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Do Sovereign Wealth Funds Reduce Fiscal Policy Pro-cyclicality? New Evidence Using a Non-Parametric Approach

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Do Sovereign Wealth Funds Reduce Fiscal Policy Pro-cyclicality? New Evidence Using a Non-Parametric Approach

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ABSTRACT: The heightened volatility of commodity prices in recent years, reflecting the effects of the pandemic and the war in Ukraine, begs the longstanding question of the optimal fiscal policy response to commodity price shocks. Fiscal performance in most commodity-exporting countries is typically shaped by shifts in commodity prices and economic activity, often resulting in procyclical fiscal policy. One way to minimize the procyclicality of fiscal policy is to set up a stabilization Sovereign Wealth Fund (SWF). While such funds can help smooth government consumption in good and bad times, the empirical evidence of their value so far has been inconclusive. However, using an unbalanced panel dataset for 182 countries during 1980-2019, with two econometric methods that address the selection-bias problem, we provide robust evidence that stabilization SWFs do indeed help smooth government consumption by reducing fiscal policy volatility associated with commodity price fluctuations.

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WORKING PAPERS

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Contents

Glossary

ATE	Average Treatment Effect
FEM	Fixed Effects Model
GDP	Gross Domestic Product
GFC	Global Financial Crisis
GMM	Generalized Methods of Moments
ILS	Instrumental Least Squares
OLS	Ordinary-Least Squares
PSM	Propensity Score Matching
SWF	Sovereign Wealth Fund

1. INTRODUCTION AND MAIN MESSAGES

Commodity price volatility has increased in recent years—especially for oil—following in large part the effects of the pandemic and the war in Ukraine.[1] This volatility points to the need for an optimal fiscal policy response to commodity price shocks, especially for commodity-exporting countries.[2]

The main policy challenge faced by most of these countries is coping with commodity price volatility. Such volatility is transmitted to the economy through several channels, including fiscal and exchange rate policy.[3] Moreover, highly volatile commodity prices generally result in volatile commodity-related revenue, especially in countries where such revenue constitutes a large share of total budget revenue. This often translates into volatile public spending (IMF 2015).

Large and persistent swings in commodity-related revenue sometimes results in a procyclical fiscal stance. Fiscal policymakers tend to increase spending during periods of expansion (when commodity prices are high) while they are forced to reduce spending when commodity prices and revenue decline (Ilzetzki and Vegh, 2008; Villafuerte and Lopez-Murphy, 2010; Erbil, 2011).

This procyclical behavior complicates macroeconomic management and leads to considerable output volatility that undermines overall macroeconomic performance.[4] Indeed, several empirical studies suggest that higher government spending volatility is associated with lower economic growth (Al-Sadiq and others, 2021; Bleaney and Greenaway, 2001; Furceri and Karras, 2007; Fatás and Mihov, 2003, 2006) while others show that fiscal policy volatility acts as a transmission mechanism for the "resource curse" (Bleaney and Halland, 2009; Sachs and Warner, 1995).[5] Moreover, large commodity price swings have major impacts on key social indicators (Estrades and Terra, 2012; Álvarez, García-Marin, and Ilabaca, 2021).

Under the neoclassical and Keynesian frameworks, the main goal of fiscal policy is to smooth output volatility during business cycles; thus, it should be countercyclical. In Barro's (1979) smoothing model, a government is expected to run surpluses in good times and fiscal deficits in bad times (Céspedes and Velasco, 2014). Under the Keynesian approach, if the economy is in recession, a government should raise spending and/or lower taxes to simulate economic activity; while during economic booms, the government should save surpluses generated by the operation of automatic stabilizers. Hence, fiscal policy is expected to follow countercyclical patterns through automatic stabilizers and discretionary channels (Erbil, 2011).

[1] Oil prices–a simple average of three spot prices: Dated Brent, West Texas Intermediate, and Dubai Fateh–increased from US$23.4 a barrel in April 2020 to US$114.7 a barrel in June 2022, its highest level since April 2012 (US$113.8).
[2] Commodity-exporting countries are those with fuel/mining exports accounting for an average of 20 percent of their exports over a decade.
[3] Large fluctuations in resource revenue may give rise to real exchange rate volatility and increases in these revenues may lead to "Dutch disease" (Davis and others 2001).
[4] Output volatility can be manifested in abrupt or unexpected changes in economic growth.
[5] The natural resource curse is associated in the related literature to those natural-resource-rich countries whose levels of wealth have been historically lower compared with non-natural resource-rich countries.

For commodity-exporting countries, an optimal fiscal policy response to commodity price fluctuations is countercyclical policy behavior: save commodity-related revenue increases during booms and use these buffers during downturns (IMF, 2012). This suggests that commodity price volatility creates an incentive to save some commodity-related revenue as self-insurance to smooth consumption spending when prices drop.[6] This in turn would help reduce the macroeconomic volatility stemming from commodity price fluctuations. This argument is supported by several empirical studies that find that limiting procyclical policies is associated with improved macroeconomic performance (Medina and Soto, 2007; Rodriguez and others, 2007; Schmidt-Hebbel, 2012; IMF, 2012).

How should commodity-exporting countries insulate their economies from the negative terms-of-trade shocks induced by large and unpredictable commodity price fluctuations? From a theoretical perspective, one approach to shield or delink public expenditures from resource revenue volatility is through the establishment of a stabilization SWF. This instrument is designed mainly to accumulate resources when the commodity price exceeds a certain reference price and to disburse when the price falls below another reference price (Davis and others, 2001). Thus, a stabilization SWF would constitute self-insurance to help smooth fluctuations in budget resources by reducing or eliminating the uncertainty and volatility of resource-related revenue flowing into the budget.

