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Government size and openness: Evidence from the commodity boom in Latin America.

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Abstract

Does government size increase to compensate for the volatility that arises from openness? We evaluate this compensation hypothesis by focusing on Latin America, whose economic growth in the 2000s has been often attributed to the commodity boom. Panel data regressions show that during the 2003-2010 commodity boom terms of trade volatility has positive effects on government size compared to the earlier 1990-2002 period. This key finding supports the compensation hypothesis, a result robust to dynamic panels allowing for reverse causation from government size to the real economy. Policy implications include diversification of the production structure and strengthening of regulatory framework.

Keywords: Commodity Boom; Government Size; Latin America; Openness; Panel Data.

JEL Classification: Q33; H50; N16; O24; C23

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1. Introduction

Much has been written in the literature regarding the causal relationships between openness and government size (normally measured as government expenditures over GDP, or G/Y). In an influential paper, Rodrik (1998) proposes a general equilibrium model to explain this with the government as the “safe” sector in terms of employment not subject to external risk. He shows that government size increases, however, to compensate for the volatility that arises from more trade openness.

The current paper examines the 2000s commodity boom period for more recent evidence on Rodrik’s (1998) compensation hypothesis through the channel of terms-of-trade volatility. Revisiting this hypothesis is crucial for at least two reasons. One is because of the risks associated with a larger government size. For instance, since countries may desire to implement trade policies that foster more openness, the potential budgetary effects (larger government expenditures) may lead to the need for further adoption of public policies. Our paper brings into the discussion that fiscal risk prevention mechanisms such as sovereign wealth funds and the diversification of the production structure are some of the public policies that could minimize the risks coming from the sticky nature of government spending especially in times of economic busts. Another reason for the relevance of this research is that existing studies with terms-of-trade volatility have focused on long-run relationships. Examples include Islam (2004), whose time series analysis is not supportive of the proposition in Rodrik (1998) and Epifani and Gancia (2009) for panel data, whose long-run conclusion is that globalization may have led to inefficiently large governments as evidenced by the significance of the openness (share of imports plus exports over GDP) coefficients but not from terms-of-trade volatility. Is it possible that the 2000s commodity boom price volatility has contributed to some response of government size to terms-of-trade volatility in Rodrik's (1998) compensation hypothesis?

The 2000s is important due to the increase in international trade in commodity-exporting countries such as the Latin American economies studied in this paper. Previous work on Latin American economies by Lizardo and Mollick (2009) finds a negative relationship between government size and economic growth, while Blanco and Grier (2012) find that different sub-categories of natural resource output (petroleum, agriculture) have different effects on physical and human capital accumulation. We reconsider these economies in this study, in which over the 25-year period government size (as the mean of 18 countries) has moved from a little more than 10% in 1990 to almost 14% in 2014. This paper investigates whether this upward trend in government size is due to characteristics of the business cycle or represents a response to external shocks – such as to terms of trade (TOT) volatility – as Rodrik (1998) suggests. We find strong support for the latter, especially during the commodity price boom of the 2000s.

2. Literature Review and the case for Latin America

2.1 General Literature Review

Rodrik (1998) posits that the positive correlation between an economy's exposure to international trade and the size of its government exists because government spending plays a risk-reducing role in economies exposed to a significant amount of external risk. Therefore, an increase in government size is associated with an effort to compensate for the volatility that arises from openness. This relationship has been referred to as the "compensation hypothesis" in

International Economics. Some authors such as Alesina and Wacziarg (1998) cast doubt on the direct link between openness and government consumption, arguing that this link is mediated by country size, by showing that smaller countries have a larger share of public consumption in GDP, and are also more open to trade. Ram (2009), however, uses fixed-effects panel data regressions in the period 1960–2000 for 154 countries and argues that the positive association between openness and government size does not seems to arise due to the mediating role of country size. Kimakova (2009) revisits government size and openness for financial openness (gross private capital flows/GDP) for panel data and finds that economies with greater exposure to cross-border capital flows tend to have larger government size. Theoretical work by Epifani and Gancia (2009) proposes a mechanism on how openness can increase government size through two channels: (1) a terms-of-trade externality, with trade lowering the domestic cost of taxation; and (2) the demand for insurance, whereby trade raises risk and public transfers. The key parameter is the elasticity of substitution between domestic and foreign goods and evidence is provided on the positive association between government size and openness. More recently, Jetter and Parmeter (2015) revisit the role of country size and find that the results differ significantly depending on the data source used. In addition, Benarroch and Pandey (2008, 2012) use both aggregate and disaggregated government expenditure data and find no evidence to support the relationship between openness and government size.

This topic can be better understood from the viewpoints of a larger literature that links natural resources to the real economy, such as Gerelmaa and Kotani (2016), who find that from 1970 to 1990 the resource curse holds but not from 1990 to 2010. Badeeb et al. (2017) contain an up-to-date literature review of the evolution of the natural resource curse thesis and propose five main causal mechanisms. First, the “Dutch disease” in which natural resource booms increase domestic income and demand for goods leading to inflation and real exchange rate appreciation, creating both "spending" effects (which have a negative effect on growth) and "pull" effects (which have a negative effect on non-resource sectors). Second, volatility in commodity prices increases uncertainty and reduces economic growth. The recent paper by Moradbeigi and Law (2016) is an example for 63 oil producing countries during 2000-2010 showing economic growth volatility responding negatively to oil terms of trade volatility. A third causal mechanism is economic mismanagement as natural resource revenues lead to overconfident policymakers. Fourth, rent seeking over the windfall of resource revenues increases the power of elites. Fifth, windfall resource revenues, rather than broadly based taxation, can make governments less accountable, putting downward pressure on institutional quality and lowering growth in turn. By examining the determinants of government size, this study might suggest another possible causal mechanism of a resource curse, as the mechanisms discussed in Badeeb et al. (2017) lead to a larger size of government, which in turn could hinder growth.

Although authors have previously investigated evidence of Rodrik's (1998) "compensation hypothesis", none has checked a period of high turbulence such as the 2000s commodity boom in Latin America to search for evidence supporting the increase in government size as a response to the increased volatility brought about by larger trade openness. In the following section, we provide details on the data and methodology used in this study.

2.2 Latin America and the 2000s Commodity Boom

The 2000s commodity boom is considered the largest commodity supercycle since the two post-World War II commodity booms which took place in the early 1950s and early to mid-1970s. Each of the first two booms lasted around two years as macroeconomic policies were employed to tackle inflation in the developed economies – the largest consumers of commodities (Baffes et al. 2008; Radetzki 2006). The most recent commodity boom is different from these previous booms because it combines a strong macroeconomic expansion in the period with a large use of commodities in emerging markets (Radetzki et al. 2008).

