemme (2011) and Catao and Milesi-Ferretti (2014) find that current accounts are a powerful predictor of crisis; a higher current account deficit position is associated with a higher risk of crisis. During the Asian currency crisis, Corsetti et al. (1999) pointed to Taiwan's current account surplus as what prevented contagion from neighboring countries. Davis et al. (2016) show that a higher private sector debt increases the probability of a crisis, especially when the current account is in a sizable deficit. Observing trade balance as a key determinant of current accounts, Kaminsky and Reinhart (1999) also conclude that exports often decrease just before a crisis.

Among other current account models, Glick and Rogoff (1995) developed an empirical model of current accounts to highlight the relationship of productivity with investment and current accounts. Current account changes are explained by country-specific productivity shocks, global productivity shocks, and lagged investments. The model performs surprisingly well with G7 data during 1975-1990. Their results show that current accounts had a negative response only to country-specific shocks, whereas investment showed a positive response to both global and country-specific productivity

shocks.

In this study, we revisit Glick-Rogoff's model, in which productivity shocks act as a key driver of current account changes, and apply the model to the BRICS countries. This study aims to contribute to the literature by having the following goals. First, a model that emphasizes productivity shocks should be tested against fast-growing countries such as the BRICS countries. The BRICS countries experience much-more-volatile productivity shocks than developed countries in the G7 do. Second, understanding the current account changes of the largest economies is important for the surveillance of the global economy. In addition to having knowledge of the G7 countries, understanding the BRICS countries' current account movements, including the world's second largest economy, is essential for policymakers to adopt appropriate macroeconomic policies.

The results of the empirical application of the Glick-Rogoff model to BRICS countries show that the empirical model with productivity shocks works relatively well for developing countries except for Russia. However, the empirical Glick-Rogoff model collapses when the sample is extended to cover the post-crisis period. The fitness of regression in terms of adjusted R-squared becomes close to zero. Following the recent development of the empirical current account literature, we extended the Glick-Rogoff model with five macroeconomic variables, namely, financial deepening, old dependency ratio, young dependency ratio, net foreign assets, and trade openness. The results of the extended model improve the fitness of regression for the pre-crisis period in India, China, and South Africa by more than ten percent and that in Brazil by two-fold[1]. Interestingly, the modified model even works well during the sample including the post-crisis period for Brazil, China, and Russia.

From the empirical investigations in this paper, we obtained the following conclusions for developing countries. (i) Productivity is only important in non-turbulent environments. The Glick-Rogoff model performs well in the period prior to the global financial crisis but loses all explanatory power in the sample period, which includes the global financial crisis. (ii) Other macroeconomic variables are important determinants regardless of the inclusion of the crisis in the sample period. Additional five macroeconomic variables in the modified Glick-Rogoff model improved the fitness of regression in both samples.

In comparison with developed countries, we also find the following implications. (iii) Productivity shocks explain the movements of the current account better for developing countries than for developed countries. (iv) However, productivity shocks

[1] The extended model cannot be applied to Russia for the pre-crisis period due to the lack of data availability.

retain some explanatory power for the current account of developed countries even in the post-crisis period, whereas productivity shocks have no effect on the current account of developing countries in the post-crisis period. (v) Inclusion of macroeconomic variables sometimes deteriorates the performance of the current account regression of developed countries, especially for euro countries.

The construction of the rest of this paper is as follows. Section 2 reviews the theoretical model of Glick and Rogoff (1995) and the subsequent developments of both theoretical and empirical studies. Section 3 examines the empirical application of the Glick-Rogoff model and its modified model with macroeconomic variables as controls to the BRICS countries. Section 4 compares the results of the BIRCS countries with those of the G7 countries and discusses the characteristics of the current account for fast-growing emerging economies. Section 5 discusses how the five macroeconomic variables used in this empirical study are related to other macroeconomic variables used in the literature. Section 6 concludes the paper.

2. Productivity shocks and current accounts

Glick and Rogoff (1995) introduced a theoretical small-country model in which productivity shocks play crucial roles in determining current account movements. The next subsection briefly reviews the assumptions and underlying structure of their model. We discuss the applicability of the model assumptions that may lead to the misspecification of the empirical model for developing countries in subsection 2-2.

2-1. Glick-Rogoff small-country model with adjustment costs to investment[2]

A small country faces both country-specific productivity shocks and global productivity shocks. Global productivity shock can be mitigated by trading global bonds in the world capital market at the riskless gross world interest rate r. However, the representative agent in each country cannot diversify country-specific shocks. The representative firm chooses the path of investments to maximize the present discounted value of future profits under the given aggregate output (1)[3]. Taking a linear approximation to the first-order condition yields equations (2) and (3).

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[2] This subsection closely follows the work of Glick and Rogoff (1995), with special focus on productivity shocks on current accounts. For the complete derivations of equation (8), please refer to the appendix of their original work. See also Marquesz (2004) and Bussiere et al. (2010) for another extension of the Glick-Rogoff model.

[3] Global productivity, A_t^W, is introduced multiplicatively to the aggregate output in a similar manner as country-specific productivity.

$$Y_t = A_t^c K_t^\alpha \left[1 - \frac{g}{2}\left(\frac{I_t^2}{K_t}\right)\right] \tag{1}$$

$$Y_t \cong \alpha_I I_t + \alpha_K K_t + \alpha_A A_t^c \tag{2}$$

$$I_t \cong \beta_1 I_{t-1} + \eta \sum_{s=1}^{\infty} \lambda^s \left(\mathrm{E}_t A_{t+s}^c - \mathrm{E}_{t-1} A_{t+s-1}^c\right) \tag{3}$$

In equation (3), the first term captures the past investment (or lagged productivity shock) on the current investment, and the second term captures the impact of revisions in expectations about the future path of productivity.