Over the past few decades, the number of SWFs established has increased significantly, particularly by commodity-exporting countries. These funds have been created for many reasons, including as (IMF, 2008):

- short-term stabilization funds, to insulate the economy from swings in commodity prices;
- long-term savings funds, to transform income from natural resources into a diversified portfolio of assets, accumulating savings for future generations;
- reserve investment corporations, to increase the return on foreign exchange reserves;
- development funds, to help fund infrastructural projects that expand the country's potential growth; and
- contingent pension reserve funds, to complement resources from individual pension contributions that provide for pension liabilities on the government's balance sheet.

Whether stabilization SWFs contribute to lower fiscal policy volatility is an empirical question that has recently received some attention in the related economic literature, but empirical results have been mixed. While some find a negative relationship between the presence of SWFs and the volatility of fiscal spending policy, others fail to find a significant relationship.

[6] Throughout this paper we use fiscal spending and government consumption interchangeably.

Thus, this paper seeks to empirically reassess whether stabilization SWFs help smooth government consumption and whether a country with such an instrument has less volatile fiscal policy. The paper contributes to the literature in several ways. First, we use a large sample of 182 advanced and developing countries over the period 1980-2019. Second, given that a country's decision to establish a stabilization SWF is not a random decision, we address the self-selection problem of having such a fund by using two different econometric approaches: i) a two-step estimation method based on a treatment effect model, and ii) a non-parametric estimation method based on a Propensity Score Matching (PSM) technique. Herein lies the methodological novelty of our approach. We believe this is the first-time fiscal policy has been evaluated in this way.

Our study finds a negative relationship between the presence of stabilization SWFs and the volatility of government consumption. Empirical results suggest that countries with stabilization SWFs tend to experience less volatile fiscal policy. The estimated average treatment effects shows that a country with a stabilization SWF has about 14 percent less volatile government consumption relative to a country without an SWF. This result is robust under different specifications and sample periods.

The rest of the paper briefly describes the frequency and the impact of commodity price volatility (Section 2); surveys the existing literature (Section 3); presents the empirical model, the estimation methods, and data sources (Section 4); discusses the empirical results (Section 5); and concludes (Section 6).

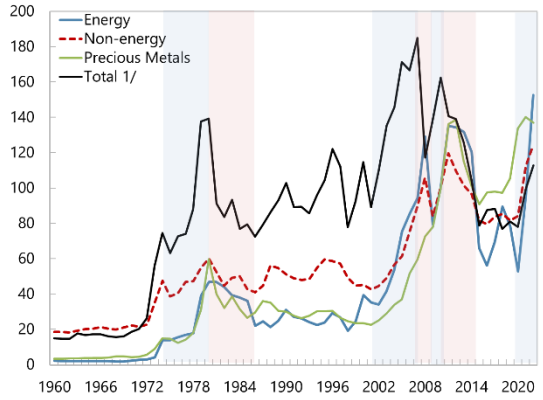
2. THE FREQUENCY AND IMPACT OF COMMODITY PRICE VOLATILITY

Commodity price cycles have been characterized by remarkable booms and slumps, as well as highly uncertain forecasts, in past decades (Figure 1). The boom episodes occurred during much of the 1970s, 2002-08, and the post-COVID-19 period, while the sharp declines took place during 1979-86, the global financial crisis, and during 2012-16. Booms and busts can mean prices moving by as much as 40-80 percent over a decade (IMF, 2015). Moreover, over the past few years, oil prices have fluctuated widely—between US$23.4 a barrel in April 2020 to US$114.7 a barrel in June 2022.[7] Apart from cyclical fluctuations, commodity prices display long-term trends. While these trends are difficult to forecast, they show that some price shocks may have a permanent component (IMF, 2012).

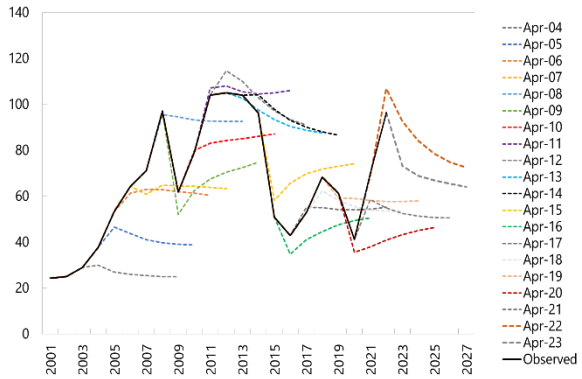
[7] Oil prices are a simple average of three spot prices: Dated Brent, West Texas Intermediate, and Dubai Fateh.

Figure 1. Commodity Price Variability and Unpredictability

a. Commodity Price Index
(Index, 2010 = 100)



b. Oil Price Forecasts
($US/barrel)

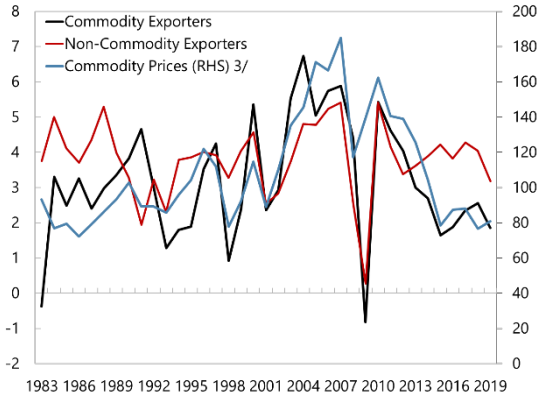


Sources: World Bank's Pink Sheet, Bloomberg LP, and IMF, World Economic Outlook.
1/ Total commodity prices measured by Bloomberg's commodity price index.