The Latin American region is one of the most commodity-dependent regions within the emerging market world. According to Harrup (2016), the region's exposure to commodities is unique in the world, even greater than middle-income African countries. Besides, the rebound in Latin American economic growth in the 2000s is often attributed to the commodity boom (Rosnick and Weisbrot, 2014).

About five decades ago, Latin America's dependence of commodities had an extra ingredient: most of the countries relied on a single commodity. Coffee is the commodity that has been exported by most Latin American economies. Blumenfeld (1961) demonstrates that, between 1957 and 1959, the following countries' exports were extremely dependent on coffee, by value: Brazil (58%), Colombia (77%), Costa Rica (51%), El Salvador (72%), Guatemala (72%) and Haiti (63%). Today, although Latin America is less dependent on coffee around 50% of the world's coffee production still comes from the region (Faostat, 2017).

Ocampo (2017) shows that Latin America's dependence on natural resource-intensive exports increased during the 2000s commodity boom. Today, crude oil, copper, iron ore and soybeans are the top exported commodities produced in Latin America. The UN Comtrade (2017) database shows that these four commodities together account for 24.2% of Latin American exports: crude oil with 13.3%, followed by copper (4.9%), iron ore (3.0%) and soybeans (3.0%).[1] Also, these four commodities accounted for 80% of Latin America's exports to China in the period from 2008 to 2014 (Casanova et al., 2016) and a recent study by Vianna (2016) provides evidence that exports to China are important to Latin American economic growth. The percentages of commodity dependence of each Latin American country are very large. Ocampo (2017, Table 4.1) shows that the percentages of natural resource dependence of 19 Latin American exports are as high as 96% for Bolivia, 94% for Ecuador, 93% for Venezuela and 91% for Paraguay, with only three exceptions: Mexico (24%), El Salvador (27%) and Costa Rica (23%). Large countries such as Brazil (63%) and Argentina (65%) also show high levels of natural resources exports dependence.

The period from 1995 to 2002 represents an era of economic deterioration in Latin America. Calvo and Talvi (2005) discuss the negative effects of the Tequila crisis in 1995 and, later, the Russian crisis of 1998 on capital inflows to the region. The shortage in those capital flows lasted until the end of 2002 (Izquierdo et al., 2008). From 2003 to 2007, the global economy rose more than 4% each year, the highest economic growth sequence since the early 1970s. China has grown 73.5% in this 5-year period, speeding up from 10 to 14.2 percent yearly growth, at the same time that the prices of many mineral materials began to increase in 2003. (International Monetary Fund, 2016).

3 The Data and Methodology

Our analysis starts with a fixed-effects approach following Benarroch and Pandey (2008). Focusing on the coefficients of openness, terms-of-trade volatility and their interaction term, we

[1] Crude oil is a major commodity in Latin America. The largest oil exporters in the region are Argentina, Brazil and Venezuela. Iron ore production in the region comes mainly from Brazil. Chile is the largest copper producer worldwide, while Brazil and Colombia are in the top three exporters of coffee (UN Comtrade, 2017).

investigate whether an increase in the dependent variable government size is associated with an increase in those variables of interest, in an effort by the government to compensate for the increased volatility as hypothesized by Rodrik (1998).

We perform fixed-effect panel-data regressions using yearly data from 18 Latin American countries in 1990-2014, a 25-year period.[2] The choice of the Latin American region for the panel data analysis is based on homogeneity of the group of countries. Country selection criterion is based on data availability of World Development Indicators (WDI) from the World Bank. The 18 Latin American countries are: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Mexico, Panama, Paraguay, Peru, Uruguay and Venezuela.[3] In addition, we select the region because of its economic growth rebound in the 2000s, a change often attributed to the commodity boom (Rosnick and Weisbrot, 2014). A recent article in the Wall Street Journal (2016) reviews the end of the commodity boom and the negative effects for economic growth in the region: "South America's exposure to commodities prices is unique in the world", says Augusto de la Torre, World Bank chief economist for Latin America and the Caribbean, explaining that not even middle-income African countries have such a strong exposure.

Table 1 reports the variables definitions and descriptive statistics. All measures are extracted from the WDI database. Over the whole time span, government size increases 3.21% on average, from 10.48% to 13.69% of GDP. This increase is more substantive if we consider the lowest value in the series of 9.69% of GDP in the year 1992. Trade Openness (OPEN) is

[2] We run the Hausman test for the regressions in Tables 3 to 5 below to help select between the Random Effects and the Fixed Effects methods. The null hypothesis is that the preferred method is Random Effects, while the alternative hypothesis is that the only consistent model is Fixed Effects. The resulting p-values are below 0.05, which suggests that Fixed Effects methods be adopted.

[3] Nicaragua was originally in the sample but was excluded since its measured government size varied erratically in the beginning of the 1990s.

calculated as $(X_{it} + M_{it})/GDP_{it}$, where X is exports, M is imports and GDP is the gross domestic product of country *i* at time *t*. OPEN has a sharp increase from 51.81% in 1990 to 63.74% of GDP in 2014. Terms-of-trade volatility (TOTVOL), the deviation from the mean of the terms of trade index value (price of exports divided by imports, varying by country), has a mean close to zero and is depicted in Figure 1. The Latin American population in our sample has grown from 421.4 million in 1990 to 597.8 million in 2014, an increase of 41.9%. Even with this population increase, the real per capita GDP grew from US$ 1,911 in 1990 to US$ 7,940 in 2014. The average urbanization rate has moved up from 61.32 to 73.56% in that period. The dependency ratio, a measure of the number of dependents to the working-age population, has dropped from 74.73 to 55.16% between 1990 and 2014, in line with economic growth.

Table 2 displays the correlation coefficients between the variables in this study. The correlation coefficients do not suggest high values, except for some controls used in previous papers in this literature: real GDP per capita and urbanization rate (0.80), real GDP per capita and dependency ratio (-0.80), and urbanization rate and dependency ratio (-0.76). In addition, population has a negative correlation with openness (-0.68). See below for more on the choice of controls to be used in the estimations.