The representative agent chooses the path of consumption to maximize the present discounted utility (4).

$$\mathrm{E}_t \sum_{s=0}^{\infty} \beta^s U\left(C_{t+s}\right), \text{ where } U_t = C_t - \frac{h}{2} C_t^2, \text{ s.t. } F_{t+1} = rF_t + Y_t - I_t - C_t, \tag{4}$$

where r is assumed to be equal to β. The solution to the maximization for consumer yields (5) and the ex post rate of change of consumption depends only on the unanticipated movement in permanent net income (6).

$$C_t = \frac{r-1}{r}\left(F_t + \mathrm{E}_t \sum_{s=0}^{\infty} \frac{Y_{t+s} - I_{t+s}}{r^s}\right) = \frac{r-1}{r} F_t + \overline{Y}_t - \overline{I}_t \tag{5}$$

$$\Delta C_t = \left(\mathrm{E}_t - \mathrm{E}_{t-1}\right)\frac{r-1}{r}\left(\mathrm{E}_t \sum_{s=0}^{\infty} \frac{Y_{t+s} - I_{t+s}}{r^s}\right) = \left(\overline{Y}_t - \overline{I}_t\right) - \mathrm{E}_{t-1}\left(\overline{Y}_t - \overline{I}_t\right) \tag{6}$$

Differencing the accounting identity for the current account, we obtain the following equation.

$$\Delta CA_t = (r-1)\Delta F_t + \Delta Y_t - \Delta I_t - \Delta C_t \tag{7}$$

Combining the equations obtained from maximization for ΔI_t, ΔY_t, ΔC_t with equation (7) yields the estimating equation for the current account[4].

$$\Delta CA_t = \gamma_1 I_{t-1} + \gamma_2 \Delta A_t^c + (r-1) CA_{t-1}, \tag{8}$$

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[4] α_I and α_K are marginal production of investment and capital as in equation (2). β_1 is the autoregressive coefficient of investment in equation (3). The first appearance of β_2 is omitted in this study, but it is equal to $\eta[\lambda/(1-\lambda)] > 0$.

where $\gamma_1 \equiv (\alpha_I - 1)(\beta_1 - 1) + \alpha_K > 0,$
$\gamma_2 \equiv -\beta_2[(\alpha_I - 1)(\beta_1 - 1) + \alpha_K] / (r - \beta_1) < 0$

If all countries are symmetric in terms of preferences, technology, initial capital stocks, and zero initial net foreign asset positions, then the global shock should not affect an individual country's current account because the global shock affects all countries in the same manner; therefore, we obtain the final version of the basic Glick-Rogoff model.

$$\Delta CA_t = \gamma_1 I_{t-1} + \gamma_2 \Delta A_t^c + \gamma_3 \Delta A_t^w, \quad \text{where} \quad \gamma_3 \text{ is assumed to be zero.} \qquad (9)$$

In this paper, leaving the investment equation aside, we focus on the effect of both country-specific and global productivity shocks on current accounts. The regression model derived from the theoretical result of Glick and Rogoff (1995) is as follows.

$$\Delta CA_t = \gamma_1 I_{t-1} + \gamma_2 \Delta A_t^c + \gamma_3 \Delta A_t^w + \varepsilon_t, \qquad (10)$$

where CA_t is the current account of the home country, A_t^c is the total factor productivity of the home country, A_t^W is the total factor productivity of the rest of the world, and I_t is the lagged investment in the home country.

2-2. Where can the Glick-Rogoff model go wrong in an application to the BRICS countries?

The effect of global productivity shocks is assumed to have no effect on a change in current accounts, as shown in equation (10). However, there are at least two strong arguments against this assumption. For the application to the BRICS countries, there are problems with assuming a zero initial net foreign asset position and assuming that global productivity shocks affect developed and developing countries equally.

First, Glick and Rogoff (1995) state that "zero initial net foreign asset positions … is a reasonable empirical approximation for the G-7 countries over the sample period." However, if positive (or negative) net foreign asset positions are at a level as high as was observed prior to global financial crisis in China, the global productivity shocks affect these countries with nonzero net foreign asset positions asymmetrically.

Second, we followed Glick and Rogoff (1995) in measuring global productivity based on the largest economies of the world. In an application to the G7 countries as in Glick and Rogoff (1995), each sample country's productivity also contributes to the global productivity. Therefore, observed country productivity (from the original data) is

decomposed into a country-specific component and a global component. The effect of the global component of productivity shock is nil because it affects both home country and the rest of the world similarly. However, for an application to the developing countries as in this study, observed country productivity (from the original data) does not constituent global productivity. The global factor should affect the BRICS countries and the rest of the world asymmetrically.

3. Domestic and Global Productivity

In this section, we apply the Glick-Rogoff model to the fast-growing emerging economies, namely, the BRICS countries, Brazil, China, India, Russia, and South Africa. The key determinants of current account change in the Glick-Rogoff model are global and country-specific productivity shocks. To account for the severe negative shocks experienced during the global financial crisis, we estimate the model in two sample periods; one ending in 2008 and the other ending in 2017. In the second subsection, we also apply the extended model with additional macroeconomic variables after we obtain the base results from the original Glick-Rogoff model. In next section, we apply the same model to developed countries, namely, Canada, France, Germany, Italy, Japan, UK, and US. We discuss similarities and differences in current account determinants between the BRICS and G7 countries.

3-1. Estimation results of the basic Glick-Rogoff model

Global productivity is constructed from the weighted average of the productivities of the G7 countries, namely, Canada, France, Germany, Italy, Japan, the UK, and the US. Alternatively, the first principal component of the productivities of the G7 countries is also used as a measure of global productivity[5]. The regression model of equation (10) is restated here.

$$\Delta CA_t = \gamma_1 I_{t-1} + \gamma_2 \Delta A_t^c + \gamma_3 \Delta A_t^w + \varepsilon_t,$$

From the Glick-Rogoff model, the expected sign of the past investment is positive, that

[5] Gregory and Head (1999) used dynamic factor analysis to construct a measure of common economic activity for the G7 countries. They find that the common economic activity has substantial impact on productivity but not on current account. İşcan (2000) further disintegrates overall productivity into traded good productivity and nontraded good productivity. He finds that the most influential of all on current account is country-specific traded good productivity.

of the first-difference of each country's productivity is negative, and that of the first-difference of worldwide productivity is zero; that is, $\gamma_1 > 0, \gamma_2 < 0$, and $\gamma_3 = 0$. The dynamic optimization model of Glick and Rogoff (1995) integrates the endogenous decisions of producers and consumers; therefore, the derived parameters of the model are affected by several sources. However, if we simply decompose the dependent variable, which is the first difference of the current account in terms of private saving and investment, and leave aside the government role, we can observe (in the first equality) the first-degree importance of the current investment and the past investment on the dependent variable. Adjusted for marginal production with respect to investment and capital stock, i.e., α_I and α_K, and the impact of past investment shock on the current investment, i.e., β_1, the coefficient of unity in the equation remains positive, γ_1, as shown in equation (8).

$$\Delta CA_t \equiv CA_t - CA_{t-1} = (S_t - I_t) - (S_{t-1} - I_{t-1}) = \Delta S_t - \Delta I_t \qquad (11)$$

It is also clear that a change in a country's productivity negatively affects a change in its current account, γ_2, via a change in investment through the second equality.