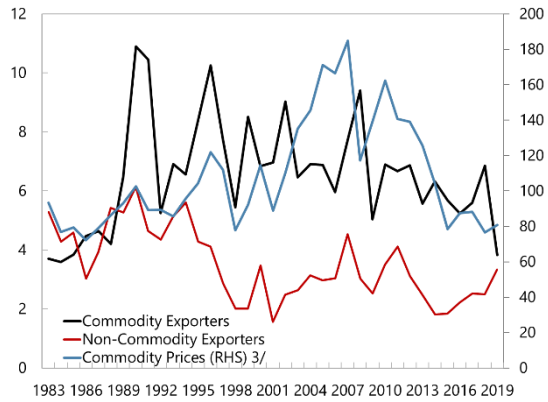
Macroeconomic performance in commodity-exporting countries tends to move with commodity price cycles. In fact, historical data show how the performance of key macroeconomic indicators can be influenced by unexpected fluctuations in international commodity prices. The global price increase observed prior to the global financial crisis coincided with current and fiscal deficit results and a notable improvement in commodity-exporting countries in the same period (Figure 2).

Figure 2. Commodity Prices and Key Macroeconomic Indicators 1/

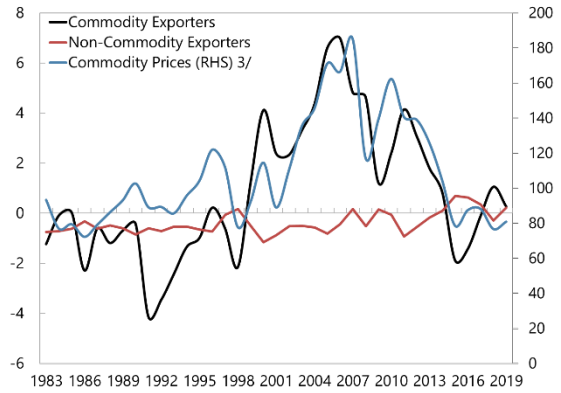
a. Economic Growth
(Percentage Change, Index)



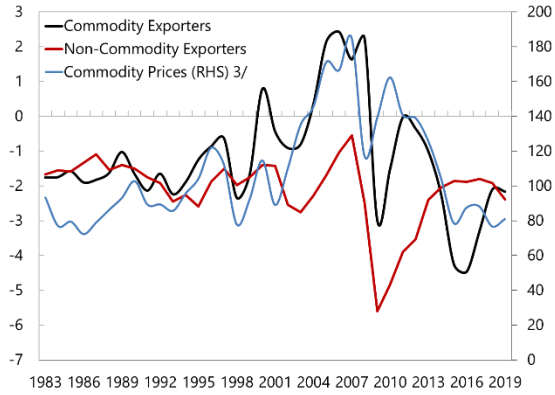
b. Inflation 2/
(Percentage Change, Index)



c. Current Account Balance
(In percent of GDP, Index)



d. Overall Fiscal Balance
(In percent of GDP, Index)



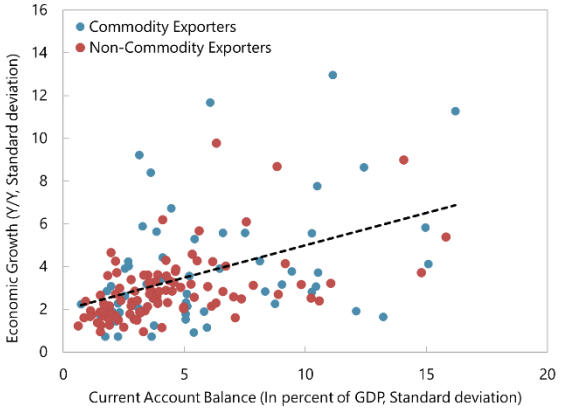
Sources: IMF, World Economic Outlook, Bloomberg LP, and authors' calculations.
1/ Key variables are expressed as the weighted average of commodity exporting and non-commodity-exporting countries by using their nominal GDP denominated in US dollars adjusted by Purchasing Power Parity. 2/ Refers to end of period inflation. 3/ Total commodity prices measured by Bloomberg's commodity price index. 4/ Years in which inflation in commodity-exporting countries reached more than 50 percent were removed from the sample.

Moreover, there is a consensus in the literature that international commodity price volatility leads to more volatile macroeconomic conditions, mitigating economic stability (Figure 3). Using annual data for 1990-2007, Cavalcanti, Mohaddes, and Raissi (2011) show that the negative growth effects of commodity terms-of-trade volatility offset the positive impact of commodity booms, contributing to the "resource curse" paradox. Similarly, Blattman and others (2007) estimate the impact of terms-of-trade volatility, the result of abrupt commodity price

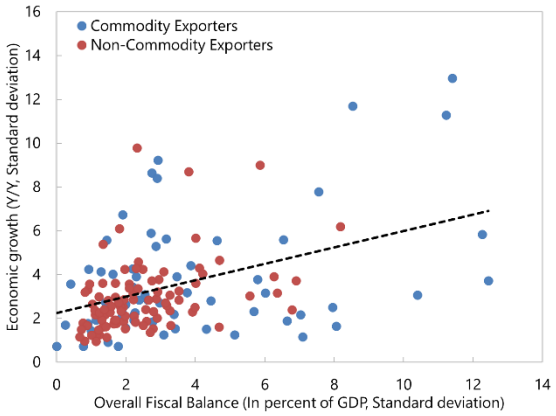
fluctuations, on foreign investment and economic growth performance for a panel of 35 countries. This negative relationship between terms-of-trade volatility and economic growth is also assessed by Bleaney and Greenaway (2001).