Figure 1 reports a long positive sequence of terms-of-trade volatility in the years 2003-2010.[4] The exceptions are years 2008 and 2009 which correspond to the global financial crisis. Moreover, the high terms of trade volatility in 1994 may be associated with trade gains at the end

[4] We follow Radetzki (2006) by determining 2003 as the initial year of the commodity boom period. More recent studies have considered 2010 as the last boom year, in line with Figure 1. Studies which focus on particular types of commodities, such as Lucotte (2016) for correlations of oil against six food commodity price indexes (cereals, dairy, meat sugar, vegetable oils, and a composite food price index) choose the pre-food crisis from 1990 to 2006 and the post-food crisis from 2007 to 2015.

of the Uruguay Round, a GATT round that lasted from 1986 to 1994 and culminated with WTO's creation.[5]

We implement the model used by Benarroch and Pandey (2008) as follows:

$$\ln(GOV\_SIZE)_{it} = \alpha_0 + \alpha_1 \ln(OPEN)_{it-1} + \alpha_2\, TOTVOL_{it-1} + \alpha_3 \,[\, \ln(OPEN)_{it-1}\, (TOTVOL)_{it-1}] + \beta \ln(X)_{it} + \eta_i + \varepsilon_{it} \qquad (1),$$

where variables for country *i* at period *t* are in natural logarithm terms (ln). The dependent variable ln(GOV_SIZE) is the natural log of government expenditures as a share of GDP; ln(OPEN) is the natural log of trade openness, lagged by one period to minimize endogeneity problems; TOTVOL is terms-of-trade volatility, calculated as the deviation from the mean of the index value (price of exports divided by imports, varying by country) also lagged by one period, as well as a lagged interactive term [$\ln(\text{OPEN})_{t-1}$ x TOTVOL_{t-1}]; X represents the control variables used in the literature in natural log terms: real GDP per capita (GDPCAP); population (POP); rate of urbanization (URBAN); and dependency ratio (DEP). We also include country-specific fixed effects (η) and an iid error term (ε).

Dynamic models allow for better estimates when including the one-period lagged government size (GOV_SIZE) in the right-hand side of the equation. As a first pass, we employ the fixed-effect estimators used in (1), which enable us to observe the increase in the model fit (R^2) in those regressions once lagged government size is taken into account. This model will be next verified by a system generalized method of moments (SGMM) approach in order to better address the endogeneity issue. The model allowing for lagged government size is as follows:

[5] GATT is the abbreviation for General Agreement on Tariffs and Trade. The World Trade Organization (WTO) was founded on January 1, 1995.

$$\ln(GOV\_SIZE)_{it} = \gamma_0 + \gamma_1 \ln(GOV\_SIZE)_{it-1} + \gamma_2 \ln(OPEN)_{it-1} + \gamma_3\, TOTVOL_{it-1} +$$

$$\gamma_4\, [\ln(OPEN)_{it-1}\, (TOTVOL)_{it-1}] + \mu \ln(X)_{it} + \eta_i + \varepsilon_{it} \qquad (2),$$

where a lagged dependent variable ln(GOV_SIZE) is inserted in the right-hand side of the equation. In the SGMM regressions, we assume that GDPCAP, URBAN and DEP, alternatively, are the endogenous variables in the model in order to address the reverse-causation bias. For example, government expenditures are part of GDP, and may be more directed to urban areas of a country, or may affect the dependency ratio via welfare and transfer programs. We alternate the control variable measures GDPCAP, URBAN and DEP subject to a multicollinearity, since they show high correlation coefficients (see Table 2). TOTVOL is employed as a purely exogenous variable to government size, consistent with the literature on terms-of-trade volatility or shocks. The presence of the interactive term captures the simultaneous openness hypothesis as put forward by Baltagi et al. (2009) on financial development (such as private credit) depending on trade and financial openness.[6] In our case, we have the level of openness and the volatility of terms of trade as key variables to explain government size, conditioned on the vector X. Both key variables are, by construction, determined by trade considerations governing the level of trade relative to GDP and also the terms of trade volatility as the ratio of price of exports to imports. Taking the partial derivative of ln (G/Y) to ln (OPEN) in (2) above yields $\gamma_2 + \gamma_4 TOTVOL_{it-1}$ and the partial derivative of ln (G/Y) to (TOTVOL) yields $\gamma_3 + \gamma_4 ln(OPEN)_{it-1}$. Both expressions can be evaluated at sample means as indicated in Table 1: the mean of OPEN is

[6] The approach with direct and indirect (interactive) effects has been used in many areas, including foreign capital inflows. Research work by Desbordes and Wei (2017), for example, assumes FDI flows respond to interactions between source and destination countries' financial development and the financial vulnerability of a sector.

62.17 and the mean of TOTVOL is 0.01. Furthermore, in order to avoid the over-identification bias associated with the proliferation of instruments we follow the collapse approach by Roodman (2009) and limit the model up to six lags to achieve a number of instruments smaller than the number of countries.

3. The Results

Table 3 reports panel data fixed effects regression results using equation (1). The specifications used are based on Benarroch and Pandey's (2008), where they alternate some controls. However, as we will show after the analysis of the results in Table 3 those specifications are subject to the multicollinearity bias, since some controls variables are highly correlated. In any case, we start our analysis by comparing our results with those authors' and later proceed to model specification adjustments. Columns 1-5 show regression results for the pre-commodity boom period from 1990 to 2002 while columns 6-10 display results for the commodity boom period from 2003 to 2010. Trade openness has no significant effect on size of government in the pre-commodity boom period, but surprisingly has negative effects on government size during the commodity boom with coefficients ranging from -0.36 to -0.29 with significance at the 5% (columns 6-7) and 1% level (columns 9-10). This result may indicate that trade, which positively impacts GDP in case of trade surpluses[7], has such a fast growth level during this period that government size is not able to follow its pace. TOTVOL has positive coefficients that are significant at the 5% level in the 2003-2010 period (columns 9-10). The TOTVOL coefficients are positive and statistically significant during 2008-2010 (2.7 or 2.2) and

[7] As in the "expenditures approach" to the calculation of the gross domestic product.

outweigh the negative effect of openness or the interaction term (-0.65 or -0.54) on government size. [8]

More urban areas require higher government size. In our estimates, URBAN impacts government size positively by 0.89%-1.26% only during the commodity boom. For each 1% increase in the urbanization ratio the response on government size is statistically significant at the 5% (columns 6, 7 and 10) and 10% (column 8) levels. In fact, Latin America increased its expenditures on infrastructure (which has reflected on higher urbanization) during the commodity boom period due to a more robust budget (more tax revenues) during that decade. According to Augusto de la Torre, World Bank Chief Economist for Latin American and the Caribbean, “during the commodity boom, Latin America became a global example for its ability to make growth benefit the poor” (World Bank, 2016). In Brazil, for example, social programs such as “Minha Casa, Minha Vida” (My Home, My Life) placed 10.5 million low-income people in 2.6 million housing units throughout the country between 2009 and mid-2016 and increased the demand for services and infrastructure as the urban population ratio grew to 84 percent; see Pacheco (2016).