The empirical results of estimating the Glick-Rogoff model for the BRICS countries during 1983 – 2008 are provided in Panel 1 of Table 1a & 1b[6]. The differences in the two tables arise from the way the global productivity index is constructed. The global productivity index is simply a GDP-weighted average of the G7 countries in Table 1a and the first principal component of the G7 countries in Table 1b. Country-specific productivity is based on total factor productivity, as shown in Figure 2.

First, by comparing Table 1a and 1b, we find that the results are quite similar in terms of both the size of the coefficients and the statistical significance except for the coefficient size of global productivity shock. The result of the basic model is robust regardless of how global productivity is measured.

Second, country-specific productivity shock is not statistically significant for all BRICS countries, although theory predicts a negative effect on change in the current account. This result is quite different from the results obtained for the G7 countries during 1961-1990 in Glick and Rogoff (1995, Table 3); the estimated coefficients of the country-

[6] The sample period for Russia only begins in 1995 due to the availability of data.

specific productivity shock are negative and statistically significant for five countries, namely, the US, Japan, Italy, the UK, and Canada.

Third, except for Brazil and South Africa (only in Table 1a), the results for global productivity shock are consistent with the Glick and Rogoff model. Under the assumption that global productivity shock symmetrically affects all countries in the world, the effect of global productivity shock on current account change must be equal to zero. The estimated coefficients for Russia, India, China, and South Africa (only in Table 1b) are not significantly different from zero at the conventional significance level. For the case of Brazil, the estimated coefficient is positive and statistically significant. The positive sign is consistent if the global productivity shock represents the rest of the world instead of the world with Brazil included (see the discussion in subsection 2-2). Foreign productivity shock should positively affect home current account change because home productivity shock negatively affects home current account change, as in γ_2.

The basic Glick-Rogoff model is also estimated for the extended sample of 1983-2017, including the post global financial crisis period, and the results are provided in Panel 2 of Table 1a and 1b. The surprising result is that nothing in the Glick-Rogoff model works for the BRICS countries if the worldwide turbulent period is included in the sample. For all BRICS counties, the fitness of the regression in terms of adjusted R-squared is literally zero.

[insert Table 1a & 1b around here]

The productivity shocks implemented in the preceding empirical approach need to meet the requirement assumed in the theoretical model; country-specific productivity and global productivity are independent. In the original Glick and Rogoff (1995) study, global productivity is constructed from the same countries in the sample; therefore, the independent assumption is more likely to be violated if no adjustment is made. Following the methodology implemented in Glick and Rogoff (1995), we regressed the original country productivity on the global productivity and used the residual as country-specific productivity. By design, the independence of country-specific and global productivity shock is guaranteed. The results using the residual as country-specific productivity are shown in Tables 2a and 2b.

The estimated results in Tables 2a and 2b are very similar to those of Tables 1a and 1b in terms of both the size of coefficients and the statistical significance. The only noteworthy point is that the global productivity shock becomes statistically significant for

an additional country in the shorter sample. For China in the period between 1983 and 2008, as seen in Table 2b, the global productivity shock is positive and statistically significant at the ten percent level. This is similar to the case of Brazil, in which the positive sign indicates foreign productivity shock rather than global productivity shock. As for the results of South Africa in Table 2a, it is puzzling that the global productivity shock is negative and statistically significant[7].

[insert Table 2a & 2b around here]

3-2. Extended models with other macroeconomic variables

Not all empirical models of current account movements emphasize productivity shocks. The advantage of the Glick-Rogoff regression model is its concrete derivation based on the theoretical dynamic model. However, many researchers have continued to explore the possibility of many other macroeconomic variables to explain current account movements, frequently without theoretical models.

Chinn and Prasad (2003) investigated the medium-term determinants of current accounts for a large sample of developed and developing countries. They find that current account balance is positively correlated with government budget balance and the initial level of net foreign assets. Among developing countries, financial deepening is positively associated with current account balance, while trade openness is negatively correlated with current account balance.

Cudre and Hoffmann (2017) and Romelli and Terra (2018) also show that trade openness is a significant driver of current accounts. Romelli and Terra (2018) investigate the impact of trade openness on the relationship between the current account and the real exchange rate. They find that during the balance of payment distress episodes, currency depreciations are associated with larger improvements in the current accounts of countries that are more open to trade, and the magnitude of exchange rate depreciations over the adjustment process of current accounts is related to the degree of openness to trade. Cudre and Hoffmann (2017) also find that trade openness is an important factor even across regions within a nation.

Following the recent development of the empirical current account literature, we extended the Glick-Rogoff model with five macroeconomic variables: financial deepening, old dependency ratio, young dependency ratio, net foreign assets, and trade

[7] Smit et al. (2014) provide an explanation of the irregular movement of South Africa's current account deficit as being driven by substantial net capital inflows and their reversals afterwards.

openness[8]. First, the fitness of regression substantially improved for Brazil, India, and China. In the shorter sample between 1983 and 2008, the adjusted R-squared increased from 0.29 to 0.60 for Brazil, from 0.60 to 0.69 for India, and from 0.58 to 0.68 for China. In the longer sample that included the post-crisis period, the adjusted R-squared values were 0.31 for Russia, 0.21 for Brazil, and 0.24 for China; all of these values increased from zero or even negative values of the adjusted R-squared in the basic model estimations.

Second, we obtained estimation results that are consistent with the theoretical prediction for country-specific productivity shock although none of the estimates were statistically significant in the base model; negative responses are obtained for South Africa in the shorter sample and Brazil for the longer sample. In addition, by assuming global productivity as foreign productivity, we find a positive association with statistical significance between the current account and global productivity for Russia in the longer sample in addition to those for Brazil.

Third, the importance of additional macroeconomic variables for explaining current accounts varies among the BRICS countries. Financial deepening has no explanatory power for all countries. The old dependency ratio has a positive effect only for Brazil in the longer sample, while the young dependency ratio exerts opposite effects on Russia and Brazil in the longer sample. Net foreign assets have a positive effect for China in the shorter sample and for Russia in the longer sample. Trade openness has a positive effect for South Africa in the shorter sample and China in the longer sample.

[insert Table 3a & 3b around here]

4. Can the same current account model be applied to both developed and developing countries?

For the BRICS countries, except for Russia, we find that the Glick-Rogoff model can explain approximately 20 – 60 percent of the changes in the current account for the period between 1983 and 2008; however, productivity shocks completely lose explanatory power when the sample is extended to cover the post-crisis period. The modified model extended with macroeconomic variables improves the fitness of regression for both samples. To conclude, whether these results are general or specific to fast-growing developing countries, we need to compare the results with those of developed countries. Therefore, we also estimated the same regression models for the G7

[8] The definitions and sources of macroeconomic variables are provided in the appendix A.

countries. The results are shown in appendix Tables C1 and C2[9].