Figure 3. Macroeconomic Volatility in Commodity-Exporting Countries

a. Current Account Balance and Growth
(Standard Deviation, 2002-2019)



b. Overall Fiscal Balance and Growth
(Standard Deviation, 2002-2019)



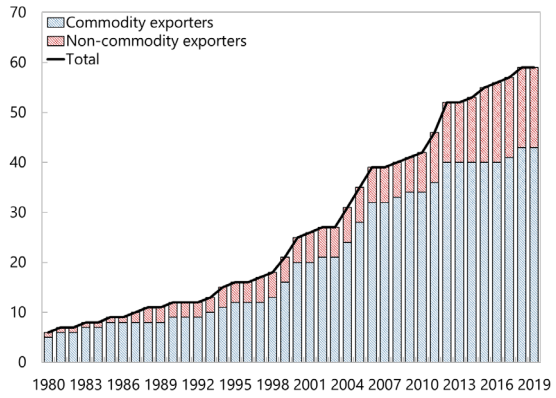
Sources: IMF, World Economic Outlook and authors' calculations.

3. Review of the Literature

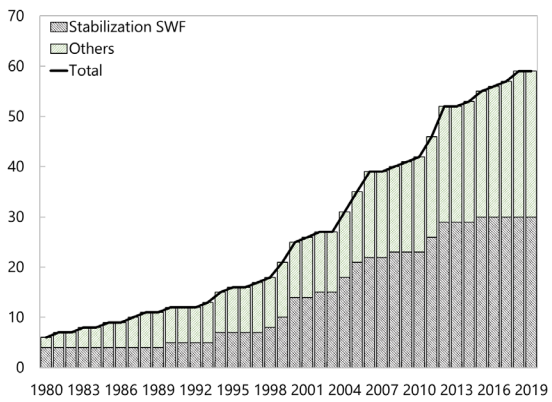
SWFs are government-owned investment funds, established for a variety of purposes. The IMF (2008) distinguishes several types of SWFs based on their main objectives: i) stabilization funds, set up to insulate the economy against swings in commodity prices; ii) savings funds, which transform the income from commodity-related resources into a diversified portfolio of assets, accumulating savings for future generations; iii) reserve investment corporations, established to increase the return on foreign exchange reserves; iv) development funds, which help fund infra-structural projects to increase the country's potential growth; and v) contingent pension reserve funds, which complement resources from individual pension contributions to provide for pension liabilities on the government's balance sheet. Over the past few decades, the number of SWFs established has increased significantly, particularly by commodity-exporting countries (Figure 4).

Figure 4. SWFs Adoption in the Past Decades 1/

a. By Commodity-Exporting Status
(Number of countries)



b. By Type of SWFs
(Number of countries)



Sources: Global SWF Database, Sovereign's Wealth Fund Institute, and IMF, World Economic Outlook.
1/ The country number is based on the sample used in this paper which covers 182 countries.

A stabilization SWF is a mechanism designed to reduce the effects of volatile commodity-related revenue on government consumption and the overall economy's performance. Its objectives may also include supporting fiscal discipline and providing greater transparency in the spending of revenue. Stabilization SWFs can help a government delink its expenditure from the negative impacts of commodity-related revenue volatility caused by the booms and busts of commodity prices. When the commodity prices exceed a certain reference level, resources are accumulated. When prices are below another reference level, government can utilize part of these resources to smooth out its spending in the short-term (Davis and others, 2001). In the absence of financing opportunities, when the commodity-related revenues are low, governments tend to cut expenditures or seek to raise non-commodity revenue. Since this sometimes could be difficult to do in the short term, a government that has a stabilization SWF could smooth its spending in short-term through drowning down resources from its fund. Thus, a stabilization SWF serves as a self-insurance instrument to help smooth fluctuations in the resources available to the budget, by reducing the uncertainty and volatility of commodity-related revenues.

However, it is important to note that in the absence of liquidity constraints, a stabilization SWF might not have direct role in stabilizing government expenditures since governments could meet their financing needs through borrowing.

From an empirical perspective, there is no consensus on whether the presence of a stabilization SWF help reduce fiscal spending volatility. Some studies find that stabilization SWFs contribute to smoothing government spending while others find that these funds lead to higher volatility in the fiscal policy and others do not find statistically significant results. Bagattini (2011) finds that the presence of a stabilization SWF helps reduce

government spending volatility although the impact is very small. Sugawara (2014), using panel data for 68 resource-rich countries over 1988–2012, finds that stabilization SWFs contribute to smoothing government expenditure. Crain and Devlin (2002) using data for 71 countries over the period of 1970–2000, show that natural resource funds increase fiscal volatility, particularly in oil-exporting countries. Ossowski and others (2008) and Bova and others (2016) did not find significant evidence that SWFs reduce fiscal volatility.[8]

While these studies employed different methodologies, different sample-selections, different sets of explanatory variables, and analytical tools, they failed to properly control for the endogeneity of the SWFs. Setting up a SWF is not a random decision but rather determined by economic and non-economic factors, including past commodity price boom and bust cycles.

This paper contributes to the literature in several ways. First, we use large sample of advanced and developing countries over the period 1980-2019. Second, given that a country's decision to establish a stabilization SWF is not a random decision, we address the self-selection problem of having such a fund through using two different econometric approaches: i) in the first approach, we use a two-step estimation method based on a treatment effect model and ii) in the second approach, we use a non-parametric estimation method based on a Propensity Score Matching (PSM) technique.