The dependency ratio has a negative effect on the size of government only in the pre-commodity boom period that ranges from -2.6% (significant at the 1% level) to -1.53% (significant at the 10% level). We do not find evidence of a significant impact of population on government size. The model fit (R^2) varies between 22.1% and 38.7%.

Table 4 addresses the multicollinearity problem by alternating the highly correlated controls (GDPCAP, URBAN and DEP) and removing population size (which has a strong

[8] For robustness, we run the same regressions excluding Argentina and Brazil, well-known closed (but very large) economies, and the coefficients remain. The corresponding TOTVOL coefficients in columns (9)-(10) are even larger and remain precisely estimated: 3.814 and 3.043, respectively. The coefficients on openness and interactions remain negative as well. A table with estimates for 16 countries is available upon request.

negative correlation coefficient of -0.68 with openness) from our regressions. Columns 1-4 control for the per capita GDP, columns 5-8 use the urbanization rate as control, and columns 9-12 adopt the dependency ratio as the control variable. Each of these groups shows regression results for the 1990-2014, 1990-2002, 2003-2014 periods and the commodity boom period from 2003 to 2010, which serve as robustness checks for estimation of equation (1). Results are consistent among those groups: OPEN has a negative impact ranging from -0.25 to -0.28 in the 2003-2014 period and is even stronger during the 2003-2010 commodity boom period, between -0.29 and -0.36. Its significance level also grows from 5% (or 10% in the equation controlling from GDPCAP) to 1% (or 5% in the equation that uses URBAN as control). The TOTVOL coefficient is only significant (at the 5% level) during the 2003-2010 commodity boom period and ranges from 1.9 to 2.7. The interaction terms are negative and statistically significant in the 2003-2014 and 2003-2010 periods (except the 2003-2014 period when controlling for DEP), with higher significance levels during the 2003-2010 commodity boom. As in the previous table, the negative effect of the interaction term on government size is outweighed by the large positive impact from TOTVOL.

GDPCAP is positively related with government size. Its coefficients range from 0.13 to 0.36 and are significant at the 1% level. URBAN also has a positive association with government size with coefficients between 0.97 and 1.68. Coefficients in the 2003-2010 and 2003-2014 periods are significant at the 1% level. DEP has a negative impact on government size and its coefficients range from -0.96 to -2.02. The model fit (R^2) in Table 4 varies between 15.9% and 38.8%, very similar to the previous table but not suffering from multicollinearity.

Table 5 reports panel data fixed effects regression results using equation (2). Although the fixed effects method is not the most efficient estimator to handle lagged dependent variables, we take this step before the SGMM approach (Table 6) to provide robustness to previous findings, examine the persistency of government size and analyze the model fit of the fixed effects model.[9] We adopt a one-period lagged government size in the right-hand side of the equation and again keep population size out of our specifications due to its high correlation with OPEN. Results show moderate to high persistency of government size, with the lagged term coefficients ranging from 0.53 to 0.76 and significant at the 1% level in all 12 regressions. OPEN has no direct effect on government size. However, TOTVOL shows strong and significant (at the 5% level) positive coefficients only during the 2003-2010 commodity boom period, between 1.54 and 2.13. In line with previous findings, these coefficients are larger than the ones from the interaction between OPEN and TOTVOL, which are negative and significant at the 5% level are range from -0.364 and -0.499.

GDPCAP, URBAN and DEP show statistically significant coefficients at the 5% level in all 12 regression results, suggesting that the insertion of the lagged dependent variable government size improves the significance of control variables. Nevertheless, we can observe that TOTVOL and these controls have smaller coefficients than in the previous table after the insertion of lagged government size as an independent variable. The model fit (R^2) in Table 5 grows from previous values and ranges between 49.2% in column (4) and 68.1% in column (1).

Table 6 reports System-GMM regressions also based on equation (2), this time addressing more efficiently the endogeneity problem by assuming reverse causation from government size to GDPCAP, URBAN or DEP, depending on each specification as previously explained. The number of instruments is 16, a result of the use of the collapse tool in SGMM and limiting the number of lags up to six. Since the number of countries is 18, this addresses the

[9] In addition, a peer reviewer has observed that the lagged term will be correlated with the error term in fixed effects, although the bias diminishes with increasing number of observations.

overidentification bias proposed by Roodman (2009). The p-values for the AB (2) and the Hansen test are above 0.10 which means we fail to reject the null hypotheses of no serial correlation and validity of instruments, respectively.

Government size shows large persistency in SGMM models, with coefficients between 0.71 and 1.01, and always statistically significant at the 1% level. In Table 6, openness is positive and significant in three regressions (columns 2, 5 and 6). However, none of these three regressions are significant in the 2003-2010 commodity boom period, suggesting that, during the commodity boom, the impact of trade on government size comes from volatility. In fact, TOTVOL has a large positive coefficient in all three regressions in the 2003-2010 commodity boom period (columns 4, 8 and 12), ranging from 3.83 to 5.74. There is little evidence of a negative impact from the interaction OPEN x TOTVOL on government size. Only in column 8, during the 2003-2010 commodity boom, there is a coefficient of -0.89 with significance at the 10% level. In line with previous findings in this paper, this coefficient is outweighed by a strong positive TOTVOL coefficient (3.83) that is significant at the 5% level.

In these SGMM results, the impacts from the control variables are gone or diminished, depending on each specification: GDPCAP is not statistically significant, while URBAN is positive and highly significant in columns 5 and 6, and DEP is negative and significant at the 1% level only in column 10. Therefore, these controls are not significant for the 2003-2010 commodity boom period.

On the partial derivatives discussed after equation (2) in the Methodology section, we note that the partial derivative of ln (G/Y) to ln (OPEN), when evaluated at sample means (means of OPEN at 62.17 and of TOTVOL at 0.01), represented by $\gamma_2 + \gamma_4 TOTVOL_{it-1}$ yields -0.0089 using the figures from Table 6 (SGMM) for the commodity boom period versus -0.00364 using the figures from Table 5 (FEM). This indicates that an increase of openness leads to lower G/Y in Latin American countries. Also, when evaluated at sample means the partial derivative of ln (G/Y) to (TOTVOL) yields $\gamma_3 + \gamma_4 ln(OPEN)_{it-1}$, which means 0.1587 using the figures from Table 6 (SGMM) for the commodity boom period versus 0.0327 using the figures from Table 5 (FEM). Therefore, we find that the effects of TOTVOL on G/Y are higher during the commodity boom period than the effects of openness. The estimated effects under SGMM methods are also higher in magnitude than those reported under FEM.