First, the explanatory power of the original Glick-Rogoff model does not work, or at least does not work better for G7 countries than for BRICS countries in the pre-crisis period. The degree of fitness in terms of adjusted R-squared are 0.16, 0.15, 0.08, and 0.28 for France, Germany, Italy, and Japan, respectively. It is less than zero for Canada and the UK. The only exception is the US; 43 percent of current account movements in the US are explained by both global and local productivity shocks and past investment.

Second, similar to the BRICS countries, the basic model fits less well for G7 countries in the post-crisis period. However, unlike the BRICS countries, even in the post-crisis period, the Glick-Rogoff model retains some explanatory power, at least for Canada, Germany, Japan, and the US. This is a surprising finding because developed countries, especially the US, are the most affected countries in the world by the global financial crisis. We may need to adjust our understanding so that the financial crisis per se does not break the relationship between productivity shocks and current account changes.

Third, unlike in the case of the BRICS countries, the modified model does not necessarily improve the fitness of regressions in terms of the adjusted R-squared. More interestingly, the decline in the explanatory power of the overall regression model is found only for European countries, more precisely euro countries. For the pre-crisis sample, additional macroeconomic variables in France, Germany, and Italy reduced the adjusted R-squared from 0.16, 0.15, and 0.08 to 0.12, 0.09, and 0.00, respectively.

By comparing the estimated results of the BRICS and G7 countries, we can draw the following implications for the movement of current accounts. (i) Productivity shocks as determinants of current account movements are more important in developing countries. (ii) However, productivity shocks lose their explanatory power for developing countries in the midst of the financial crisis. (iii) Demography, net foreign assets, and trade openness contribute to the movements of the current account for the BRICS countries, but this is less so for the G7 countries and even the opposite for euro countries.

5. Discussions

In this study, five macroeconomic variables are selected for the modified Glick-

[9] These conclusions are drawn from comparing the results in Table 2a (2b) and Table 3a (3b). However, the sample periods for the modified model do not exactly match those in the basic model due to the exclusion of a few years for missing macroeconomic variables. The estimation results in Appendix Tables B1a and B1b with the sample period adjusted to match those of Table 3a and 3b confirm that the qualitative results do not change.

Rogoff model, which examines the effects of productivity shocks on current account changes. In the current account literature, researchers tested many more variables as determinants of current account movements. In this section, we discuss the possibility of other macroeconomic variables that may contribute to an increase in the fitness of the current empirical model. Some of the discussions in this section are meant to help improve future works.

First, in addition to trade openness, financial openness is also an important determinant of current account movements. By interpreting financial openness as unrestricted international capital flow, Yan and Yang (2012) find a shift in causality between the current account and capital inflows after the global financial crisis. Chin and Ito (2007) find that financial market development causes developed countries to have smaller savings and thus a current account deficit, while the opposite is true for Asian countries. Furthermore, Tan et al. (2015) examine the effect of the structure of the financial system on current accounts. They find that a country with a fully developed capital market is more likely to run a current account deficit. In this study, the financial deepening variable, i.e., the ratio of broad money to GDP, is most closely related to financial openness; however, this variable is not statistically significant for most of the cases in either the BRICS or the G7 countries. Our study confirmed the finding in the literature that development in capital markets is more relevant for current account adjustment than the growth in bank lending or money supply are.

Second, the income distribution within a country matters for current accounts. Income inequality raises national savings and thus increases current accounts if the savings rate of the richer individuals is higher than that of the poorer individuals. However, there are a variety of theoretical models that can generate the reduction in the current account associated with income inequality; see Behringer and van Treeck (2018). Belabed et al. (2018) suggest that the US current account deficit can be explained in part by rising income inequality in the US. From investigating a sample of 20 countries, Behringer and van Treeck (2018) also find that income inequality leads to a decline in current accounts. In our study, the dependency ratio of young and elderly individuals may capture the part of the mechanism by which income distribution affects current accounts. The national savings rate should decline if the dependency ratio of elder (or dissaving) cohorts increases. Puzzlingly, in this study, the dependency ratio of elder cohorts on current accounts is positive for both BRICS and G7 countries whenever the ratio is statistically significant. One possible explanation for this contradiction between the theoretical predictions and empirical results in this paper may come from regressions based on the time-series of a single country rather than the panel framework used in Chin and Ito

(2007). As often experienced in many other applied works, demographical characteristics can only be captured in the difference in cross-sections of countries.

Third, real exchange rates, or terms of trade, is not considered in this study. The effects of the terms of trade, i.e., relative price of exports and imports or relative price of tradable and non-tradable goods, on the current account is a classic issue in international macroeconomics. The so-called HLM effect works through the real income effect by which the terms of trade deterioration decreases the current account balance (Harberger, 1950 and Laursen and Metzler, 1950). Svensson and Razin (1983) examined the effect of terms-of-trade changes on a small country's current account under perfect international capital mobility. A temporary terms-of-trade deterioration implies a deterioration of the current account, whereas a permanent terms-of-trade deterioration has an uncertain effect on the current account. Gervais et al. (2016) analyze a large set of emerging countries over the period from 1975 to 2008. They indicate that real exchange rate adjustment contributed to reducing current account imbalances. Focusing on the non-tradable sector, as in the Balassa-Samuelson effect on the real exchange rate, Hoffmann (2013) claims that the present-value model with non-tradeable goods explains more than 70 percent of China's current account variability over the period 1982-2007.

6. Conclusion

Current account adjustment became a classic macroeconomic issue in the 1950s and is still one of the important macroeconomic policy objectives today. Especially for fast-growing developing counties such as Brazil, China, India, Russia, and South Africa, a large current account imbalance can lead to an economic crisis for the worst case. In this study, we investigated the determinants of current account changes for these BRICS countries between 1983 and 2017. As an empirical model, we selected the Glick-Rogoff model, which emphasizes productivity shocks at home and in the world and fits well with developed economies in the 1970s and 1980s (Glick and Rogoff, 1985). However, the Glick-Rogoff model fits poorly when it is applied to fast-growing BRICS countries for the period including the global financial crisis.