4. EMPIRICAL ANALYSIS

4.1 The Model

We begin our empirical analysis by noting that the effects of a stabilization SWF on government consumption volatility may be formalized in the following linear relationship:

$$\sigma_{i,t} = x'_{i,t}\boldsymbol{\beta} + \rho\, SWF_{i,t} + \eta_i + \delta_{i,t} \qquad (1)$$

where $\sigma_{i,t}$ is a measure of discretionary fiscal policy volatility in a country (i) at time (t). *x* is a vector of exogenous variables. SWF is a dummy variable equals to one if country (i) has a stabilization SWF at time *t* and zero otherwise. $\boldsymbol{\beta}$ and ρ are parameters to be estimated, η is time invariant country-specific error term, and δ is a time dependent random disturbance term.

4.1.1 Measuring Discretionary Fiscal Policy Volatility

The literature on fiscal policy uses several approaches to measuring the discretionary fiscal policy volatility, none is clearly superior to any other. The first approach consists of calculating the standard deviation of the annual growth rate of real government consumption. However, the main problem of this approach is that it

[8] Several empirical studies also looked at the relationship between oil funds and macroeconomic stability (Shabsigh and Ilahi, 2007; Mehrara, Karsalari and Haghiri, 2012).

ignores the cyclical state of the economy. The second approach—which is based on the pioneer work of Fatás and Mihov (2003, 2006)—measures volatility based on the standard deviation of the residuals from a regression of a fiscal reaction function. According to Fatás and Mihov (2003), fiscal policy consists of three main components: (i) automatic stabilizers; (ii) discretionary policy that reacts to the state of the economy; and (iii) discretionary policy that is implemented for reasons other than current macroeconomic conditions. In particular, the discretionary fiscal policy volatility is measured as the logarithm of the standard deviation of the residuals recovered from the following equation.

$$\Delta \ln(G_{i,t}) = \alpha + \beta \Delta \ln(Y_{i,t}) + \delta W_{i,t} + \varepsilon_{i,t} \quad (2)$$

where $G_{i,t}$ is real government consumption, $Y_{i,t}$ is real GDP, and $W_{i,t}$ is a set of control variables including inflation and its square, and real GDP per capita. The error terms $\varepsilon_{i,t}$ now represents discretionary fiscal policy: fiscal policy changes that are exogenous to output growth and automatic stabilizers. Thus, the country-specific volatility of the residual $\sqrt{Var_i}(\varepsilon_{i,t})$, and denoted as $\sigma_{i,t,}$ captures the third component of the fiscal policy (i.e., the excessive discretionary changes in fiscal policy that are not related to the cyclical state of the economy).[9] Fatás and Mihov (2003) estimates Equation (2) for each country using Instrumental Least Squares (ILS) to take into account the simultaneity between real government consumption and real GDP.

In this paper, we measure discretionary fiscal policy volatility in line with the approach developed by Fatás and Mihov (2003, 2006), with the following differences: i) we use panel data to estimate Equation (2). This enables us to control for unobservable country-specific effects that may vary across countries, improving the efficiency of econometric estimates. ii) Since it is difficult to find a proper instrument for real GDP, we estimate Equation (2) by system Generalized Methods of Moments (GMM) to solve the endogeneity problem by using a series of internal instrumental variables based on lagged values of the dependent and independent variables. iii) We control for the presence of fiscal rules. The results—presented in Appendix Table 3—are in line with the expectations.

4.1.2 The Endogeneity of SWF

The presence of the stabilization SWF dummy variable in Equation (1) creates two critical statistical problems. The first potential problem is the endogeneity of the dummy variable. A necessary condition for the estimated coefficient of the effect of having a stabilization SWF (i.e., δ) to be unbiased and consistent is that the stabilization SWF dummy variable and the error terms ($\eta_i + \varepsilon_{i,t}$) are uncorrelated. However, a country's decision to establish such a fund is determined by other factors including episode of poor macroeconomic performance and so it must be treated as an endogenous variable. Since setting up a stabilization SWF is not a random

[9] A less common approach is to measure volatility as the standard deviation of the unsystematic component of public consumption expenditure, which is extracted from the series, using the Hodrick-Prescott or Baxter-King filters (see Furceri and Karras, 2007 and Afonso and Furceri, 2010).

decision, the biasness of the estimated effect of such a SWF on volatility of fiscal policy due to the endogeneity problem is called a "selection bias".

The second problem with this setting is that we cannot observe $\sigma_i|SWF_i = 1$ and $\sigma_i|SWF_i = 0$ for the country (i) at the same time. We only observe what happens to country (i) after the establishment of a stabilization SWF, but not what would have happened in the absence of such a fund. The challenge is to construct a suitable counterfactual of country (i)'s treatment status. Thus, we need to construct what happens were country (i) has (did not have) when it actually did not (did).

Against this background, estimating Equation (1) using conventional estimation methods such as Ordinary-Least Square (OLS) would yield biased and inconsistent estimates of the effects of a stabilization SWF on fiscal policy volatility. In addition, we want to compare the level of volatility in the discretionary fiscal policy in countries with a stabilization SWF relative to countries that do not have such a fund. To do this, we want to select the comparator countries based on varying proximity criteria. To overcome these issues, we use two different econometric methods to correct the selection bias and be able to estimate the stabilization SWF impacts consistently. The first one is a regression-based treatment effect model developed by Maddala (1983) and the second one is a non-parametric approach based on a Propensity Score Matching (PSM) method.