The SGMM results suggest that the own stochastic process for government size (measured by the large persistence implied by the lagged dependent term) and TOTVOL are the main factors impacting government size. TOTVOL, in particular, operates according to the conjecture by Rodrik (1998) during the commodity price boom. Motivated by Frankel et al. (2013), what TOTVOL is doing per se is to help the procyclicality of government expenditures with a positive effect on government size. OPEN also does it in theory – in line with Rodrik (1998) – but it turns out to be not statistically significant. In some cases, for the commodity boom, we find the interactive term to be negative, which actually would help lowering the procyclicality of government size, also consistent with Frankel et al. (2013, p. 33), who argue that "over the last decade several developing countries have been able to 'graduate' in the sense of overcoming the problem of procyclicality and becoming countercyclical".

4. Conclusions

In panel data and controlling for GDP per capita, Rodrik (1998) reports that neither openness nor TOTVOL have statistically significant main effects, but their interaction is generally positive and significant. In our case for Latin America, we find a strong positive association between volatility in terms of trade and government size. In periods of so much volatility like that observed in the commodity boom period, the size of government increases, possibly to handle trade risk. Rodrik (1998, p. 997) notes that "the relationship between openness and government size is strongest when terms-of-trade risk is highest". We find supportive evidence in this paper as follows. Rodrik (1998) shows from the government maximization problem that as a result of exposure to external risk the optimal level of government size is larger. The theoretical framework has the government determining the size of the public sector before the specific realization of terms of trade, while there are two ways openness can have an impact on government size. One is the level effect; the other is the volatility channel.

Our evidence suggests volatility is particularly important during the 2003-10 commodity boom for the panel of Latin American countries. The evidence found in this paper for the recent commodity boom can be compared to longer-run studies, such as Islam (2004), who finds only for Australia that government size is positively related to external risk using bounds test for the U.S. from 1929 to 1997 and post-WWII data for other countries, thus indicating that time series analysis in general is not supportive of the proposition in Rodrik (1998). Also, Epifani and Gancia (2009) propose a theoretical framework on how openness can increase government size through a terms-of-trade externality and demand for insurance channels. Their findings for panel data from 1950 to 2000 are that when they control for the standard deviation of the lagged terms of trade and its interaction with openness, both are insignificant and the openness coefficient is unaffected. Their long-run conclusion is that globalization may have led to inefficiently large governments, which comes from the positive and statistically significant openness coefficient but not from the terms of trade volatility.

In light of the recent commodity bust and economic crisis in Latin America at the first half of the 2010s, some public policy considerations arise from the results herein linking government size to terms of trade volatility. First, if more volatility implies increasing government expenditure in natural resource dependent countries, one could claim that commodity boom episodes represent a great risk to these countries due to the typical procyclicality of their fiscal policies. In line with these implications, Calderón et al. (2016, p. 651) report that "(…) monetary and fiscal policies in developing countries – and, especially, in Latin America – are predominantly procyclical". Using panel data methods for 30 years, Brueckner and Carneiro (2017), for instance, explore the effects of terms of trade volatility on economic growth and find negative effects in countries where government spending is procyclical. In that sense, Frankel et al. (2013, p. 32) explain that "an important reason for procyclical spending is precisely that government receipts from taxes or mineral royalties rise in booms, and the government cannot resist the temptation or political pressures to increase spending proportionately, or even more than proportionately". Therefore, if governments make use of fiscal risk prevention mechanisms such as sovereign wealth funds, the natural resource curse can be minimized or avoided.[10]

Second, a higher level of diversification should be an ultimate goal for these countries. Once we find support for the compensation hypothesis, the sticky nature of government spending could generate budgetary risks in times of economic busts. In that case, diversification helps mitigate the resource curse: as stated by Badeeb et al. (2017, p. 127), "a nation that is resource

[10] For instance, Chile used its fiscal policy tools to save the exports surplus within its sovereign wealth fund, later using those resources to compensate for the drastic drop in copper price to US$ 1.40 in 2009 and for the economic impact of a severe earthquake in 2010 (Bacha and Fishlow, 2010).

abundant may not be resource dependent if it diversifies its production structure”.[11] And since cultural, institutional and regulatory framework aspects play an important role in the resource curse in emerging economies, rent seeking, corruption and economic mismanagement could eventually hinder policymakers’ efforts to address the resources curse. Therefore, effective public policies should aim at adopting long-lasting rules and goals that could be managed and pursued by institutions and society.

[11] Note, however, that recent research on commodities has shown that benefits to diversification may change over time. Merener and Steglich (2018, p. 332) provide evidence in that direction, showing a large risk reduction as a response to diversification in the production of commodities in the 1987–2016 period but “a significant reduction in the 2007–12 period due to an increase in correlations among commodities”.

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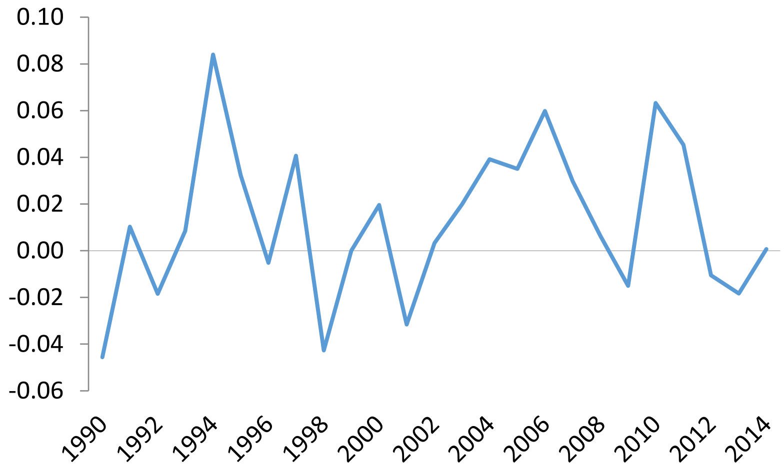
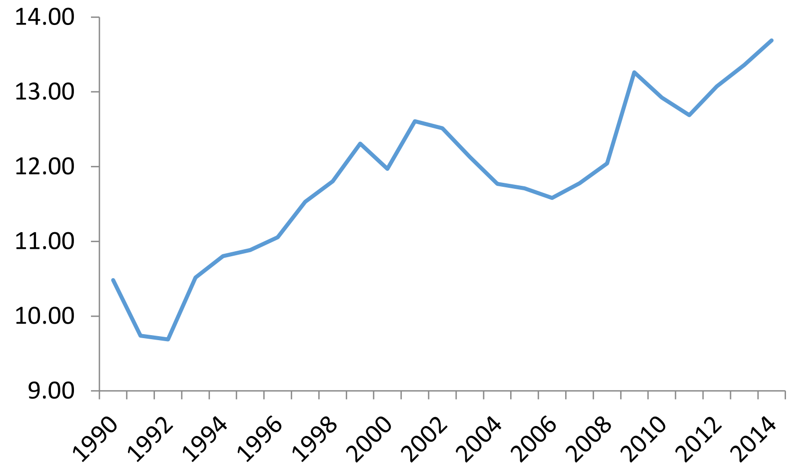
Figure 1