Productivity shocks are important determinants of current account movements; however, a set of global and country-specific productivity shocks alone cannot explain a country's current account. A set of macroeconomic variables help to improve the fitness of regression for developing countries but can worsen the adjusted R-squared for euro countries. It is not surprising that different mechanisms of current account adjustment work for different groups of countries, i.e., developed and developing countries, because there are many differences in terms of monetary policy, exchange rate systems, tariffs and

trade regulations between the two groups. This result suggests that policymakers should search for a framework in which the current account adjusts through its own country-specific mechanism.

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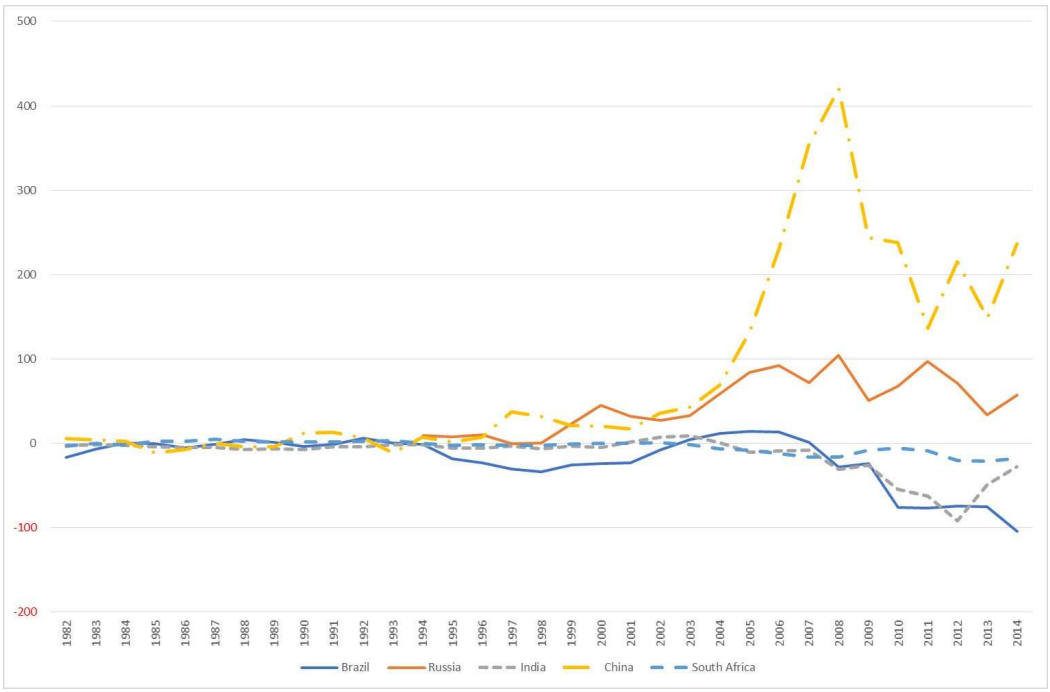
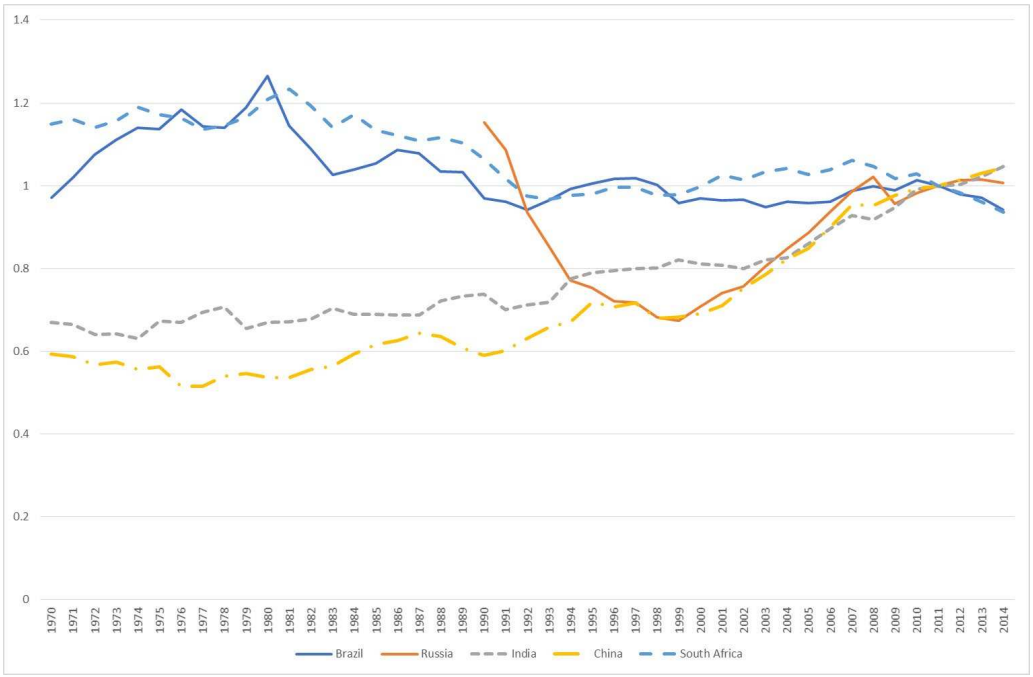
Figure 1. Current Accounts of BRICS Countries



Note: Current accounts are in terms of current billion US dollars. Source: World Development Indicators, the World Bank.

Figure 2. Total Factor Productivity of BRICS Countries



Note: Total factor productivity is normalized for unity in 2011 for each country. Source: World Development Indicators, the World Bank.

Table 1a. Basic Glick-Rogoff regression with TFP as country-specific shock and weighted average as global shock

		Russia	Brazil	India	China	South Africa
Panel1	Period	1995-2008	1983-2008	1983-2008	1983-2008	1983-2008
Country-specific		-1.12(1.72)	-0.01(0.04)	0.04(0.07)	0.13(0.08)	-0.06(0.05)
Global		5.14(10.09)	0.91(0.40) **	-0.03(0.20)	0.40(0.26)	-0.38(0.22) *
Investment		0.10(0.09)	0.01(0.03)	-0.02(0.01)	0.06(0.01) ***	-0.10(0.02) ***
Number of obs		14	26	26	26	26
Adj R-squared		-0.14	0.29	0.20	0.60	0.58
Panel2	Period	1995-2017	1983-2017	1983-2017	1983-2017	1983-2017
Country-specific		0.11(1.33)	-0.18(0.12)	0.27(0.15) *	0.17(0.18)	-0.14(0.09)
Global		15.17(9.56)	0.15(0.45)	-0.29(0.33)	0.62(0.78)	-0.20(0.70)
Investment		-0.02(0.05)	0.00(0.03)	-0.01(0.01)	-0.02(0.01)	0.00(0.02)
Number of obs		23	35	35	35	35
Adj R-squared		-0.05	-0.01	-0.02	0.02	-0.06

Note: Global shock is calculated as the weighted average of total factor productivity of the G7 and country-specific shocks as the country's total factor productivity. Heteroscedasticity-robust standard errors are in parentheses. *, **, and *** represent the 10, 5, and 1 percent statistical significance levels, respectively.