4.1.3 The Treatment Effect Model

As noted above, since establishing a stabilization SWF is not a random decision, the treatment effect model allows us to generate selection-corrected estimates of SWF impacts on the volatility of government consumption. This is done in a two-step procedure. In the first step, we estimate the probability of establishing a stabilization SWF (i.e., the selection equation). Then using the results of this regression, we can consistently estimate the impact of the presence of a stabilization SWF on the volatility of fiscal policy (i.e., the outcome equation).[10] That is,

$$\sigma_{i,t} = x'_{i,t}\boldsymbol{\beta} + \rho D_{i,t}^{SWF*} + \eta_i + \varepsilon_{i,t} \qquad (3)$$

$$D_{i,t}^{SWF*} = z'_{i,t}\boldsymbol{\gamma} + \mu_{i,t} \qquad (4)$$

Where $D_{i,t}^{SWF*}$ is a latent endogenous variable which its observable counterpart $D_{i,t}^{SWF}$ is generated as follows:

$$D_{i,t} = \begin{cases} 1 \; if \; D_{i,t}{}^{SWF^*} > 0 \\ 0 \; otherwise \end{cases}$$

[10] The discussion on the treatment effect model is drawn from Wooldridge (2002).

z is a vector of exogenous variables and *μ* is the error term. To obtain consistent estimates of the parameters under the treatment effect model, the two equations' error terms (ε and μ) must be correlated. If these error terms are uncorrelated, the outcome equation can be estimated consistently by a means of OLS.[11]

The remaining part is to specify the potential determinants of our outcome equation and the factors leading a country to establish a stabilization SWF (i.e., the selection equation). The choice of the control variables for the outcome question is motivated by the related existing empirical studies and the availability of data. In particular, we assume that the discretionary fiscal policy volatility is determined by: 1) the size of the economy measured by real GDP; 2) macroeconomic stability proxied by inflation rates; 3) the size of the government proxied by government consumption as a percentage of GDP; 4) degree of openness proxied by total exports and imports as a percentage of GDP; 5) commodity terms of trade index, capital mobility degree, and real effective exchange rate. Countries with sound institutions, low corruption levels, democratic institutions, and fiscal rules are found to have less volatile government consumption and so we control for these factors (Alesina and others, 1999; Acemoglu, 2005; Albuquerque, 2011).

With respect to the determinants of establishing a stabilization SWF (the selection equation), we also rely on the existing literature. We assume that the country's decision to establish such fund depends on 1) country-specific macroeconomic factors such as the level of development, real GDP growth rate, level of foreign reserves, inflation rates, commodity terms of trade; 2) institutional factors such as democratic institutions and fiscal rules; and 3) global factors proxied by real oil prices.

4.1.4 Propensity Score Matching

Given that the results of the regression-based treatment effect model outlined above are sensitive to the selection equation's specifications, the literature proposes an alternative approach that yields consistent estimates despite the presence of the selection bias problem (Verbeek, 2017). This approach estimates the average treatment effect of program evaluation based on a non-parametric technique using a PSM. The basic idea of the PSM is that we compare the level of fiscal policy volatility into a group of countries that have stabilization SWFs to another group of countries which do not.

Let $Y_{1,i}$ be the value of outcome variable when the country i decides to establish a SWF and Y_{0i} be the value of the outcome variable when the country (i) does not have such as a fund.[12] Thus, countries that have stabilization SWFs are called the "treatment group" and the countries that do not have such a fund are called "the control group". Further, there are a set of observed covariates, X. Thus, for each country, we observe (D_i, Y_i, X_i), where Y_i is the realized outcome:

11 The model can be estimated by Maximum Likelihood estimator (MLE) and Heckman's two-step estimator.

12 The outline of the PSM is largely drawn from Hirano and Imbens (2004) and Wooldridge (2002).

$$Y_i = \begin{cases} Y_{0i} \ \ if\ Di = 0 \\ Y_{1i} \ \ if\ Di = 1 \end{cases}$$

Since it is impossible to observe the same country with and without stabilization SWF at the same time, the effect of a treatment on country i, δ is the difference between potential outcomes with and without a treatment.

$$\delta_i = Y_{1i} - Y_{0i}$$

Thus, to evaluate the effect of stabilization SWF on fiscal policy volatility, we may compute the Average Treatment Effects (ATE):

$$ATE = E(\delta_i) = E[Y_{1i} - Y_{01}]$$

Further, we may be interested in computing the average Treatment Effect on the Treated (ATT) as follows:

$$ATT = E[Y_{1i}|D_i = 1] - E[Y_{0i}|D_i = 1]$$

The probability of the treatment as a function of X is known as the propensity score. Instead of attempting to create a match for each participant with the same value of X, we can instead match the probability of establishment.

$$P(s) = P(D_i = 1|X = x)$$

To be able to identify the impact of the presence of a stabilization SWFs (i.e., treatment effects), we need two key assumptions. 1) conditional independence (unconfoundedness) which implies there exists a set X of observable covariates such that, after controlling for these covariates, the potential outcomes are independent of treatment status:

$$(Y_{1i}, Y_{0i}) \perp D|X$$

2) The common support (the overlap) which implies that for each value of X, there is a positive probability of being either treated or untreated:

$$1 > P(D = 1|X) > 0$$

This assumption implies that each country in our sample is equally likely (i.e., having common support) to receive treatment (i.e., to establish or not a stabilization SWF). This assumption of common support ensures that the treated and untreated (control) countries (which are different) can be used as counterfactuals.