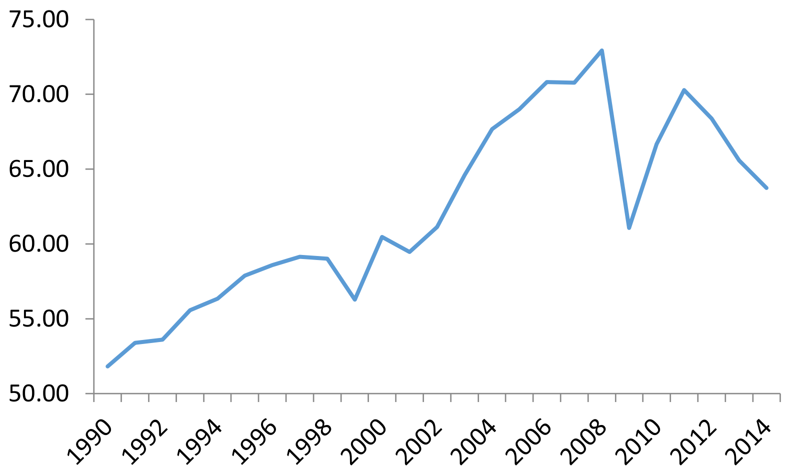
(a) Terms-of-trade volatility from 1990 to 2014.



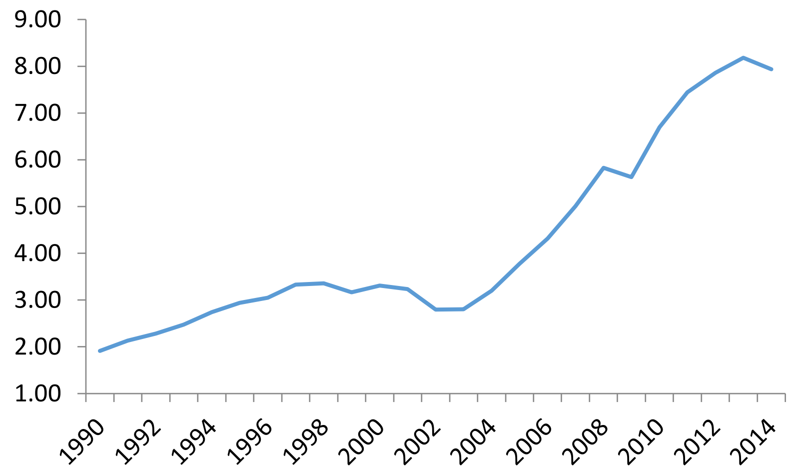
(b) Government size (% of GDP) from 1990 to 2014.



(c) Trade openness (% of GDP) from 1990 to 2014.



(d) Real per capita GDP (US$ thousand) from 1990 to 2014.



Source: World Development Indicators (World Bank) database.

Table 1
Variables definitions and descriptive statistics.

Panel A: Definitions.

Variables	GOV_SIZE	OPEN	TOTVOL	POP	GDPCAP	URBAN	DEP
	Government expenditures as a share of GDP	(X + M)/GDP, where X is exports, M is imports and GDP is gross domestic product	Terms-of-trade volatility: deviation from the mean of the index value (price of exports divided by imports)	Population, in million people	Real GDP per capita, in constant 2010 US$ thousand	Percentage of people living in urban areas	Ratio of dependents (people younger than 15 or older than 64) to the working-age population (ages 15-64)

Source: World Development Indicators (World Bank) database.

Panel B: Descriptive statistics.

Year	GOV_SIZE	OPEN	TOTVOL	POP	GDPCAP	URBAN	DEP
1990	10.48	51.81	-0.046	421.4	1.91	61.32	74.73
1991	9.74	53.39	0.010	429.3	2.13	61.89	74.09
1992	9.69	53.60	-0.018	437.1	2.28	62.45	73.39
1993	10.51	55.58	0.008	444.9	2.48	62.99	72.63
1994	10.80	56.34	0.084	452.7	2.74	63.55	71.83
1995	10.89	57.89	0.033	460.5	2.94	64.12	70.99
1996	11.06	58.59	-0.005	468.3	3.05	64.67	70.23
1997	11.53	59.15	0.041	476.1	3.33	65.22	69.44
1998	11.80	59.02	-0.043	483.8	3.36	65.77	68.60
1999	12.31	56.27	0.000	491.5	3.16	66.27	67.73
2000	11.97	60.47	0.020	499.0	3.31	66.77	66.84
2001	12.61	59.46	-0.032	506.4	3.24	67.30	65.98
2002	12.51	61.13	0.003	513.7	2.79	67.82	65.09
2003	12.13	64.59	0.020	520.9	2.80	68.34	64.18
2004	11.77	67.68	0.039	528.1	3.20	68.85	63.27
2005	11.71	69.01	0.035	535.2	3.77	69.36	62.37
2006	11.58	70.82	0.060	542.3	4.31	69.87	61.44
2007	11.78	70.78	0.030	549.4	5.01	70.36	60.55
2008	12.04	72.93	0.006	556.5	5.83	70.85	59.68
2009	13.26	61.07	-0.015	563.6	5.63	71.33	58.83
2010	12.92	66.66	0.063	570.5	6.69	71.80	58.01

2011	12.69	70.28	0.045	577.4	7.44	72.26	57.24
2012	13.08	68.39	-0.011	584.3	7.86	72.71	56.50
2013	13.36	65.57	-0.018	32.8	8.18	73.14	55.79
2014	13.69	63.74	0.001	597.8	7.94	73.56	55.16
Mean	11.84	62.17	0.01	489.75	4.22	67.70	64.98
Difference	3.21	11.93	0.05	176.39	6.03	12.24	-19.57

Source: World Development Indicators (World Bank) database.
Notes: GOV_SIZE, OPEN, and URBAN are measured as % of GDP. TOTVOL is in percentage points (deviations from the TOT mean). POP is measured in million people. GDPCAP is measured in US$ thousand. DEP is a ratio.