Table 1b. Basic Glick-Rogoff regression with TFP as country-specific shock and principal component as global shock

		Russia	Brazil	India	China	South Africa
Panel1	Period	1995-2008	1983-2008	1983-2008	1983-2008	1983-2008
Country-specific		-1.23(1.58)	-0.00(0.04)	0.02(0.07)	0.14(0.09)	-0.08(0.05)
Global		0.16(0.28)	0.02(0.01) **	0.00(0.01)	0.01(0.01)	0.00(0.01)
Investment		0.11(0.08)	-0.01(0.02)	-0.02(0.01)	0.06(0.01) ***	-0.07(0.02) ***
Number of obs		14	26	26	26	26
Adj R-squared		-0.13	0.20	0.23	0.58	0.53
Panel2	Period	1995-2017	1983-2017	1983-2017	1983-2017	1983-2017
Country-specific		-0.21(1.39)	-0.18(0.12)	0.23(0.13)	0.16(0.18)	-0.15(0.10)
Global		0.30(0.25)	0.00(0.10)	0.00(0.01)	0.01(0.02)	0.01(0.02)
Investment		-0.02(0.05)	0.00(0.02)	-0.01(0.01)	-0.01(0.07)	0.00(0.02)
Number of obs		23	35	35	35	35
Adj R-squared		-0.08	-0.01	-0.04	-0.01	-0.05

Note: Global shock is calculated as the first principal component of the total factor productivity of the G7 and country-specific shocks as each country's total factor productivity. Heteroscedasticity-robust standard errors are in parentheses. *, **, and *** represent the 10, 5, and 1 percent statistical significance levels, respectively.

Table 2a. Basic Glick-Rogoff regression with TFP residual as country-specific shock and weighted average as global shock

		Russia	Brazil	India	China	South Africa
Panel1	Period	1995-2008	1983-2008	1983-2008	1983-2008	1983-2008
Country-specific		-1.12(1.72)	-0.01(0.04)	0.04(0.07)	0.13(0.08)	-0.06(0.05)
Global		4.10(10.52)	0.90(0.39) **	0.01(0.22)	0.51(0.27) *	-0.44(0.20) **
Investment		0.10(0.09)	0.01(0.03)	-0.02(0.01)	0.06(0.01) ***	-0.10(0.02) ***
Number of obs		14	26	26	26	26
Adj R-squared		-0.14	0.29	0.20	0.60	0.58
Panel2	Period	1995-2017	1983-2017	1983-2017	1983-2017	1983-2017
Country-specific		0.11(1.33)	-0.18(0.12)	0.27(0.15) *	0.17(0.18)	-0.14(0.09)
Global		15.31(9.32)	-0.04(0.51)	-0.03(0.34)	0.76(0.76)	-0.35(0.73)
Investment		-0.02(0.05)	0.00(0.03)	-0.01(0.01)	-0.00(0.01)	0.00(0.02)
Number of obs		23	35	35	35	35
Adj R-squared		-0.05	-0.01	-0.02	0.02	-0.06

Note: Global shock is calculated as the weighted average of total factor productivity of the G7 and country-specific shocks as the residual of each country's total factor productivity on Global shock. Heteroscedasticity-robust standard errors are in parentheses. *, **, and *** represent the 10, 5, and 1 percent statistical significance levels, respectively.

Table 2b. Basic Glick-Rogoff regression with TFP residual as country-specific shock and principal component as global shock

		Russia	Brazil	India	China	South Africa
Panel1	Period	1995-2008	1983-2008	1983-2008	1983-2008	1983-2008
Country-specific		-1.24(1.58)	-0.00(0.04)	0.02(0.07)	0.14(0.08)	-0.08(0.06)
Global		-0.32(0.71)	0.02(0.01) **	0.01(0.01)	0.02(0.01) *	-0.00(0.01)
Investment		0.11(0.08)	-0.01(0.02)	-0.02(0.01)	0.06(0.01) ***	-0.07(0.02) ***
Number of obs		14	26	26	26	26
Adj R-squared		-0.13	0.20	0.23	0.58	0.53
Panel2	Period	1995-2017	1983-2017	1983-2017	1983-2017	1983-2017
Country-specific		-0.22(1.39)	-0.18(0.12)	0.23(0.13) *	0.16(0.18)	-0.15(0.10)
Global		0.21(0.54)	-0.00(0.01)	0.02(0.02)	0.03(0.02)	-0.01(0.02)
Investment		-0.02(0.05)	0.00(0.02)	-0.01(0.01)	-0.00(0.01)	0.00(0.02)
Number of obs		23	35	35	35	35
Adj R-squared		-0.08	-0.01	-0.04	-0.01	-0.05

Note: Global shock is calculated as the first principal component of the total factor productivity of the G7 and country-specific shocks as the residual of each country's total factor productivity on global shock. Heteroscedasticity-robust standard errors are in parentheses. *, **, and *** represent the 10, 5, and 1 percent statistical significance levels, respectively.

Table 3a. Modified Glick-Rogoff regression with TFP residual as country-specific shock and weighted average as global shock