4.2 Data Sources

The empirical analysis is based on unbalanced panel data for 182 advanced and developing countries over the period 1980–2019. Data on real government expenditure, real GDP come from the *World Penn table*. Macroeconomic data are from the *IMF, World Economic Outlook database* (2021) and the *World Bank, World Development Indicators* (2021). Democracy index is measured as the sum of political and civil right indices and data come from *Freedom House's* database (2021). Data on SWFs come from *Sovereign Wealth Fund Institute* and the *International Forum of Sovereign Wealth Funds.*[13] The dummy variable equals one if a country has a stabilization SWF at time t and zero otherwise. All independent variables are lagged one year to reduce the simultaneity problem. A full description of the data and their sources are in the Appendix. Appendix Table A1 reports the descriptive statistics and Appendix Table A2 reports the correlation matrices.

5. EMPIRICAL Results

To test the effects of the presence of a stabilization SWF on the volatility of fiscal policy, we estimate Equation (2) by a means of Fixed Effects Model (FEM) as an initial step to confirm previous studies. [14] Also, to achieve worthwhile empirical results, we first sketch out the model using full sample which includes advanced and developing economies. Then we run regressions only including developing countries and other regressions for commodity-exporting countries only.[15] As can be seen from Table 1, the estimated coefficient of the stabilization SWF is negative and robustly statistically significant in all specifications.

[13] Information on the main purposes of the SWFs is based on the *de jure* function of SWFs.

[14] In unreported regressions, we also estimate Equation (2) by Random Effects model. The results remain almost the same.

[15] Also, one may want to group the sample based on income levels (high-, medium-, and low-income). However, due to insufficient number of countries that have a stabilization SWF in each group prevents us from doing so.

Table 1. Sovereign Wealth Funds and Volatility of Fiscal Policy: Fixed Effects Model

Dependent variable *: log of volatility of discretionary government expenditure: 1980-2019*

	Full Sample		Developing Countries			Commodity-Exporters		Developing Commodity-Exporters	
Independent Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
SWF (t-5)	-0.16	-0.26*	-0.18*	-0.28*	-0.1	-0.17**	-0.22**	-0.20*	-0.26*
	(-1.78)	**(-2.21)**	**(-2.00)**	**(-2.34)**	**(-0.64)**	**(-1.93)**	**(-1.82)**	**(-2.19)**	**(-2.07)**
Log (GDP)	-0.03**	0.03	-0.02*	0.03	-0.01	-0.02**	0.02	-0.02**	0.03
	(-3.02)	**(1.51)**	**(-2.50)**	**(1.84)**	**(-0.83)**	**(-3.02)**	**(1.51)**	**(-2.85)**	**(1.65)**
Log(Govsize)	0.04	0.1	0.01	0.08	-0.42	-0.02	0.1	-0.03	0.1
	(0.44)	**(1.03)**	**(0.04)**	**(0.73)**	**(-1.32)**	**(-0.20)**	**(0.74)**	**(-0.24)**	**(0.68)**
Inflation	0.01***		0.01***		0.01	0.01***		0.01***	
	(9.04)		**(9.24)**		**(-6.71)**	**(7.54)**		**(7.58)**	
Degree of Openness		-0.001		-0.0001			0.002		0.003
		(-1.08)		**(-0.04)**			**(1.17)**		**(1.64)**
Debt to GDP					-0.002				
					(-0.64)				
Log (commodity ToT)		-0.01		-0.09			-0.4		-0.4
		(-0.02)		**(-0.18)**			**(-0.76)**		**(-0.78)**
Log (REER)		-0.15		-0.12			-0.05		-0.01
		(-1.48)		**(-1.11)**			**(-0.34)**		**(-0.11)**
Democracy index		-0.5*		-0.4**			-0.4		-0.4
		(-2.30)		**(-1.88)**			**(-1.20)**		**(-0.91)**
Constant	-2.9***	-2.4	-2.7***	-2.2	-1.8	-2.5***	-1.3	-2.5***	-1.4
	(-10.82)	**(-1.03)**	**(-9.95)**	**(-0.92)**	**(-2.07)**	**(-7.30)**	**(-0.52)**	**(-6.89)**	**(-0.55)**
No. of Observations	5,811	4,935	4,730	3,933	745	2,504	2,138	2,199	1,834
No. of Countries	**182**	**166**	**150**	**135**	**58**	**80**	**74**	**71**	**65**
R-Sequared	0.129	0.01	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Source: Authors' calculations.

Notes

1. All variables, except SWF, are measured as 5-year moving average.
2. Robust t-values are in parentheses. ***, **, and * indicate statistical significance at 1, 5, and 10 percent levels, respectively.

5.1 The results of the treatment effect model

Table 2 presents the results of the treatment effect model. We follow the same specifications as above for the outcome equation. As can be seen, the results remain robustly negative at one percent level. The estimated average treatment effect indicates that the volatility of the fiscal policy in country with a stabilization SWF is less than that of a country without such a fund, suggesting that having a stabilization SWF help smooth government consumption. As mentioned above, the treatment effect model would yield consistent estimates only when the error terms of the two questions are significantly correlated. As can be seen from the corresponding *p*-values of the Wald tests reported at the bottom of Table 2 indicates that the correlation between the two error terms is statistically significant suggesting that the treatment effects model is appropriate.