Table 2
Correlation coefficients.

Correlations	GOV_SIZE	OPEN	TOTVOL	POP	GDPCAP	URBAN	DEP
GOV_SIZE	1.00						
OPEN	-0.09	1.00					
TOTVOL	-0.03	-0.01	1.00				
POP	0.25	-0.68	0.08	1.00			
GDPCAP	0.40	-0.12	0.05	0.30	1.00		
URBAN	0.39	-0.38	0.05	0.43	0.80	1.00	
DEP	-0.50	0.13	-0.03	-0.32	-0.80	-0.76	1.00

Note: Except for *totvol*, the variables are in natural logarithm.

Table 3

Panel data fixed effect regressions.

Dependent variable: ln(GOV_SIZE)	Pre-commodity boom period (1990-2002)					Commodity boom period (2003-2010)				
	1	2	3	4	5	6	7	8	9	10
$\ln(\text{OPEN})_{t-1}$	0.173	0.170		0.224	0.125	-0.287**	-0.286**		-0.364***	-0.332***
	(0.268)	(0.263)		(0.231)	(0.234)	(0.106)	(0.103)		(0.118)	(0.102)
TOTVOL_{t-1}			-0.145	-2.84	-2.766			-0.0675	2.684**	2.224**
			(0.186)	(1.616)	(1.636)			(0.0914)	(0.962)	(0.816)
$\ln(\text{OPEN})_{t-1}$ x TOTVOL_{t-1}				0.696	0.664				-0.648**	-0.541**
				(0.404)	(0.407)				(0.228)	(0.195)
ln(GDPCAP)	0.253**	0.233**	0.247**	0.364***	0.275***	0.00707	0.0121	-0.00590	0.127***	0.0253
	(0.0931)	(0.0985)	(0.0856)	(0.123)	(0.0919)	(0.0623)	(0.0633)	(0.0661)	(0.0431)	(0.0613)
ln(URBAN)	-1.854	-2.184	-1.495		-1.697	0.972**	0.989**	1.256*		0.891**
	(1.213)	(1.303)	(0.913)		(1.172)	(0.421)	(0.437)	(0.663)		(0.378)
ln(DEP)	-2.574***	-1.531*	-2.563***		-2.453***	-0.593	-0.684	-0.392		-0.548
	(0.824)	(0.839)	(0.859)		(0.787)	(0.428)	(0.727)	(0.548)		(0.418)
ln(POP)		1.076					-0.158			
		(0.678)					(0.980)			
Constant	18.30**	13.11*	17.49**	-1.323	17.16**	1.911	2.588	-1.191	2.920***	2.102
	(7.350)	(7.169)	(7.131)	(1.103)	(7.005)	(3.311)	(5.636)	(5.055)	(0.457)	(3.051)
R-squared	26.9%	28.0%	26.4%	22.1%	30.7%	34.7%	34.8%	23.9%	29.6%	38.7%
Observations	214	214	216	214	214	144	144	144	144	144
Countries	18	18	18	18	18	18	18	18	18	18

Notes: Robust standard errors in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 4

FEM regressions alternating strongly correlated controls.

Dependent variable: ln(GOV_SIZE)

	1	2	3	4	5	6	7	8	9	10	11	12
	1990-2014	1990-2002	2003-2014	2003-2010 (Commodity boom)	1990-2014	1990-2002	2003-2014	2003-2010 (Commodity boom)	1990-2014	1990-2002	2003-2014	2003-2010 (Commodity boom)
$\ln(OPEN)_{t-1}$	0.0694	0.224	-0.266*	-0.364***	0.0725	0.158	-0.251**	-0.286**	-0.00706	0.0830	-0.280**	-0.358***
	(0.150)	(0.231)	(0.139)	(0.118)	(0.153)	(0.241)	(0.102)	(0.105)	(0.153)	(0.202)	(0.132)	(0.112)
$TOTVOL_{t-1}$	-2.203	-2.34	1.273	2.684**	-2.165	-2.498	1.008	1.900**	-2.256	-2.779	1.043	2.315**
	(1.645)	(1.616)	(0.796)	(0.962)	(1.679)	(1.656)	(0.613)	(0.739)	(1.628)	(1.672)	(0.654)	(0.854)
$\ln(OPEN)_{t-1}$ x $TOTVOL_{t-1}$	0.519	0.696	-0.324*	-0.648**	0.530	0.718	-0.266*	-0.470**	0.548	0.691	-0.264	-0.556**
	(0.409)	(0.404)	(0.186)	(0.228)	(0.420)	(0.419)	(0.146)	(0.178)	(0.406)	(0.417)	(0.156)	(0.203)
ln(GDPCAP)	0.177***	0.364***	0.131***	0.127***								
	(0.0570)	(0.123)	(0.0428)	(0.0431)								
ln(URBAN)					0.967*	1.678*	1.595***	1.576***				
					(0.502)	(0.820)	(0.180)	(0.369)				
ln(DEP)									-0.960***	-2.019***	-1.088***	-1.241***
									(0.241)	(0.545)	(0.314)	(0.272)
Constant	0.728	-1.323	2.493***	2.920***	-1.914	-5.197	-3.237***	-3.025*	6.447***	10.59***	8.081***	9.025***
	(0.562)	(1.103)	(0.698)	(0.457)	(1.916)	(3.062)	(0.921)	(1.585)	(1.431)	(2.486)	(1.439)	(1.332)
R-squared	21.4%	22.1%	28.3%	29.6%	18.7%	15.9%	38.8%	35.0%	23.9%	24.5%	34.9%	35.4%
Countries	18	18	18	18	18	18	18	18	18	18	18	18
Observations	429	214	215	144	430	214	216	144	430	214	216	144

Notes: Robust standard errors in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively. Differently from previous table, here the strongly correlated controls GDPCAP, URBAN and DEP are adopted in separate specifications to address the multicollinearity bias.

Table 5

FEM regressions with lagged dependent variable on the right-hand side.