		Russia	Brazil	India	China	South Africa
Panel1	Period		1983-2008	1983-2008	1983-2008	1983-2008
Country-specific			0.01(0.03)	0.02(0.06)	0.02(0.08)	-0.13(0.04) **
Global			0.86(0.26) ***	-0.01(0.22)	-0.26(0.43)	-0.43(0.27)
Investment			-0.21(0.07) ***	0.00(0.08)	-0.19(0.15)	-0.14(0.10)
fdeep			-0.01(0.01)	-0.01(0.05)	-0.05(0.05)	-0.03(0.05)
reldepo			0.87(0.98)	2.76(3.20)	1.38(2.69)	-0.79(0.82)
reldepy			-0.15(0.08)	0.02(0.21)	0.02(0.12)	-0.05(0.03)
nfa/GDP			2.87(1.66)	1.50(13.68)	18.58(7.88) **	
open			8.08(7.73)	-11.96(11.37)	8.12(5.10)	7.49(1.84) ***
Number of obs			26	26	26	26
Adj R-squared			0.60	0.29	0.69	0.68
Panel2	Period	2001-2017	1983-2016	1983-2015	1983-2017	1983-2017
Country-specific		7.07(4.46)	-0.23(0.12) *	0.10(0.10)	-0.21(0.14)	0.05(0.13)
Global		40.35(16.75) **	-0.44(0.65)	-0.25(0.34)	0.54(037)	-0.56(0.78)
Investment		0.31(0.26)	-0.26(0.08) **	0.03(0.06)	0.02(0.03)	0.10(0.07)
fdeep		-0.03(0.03)	0.01(0.01)	-0.04(0.09)	-0.01(0.03)	-0.03(0.08)
reldepo		-0.21(0.22)	5.09(1.76) ***	0.95(7.51)	0.45(1.18)	-0.70(2.26)
reldepy		-0.37(0.13) **	0.40(0.17) **	-0.09(0.47)	0.43(0.28)	0.08(0.06)
nfa/GDP		4.30(1.87) *	1.70(2.11)	5.69(21.77)	2.56(5.46)	
open		13.77(12.05)	8.81(20.97)	-14.10(13.64)	24.99(7.79) ***	-6.68(7.64)
Number of obs		17	34	33	35	35
Adj R-squared		0.31	0.22	-0.02	0.24	-0.04

Note: Global shock is calculated as the weighted average of total factor productivity of the G7 and country-specific shocks as residual of each country's total factor productivity on global shock. Heteroscedasticity-robust standard errors are in parentheses. *, **, and *** represent the 10, 5, and 1 percent statistical significance levels, respectively.

Table 3b. Modified Glick-Rogoff regression with TFP residual as country-specific shock and principal component as global shock

		Russia	Brazil	India	China	South Africa
Panel1	Period		1983-2008	1983-2008	1983-2008	1983-2008
Country-specific			0.01(0.04)	0.02(0.07)	0.02(0.08)	-0.14(0.04) ***
Global			0.01(0.01) **	0.01(0.01)	0.00(0.01)	-0.00(0.01)
Investment			-0.26(0.08) ***	0.01(0.08)	-0.12(0.14)	-0.05(0.10)
fdeep			-0.01(0.01)	-0.01(0.05)	-0.02(0.05)	-0.06(0.04)
reldepo			1.65(1.00)	2.26(3.24)	0.12(2.64)	-1.70(1.26)
reldepy			-0.12(0.08)	-0.02(0.21)	0.02(0.12)	-0.05(0.04)
nfa/GDP			3.69(1.95) *	0.38(13.35)	16.13(7.25) **	
open			3.64(7.63)	-12.22(11.27)	6.38(5.18)	8.09(2.16) ***
Number of obs			26	26	26	26
Adj R-squared			0.45	0.31	0.68	0.66
Panel2	Period	2001-2017	1983-2016	1983-2015	1983-2017	1983-2017
Country-specific		4.58(4.07)	-0.23(0.12) *	0.06(0.07)	-0.19(0.15)	0.00(0.13)
Global		2.51(1.78)	-0.01(0.01)	0.01(0.05)	-0.01(0.01)	-0.01(0.02)
Investment		0.31(0.26)	-0.25(0.10) ***	0.03(0.08)	0.02(0.03)	0.10(0.09)
fdeep		-0.02(0.03)	0.01(0.01)	-0.04(0.49)	-0.02(0.04)	-0.04(0.08)
reldepo		-0.15(0.21)	5.03(1.77) ***	-0.34(3.24)	0.36(1.21)	-0.75(2.63)
reldepy		-0.38(0.14) **	0.40(0.17) **	-0.18(0.21)	0.30(0.28)	0.06(0.05)
nfa/GDP		3.96(1.88) *	1.85(2.10)	8.69(13.35)	-0.38(5.68)	
open		16.74(13.05)	9.93(23.14)	-14.77(11.27)	23.92(7.52) ***	-5.76(7.32)
Number of obs		17	34	33	35	35
Adj R-squared		0.29	0.22	-0.04	0.20	-0.05

Note: Global shock is calculated as the first principal component of the total factor productivity of the G7 and country-specific shocks as the residual of each country's total factor productivity on global shock. Heteroscedasticity-robust standard errors are in parentheses. *, **, and *** represent the 10, 5, and 1 percent statistical significance levels, respectively.

Appendix A. List of variables

Variable	Source	Description
tfp	PWT9.1	TFP at constant national prices (2011=1)
GDP	WDI	gross domestic product (current LCU)
ca	WDI	current account balance (BoP, current US$) times official exchange rate (LCU per US$, period average)
investment	WDI	gross fixed capital formation (current LCU) plus changes in inventories (current LCU)
aw1		weighted average of G7 countries' TFP
aw2		principal component of G7 countries' TFP
fdeep	WDI	financial deepening: broad money (% of GDP)
reldepo	WDI	age dependency ratio, old (% of working-age population)
reldepy	WDI	age dependency ratio, young (% of working-age population)
nfa	WDI	net foreign assets (current LCU); Net foreign assets are the sum of foreign assets held by monetary authorities and deposit money banks minus their foreign liabilities. Data are in current local currency.
open	WDI	[exports of goods and services (current LCU) + imports of goods and services (current LCU)] /GDP (current LCU)

Appendix B.

Table B1a. Basic Glick-Rogoff regression with the TFP residual as country-specific shock and weighted average as global shock; sample adjusted to coincide with Table 3a

		Russia	Brazil	India	China	South Africa
Panel2	Period	2001-2017	1983-2016	1983-2015	1983-2017	1983-2017
Country-specific		0.01(3.12)	-0.19(0.11)	0.26(0.15) *	0.17(0.18)	-0.14(0.09)
Global		14.62(13.29)	-0.15(0.48)	0.12(0.37)	0.76(0.76)	-0.35(0.73)
Investment		-0.02(0.06)	-0.00(0.03)	-0.00(0.02)	-0.00(0.01)	0.00(0.02)
Number of obs		17	34	33	35	35
Adj R-squared		-0.13	0.00	-0.02	0.02	-0.06

Note: Global shock is calculated as the weighted average of total factor productivity of the G7 and country-specific shocks as the residual of each country's total factor productivity on global shock. Heteroscedasticity-robust standard errors are in parentheses. *, **, and *** represent the 10, 5, and 1 percent statistical significance levels, respectively.