Dependent variable: ln(GOV_SIZE)

	1	2	3	4	5	6	7	8	9	10	11	12
	1990-2014	1990-2002	2003-2014	2003-2010 (Commodity boom)	1990-2014	1990-2002	2003-2014	2003-2010 (Commodity boom)	1990-2014	1990-2002	2003-2014	2003-2010 (Commodity boom)
ln(GOV_SIZE)$_{t-1}$	0.708***	0.609***	0.765***	0.577***	0.719***	0.632***	0.707***	0.572***	0.709***	0.601***	0.732***	0.531***
	(0.0547)	(0.0452)	(0.0656)	(0.113)	(0.0442)	(0.0488)	(0.107)	(0.119)	(0.0563)	(0.0541)	(0.0802)	(0.121)
ln(OPEN)$_{t-1}$	0.00929	0.0872	0.0324	-0.0981	0.0123	0.0518	0.0200	-0.0403	0.00426	0.0604	0.0184	-0.112
	(0.0422)	(0.110)	(0.0627)	(0.0954)	(0.0376)	(0.107)	(0.0603)	(0.0838)	(0.0453)	(0.106)	(0.0692)	(0.0927)
TOTVOL$_{t-1}$	-0.795	-1.678	1.170	2.129**	-0.751	-1.589	1.031	1.536**	-0.758	-1.533	1.048	1.875**
	(0.893)	(1.124)	(0.707)	(0.809)	(0.873)	(1.128)	(0.612)	(0.625)	(0.885)	(1.162)	(0.623)	(0.705)
ln(OPEN)$_{t-1}$ x TOTVOL$_{t-1}$	0.206	0.425	-0.280	-0.499**	0.202	0.422	-0.253	-0.364**	0.202	0.407	-0.252	-0.437**
	(0.221)	(0.282)	(0.167)	(0.195)	(0.219)	(0.285)	(0.147)	(0.154)	(0.221)	(0.293)	(0.149)	(0.171)
ln(GDPCAP)	0.0640***	0.211***	0.0616**	0.0958**								
	(0.0212)	(0.0570)	(0.0222)	(0.0332)								
ln(URBAN)					0.325**	0.882**	0.792***	1.296***				
					(0.132)	(0.338)	(0.165)	(0.229)				
ln(DEP)									-0.258**	-0.775***	-0.471**	-0.914***
									(0.0913)	(0.257)	(0.210)	(0.228)
Constant	0.168	-1.033*	-0.0590	0.660	-0.719	-2.969**	-2.705***	-4.261***	1.772***	4.002***	2.513*	5.364***
	(0.164)	(0.508)	(0.260)	(0.469)	(0.468)	(1.176)	(0.467)	(1.098)	(0.552)	(1.269)	(1.200)	(1.372)
R-squared	68.1%	59.4%	65.8%	49.2%	67.6%	57.1%	67.3%	54.7%	67.4%	57.1%	65.2%	51.3%
Countries	18	18	18	18	18	18	18	18	18	18	18	18
Observations	429	214	215	144	430	214	216	144	430	214	216	144

Notes: Robust standard errors in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 6
System GMM regressions.

Dependent variable: ln(GOV_SIZE)

	1	2	3	4	5	6	7	8	9	10	11	12
	1990-2014	1990-2002	2003-2014	2003-2010 (Commodity boom)	1990-2014	1990-2002	2003-2014	2003-2010 (Commodity boom)	1990-2014	1990-2002	2003-2014	2003-2010 (Commodity boom)
$\ln(GOV\_SIZE)_{t-1}$	0.742***	0.710***	1.000***	0.976***	0.744***	0.708***	1.009***	0.886***	0.728***	0.801***	0.861***	0.834***
	(0.134)	(0.116)	(0.289)	(0.258)	(0.0970)	(0.0756)	(0.241)	(0.236)	(0.108)	(0.0874)	(0.163)	(0.135)
$\ln(OPEN)_{t-1}$	0.254	0.298**	0.0440	-0.0006	0.192**	0.296*	0.125	0.0447	0.198	0.119	0.0138	0.0454
	(0.184)	(0.135)	(0.174)	(0.189)	(0.0831)	(0.178)	(0.110)	(0.150)	(0.153)	(0.150)	(0.0448)	(0.0755)
$TOTVOL_{t-1}$	1.512	1.152	1.800	4.070*	0.605	-0.0893	0.735	3.826**	1.363	-0.712	4.531	5.737*
	(2.491)	(1.968)	(3.885)	(2.322)	(2.912)	(2.238)	(2.699)	(1.851)	(3.438)	(2.707)	(3.967)	(3.223)
$\ln(OPEN)_{t-1}$ x $TOTVOL_{t-1}$	-0.380	-0.311	-0.350	-0.912	-0.0953	0.0489	-0.130	-0.888*	-0.297	0.232	-1.078	-1.383
	(0.618)	(0.469)	(1.009)	(0.614)	(0.753)	(0.583)	(0.701)	(0.489)	(0.879)	(0.706)	(0.997)	(0.971)
ln(GDPCAP)	0.00808	-0.0236	0.0294	0.0441								
	(0.0463)	(0.114)	(0.0337)	(0.0392)								
ln(URBAN)					0.311**	0.400***	0.0360	0.106				
					(0.122)	(0.0913)	(0.171)	(0.197)				
ln(DEP)									-0.139	-0.543***	-0.131	-0.225
									(0.227)	(0.184)	(0.158)	(0.284)
Constant	-0.447	-0.277	-0.430	-0.304	-1.442**	-2.106**	-0.689	-0.352	0.450	2.319*	0.824	1.139
	(0.614)	(0.645)	(1.178)	(1.159)	(0.634)	(0.966)	(0.729)	(0.789)	(1.632)	(1.188)	(0.983)	(1.329)
AB(2) test p-value	0.390	0.420	0.986	0.515	0.106	0.112	0.617	0.471	0.830	0.121	0.839	0.549
Hansen test p-value	0.562	0.273	0.152	0.126	0.431	0.765	0.168	0.337	0.223	0.619	0.224	0.169
Instruments	16	16	16	16	16	16	16	16	16	16	16	16
Observations	429	214	215	144	429	214	215	144	429	214	215	144
Countries	18	18	18	18	18	18	18	18	18	18	18	18

Notes: Robust standard errors in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively. The variable TOTVOL is specified as the exogenous variable in the model while GDPCAP, URBAN and DEP are the endogenous variables in their respective equations; therefore, we assume reverse causation from government size to those variables.