Table B1b. Basic Glick-Rogoff regression with the TFP residual as country-specific shock and the principal component as global shock; sample adjusted to coincide with Table 3b

		Russia	Brazil	India	China	South Africa
Panel2	Period	2001-2017	1983-2016	1983-2015	1983-2017	1983-2017
Country-specific		-1.45(2.95)	-0.19(0.11) *	0.23(0.13) *	0.16(0.18)	-0.15(0.10)
Global		-0.29(1.27)	-0.01(0.11)	0.26(0.17)	0.03(0.02)	-0.01(0.02)
Investment		-0.03(0.06)	-0.01(0.03)	0.00(0.02)	-0.00(0.01)	0.00(0.02)
Number of obs		17	34	33	35	35
Adj R-squared		-0.15	0.00	-0.02	-0.01	-0.05

Note: Global shock is calculated as the first principal component of the total factor productivity of the G7 and country-specific shocks as the residual of each country's total factor productivity on global shock. Heteroscedasticity-robust standard errors are in parentheses. *, **, and *** represent the 10, 5, and 1 percent statistical significance levels, respectively.

Table C1. Basic Glick-Rogoff regression for G7 countries with the TFP residual as country-specific shock and the principal component as global shock

		Canada	France	Germany	Italy	Japan	United Kingdom	United States
Panel1	Period	1983-2008	1983-2008	1983-2008	1983-2008	1983-2008	1983-2008	1983-2008
Country-specific		0.18(0.17)	-0.01(0.18)	-0.39(0.18) *	0.07(0.10)	-0.43(0.17) **	0.05(0.12)	-0.57(0.15) ***
Global		0.49(0.39)	-0.44(0.30)	0.43(0.59)	-0.28(0.56)	0.67(0.39) *	-0.08(0.27)	-0.43(0.16) **
Investment		0.02(0.03)	-0.07(0.02) **	0.07(0.07)	-0.05(0.03)	0.01(0.03)	-0.05(0.03)	-0.02(0.02)
Number of obs		26	26	26	26	26	26	26
Adj R-squared		-0.02	0.16	0.15	0.08	0.28	-0.02	0.43
Panel2	Period	1983-2017	1983-2017	1983-2017	1983-2017	1983-2017	1983-2017	1983-2017
Country-specific		0.34(0.15) **	-0.06(0.17)	-0.33(0.18) *	0.03(0.14)	-0.30(0.14) **	0.01(0.14)	-0.25(0.23)
Global		0.76(0.45)	-0.12(0.17)	0.46(0.29)	-0.59(0.38)	0.63(0.25) **	-0.05(0.35)	-0.76(0.27) ***
Investment		-0.01(0.02)	-0.02(0.02)	0.07(0.04) *	-0.02(0.03)	0.01(0.03)	-0.01(0.04)	-0.01(0.01)
Number of obs		35	35	35	35	35	35	35
Adj R-squared		0.21	-0.04	0.14	0.01	0.13	-0.10	0.34

Note: Global shock is calculated as the first principal component of the total factor productivity of the G7 and country-specific shocks as the residual of each country's total factor productivity on global shock. Heteroscedasticity-robust standard errors are in parentheses. *, **, and *** represent the 10, 5, and 1 percent statistical significance levels, respectively.

Table C2. Modified Glick-Rogoff regression for G7 countries with the TFP residual as country-specific shock and the principal component as global shock

		Canada	France	Germany	Italy	Japan	United Kingdom	United States
Panel1	Period	1983-2008	1983-2008	1983-2008	1983-2008	1983-2008	1983-2008	1983-2008
Country-specific		0.13(0.11)	0.05(0.17)	-0.38(0.37)	0.11(0.15)	-0.24(0.31)	0.18(0.14)	-0.36(0.11) ***
Global		1.08(0.37) ***	-0.25(0.25)	0.58(0.70)	-0.38(0.57)	1.42(0.52) **	0.07(0.32)	-0.29(0.22)
Investment		0.17(0.15)	0.02(0.14)	0.04(0.09)	-0.12(0.19)	0.25(0.19)	0.05(0.16)	0.01(0.04)
fdeep						-0.01(0.01)	-0.01(0.01)	0.05(0.04)
reldepo		0.50(0.28) *	0.34(0.17) *	0.10(0.47)	0.34(0.35)	0.27(0.36)	-0.06(0.82)	0.73(0.41) *
reldepy		0.77(0.43) *	0.56(0.53)	-0.14(0.62)	0.05(0.17)	0.49(0.57)	0.33(0.37)	0.11(0.44)
nfa/GDP		0.72(2.71)	3.33(4.82)	1.91(14.65)	5.04(5.66)	4.96(4.31)	-16.09(9.41)	10.41(17.13)
open		1.88(3.20)	-7.68(7.80)	-0.03(11.06)	-7.72(8.30)	-4.29(8.91)	1.40(9.40)	-1.64(9.15)
Number of obs		26	26	26	26	26	26	26
Adj R-squared		0.24	0.12	0.09	0.00	0.33	0.13	0.53
Panel2	Period	1983-2017	1983-2017	1983-2017	1983-2017	1983-2017	1983-2017	1983-2017
Country-specific		0.23(0.15)	-0.01(0.13)	-0.29(0.20)	-0.06(0.23)	-0.28(0.17)	-0.05(0.23)	-0.22(0.16)
Global		0.95(0.39) **	-0.15(0.15)	0.39(0.39)	-0.80(0.37) **	0.88(0.37) **	-0.03(0.42)	-0.71(0.25) ***
Investment		0.08(0.14)	-0.00(0.09)	0.03(0.07)	-0.16(0.13)	0.14(0.08) *	0.01(0.15)	0.00(0.04)
fdeep						-0.02(0.01)	0.00(0.02)	0.09(0.06)
reldepo		0.07(0.21)	0.17(0.10) *	-0.10(0.30)	0.25(0.11) **	0.12(0.07)	0.16(0.68)	0.08(0.09)
reldepy		0.34(0.39)	0.25(0.26)	-0.03(0.32)	0.06(0.15)	0.19(0.11)	0.36(0.38)	0.53(0.43)
nfa/GDP		-1.74(1.58)	1.66(4.35)	-4.53(5.81)	-1.63(5.88)	3.92(4.03)	-2.13(11.73)	6.33(13.42)
open		6.20(2.63) **	-5.28(5.41)	3.32(7.47)	-2.77(7.17)	-1.77(6.54)	2.27(10.22)	-0.74(3.99)
Number of obs		35	35	35	35	35	35	35
Adj R-squared		0.33	0.00	0.11	0.07	0.21	-0.23	0.57

Note: Global shock is calculated as the first principal component of the total factor productivity of the G7 and the country-specific shocks as the residual of the country's total factor productivity on global shock. Heteroscedasticity-robust standard errors are in parentheses. *, **, and *** represent the 10, 5, and 1 percent statistical significance levels, respectively.