Table 2. Sovereign Wealth Funds and Volatility of Fiscal Policy: Average Treatment Effects

	Dependent variable *: log of volatility of discretionary government expenditure: 1980-2019*			
Independent Variables	**Full Sample**	**Developing Countries**	**Commodity-Exporters**	**Developing Commodity-Exporters**
SWF (t-5)	-0.62***	-0.60***	-0.77***	-0.66***
	(-6.23)	**(-5.27)**	**(-4.71)**	**(-3.80)**
Log (GDP)	-0.06***	-0.05***	-0.03***	-0.02*
	(-14.57)	**(-8.60)**	**(-4.64)**	**(-2.53)**
Log (Govsize)	-0.11***	-0.07*	-0.19***	-0.16***
	(-4.46)	**(-2.57)**	**(-4.75)**	**(-3.64)**
Degree of Openness	-0.002	-0.001*	0.001*	0.001*
	(-1.05)	**(-2.27)**	**(2.29)**	**(2.07)**
Log (CTOT)	-0.7***	-0.8***	-1.0***	-1.1***
	(-6.02)	**(-6.64)**	**(-7.19)**	**(-7.27)**
Log (REER)	-0.06	0.002	-0.21**	-0.19*
	(-1.29)	**(0.05)**	**(-2.94)**	**(-2.41)**
Democracy index	-0.72***	-0.42***	-0.53***	-0.30**
	(-15.75)	**(-7.30)**	**(-6.57)**	**(-2.64)**
Constant	1.8**	1.7**	3.8***	3.8***
	(3.17)	**(2.82)**	**(5.12)**	**(4.63)**
No. of Observations	**4,026**	**3,140**	**1,608**	**1,321**
Wald Test 5/	30.05	20.33	14.88	12.51
P-value	0.000	0.000	0.000	0.000

Source: Author's calculations.
1/ Models are estimated by full maximum likelihood.
2/ All variables, except SWF, are measured as 5-year moving average.
3/ Robust z-values are in parentheses.
4/ ***, **, and * indicate statistical significance at 1, 5, and 10 percent levels, respectively.
5/ The null hypothesis is that error terms in both equations are uncorrelated.

5.2 The Results of Propensity Score Matching

The PSM procedure is done in three steps: first, we estimate propensity scores – i.e., the probability of establishing a stabilization SWF given a set of observed covariates using a pooled panel Probit regression model. Second, we choose a matching algorithm that will use the estimated propensity scores to match countries that have such a fund with similar countries that do not have. Third, we estimate the average treatment effect of the intervention with the matched sample and calculate the standard errors.

We specify the determinants of stabilization SWFs as in Equation (4) and we estimate it by pooled panel Probit regressions. To match treated (with SWFs) and untreated (without SWFs) countries, we use the Nearest Neighbor matching.

The results reported in Table 3 confirm our findings above although the estimated effects appear to be smaller. The PSM results suggest that a country a stabilization SWF has less volatile fiscal policy and this result is robustly significant at one percent level.

Table 3. Stabilization Sovereign Wealth Funds and Volatility of Fiscal Policy: Non-Parametric Estimations

Estimator: Nearest-Neighbor Matching

	Full sample			Developing Countries			Commodity-Exporters			Developing Commodity-Exporters		
	Nearest Neighbor Matching											
	(1)	(3)	(5)	(1)	(3)	(5)	(1)	(3)	(5)	(1)	(3)	(5)
SWF	-0.11*	-0.13**	-0.14**	-0.12*	-0.14**	-0.14**	-0.18***	-0.19***	-0.19***	-0.20***	-0.21***	-0.22***
	(-2.23)	(-2.89)	(-2.94)	(-2.27)	(-2.90)	(-2.87)	(-3.93)	(-4.71)	(-4.72)	(-4.14)	(-4.87)	(-4.84)
No. of Observations	5,309	5,309	5,309	4,304	4,304	4,304	2,311	2,311	2,311	2,007	2,007	2,007
No. of Groups	166	166	166	151	151	151	80	80	80	65	65	65

Source: Authors' calculations.
1/ The treatment is whether a country has a stablization SWF at time (t-5) and the the outcome is the log of volatility of discretionary government expenditure: 1980-2019.
2/ Robust t-stat in parentheses.
3/ ***, ** and * indicate statistical significance at 1, 5, and, 10 percent levels, respectively.
4/ (1), (3) and (5) refer to the number of nearest neighbors used.

6. CONCLUSION

We have assessed the relationship between the presence of stabilization SWFs and the degree of volatility of fiscal policy. This issue became relevant again recently due to the volatility in commodity prices following the pandemic and the war in Ukraine. From a theoretical perspective, a stabilization SWF helps smooth fluctuations in budget resources by reducing or eliminating the uncertainty and volatility of resource-related revenue flowing into the budget.

Using an unbalanced panel dataset for 182 advanced and developing countries during 1980-2019, we estimate the average treatment effects by two different econometric approaches to address the self-selection problem. In the first approach, we use a two-step regression-based method that estimates the outcome and selection equations simultaneously. In the second approach, we rely on a non-parametric approach in which the average treatment effect is estimated by propensity score matching. The empirical findings support the argument that stabilization SWFs help smooth government consumption during bad times. The empirical results show that fiscal policy volatility in countries with stabilization SWFs is lower, relative to that in countries without such a fund, by about 14 percent. However, the establishment of a stabilization SWF does not in itself ensure that fiscal policy will insulate the domestic economy from commodity price fluctuations since these funds are not a substitute for fiscal policy.

That said, there is scope for future research. In particular, given that stabilization SWFs vary in size, the deposit/withdrawal rules one may want to distinguish between them (this is not clear), as the use of a simple binary variable in this study to capture the impact of stabilization SWFs on fiscal policy behavior cannot capture those differences which could be addressed in future work.

APPENDIX

Appendix Table 1. Summary Statistics

	Obs.	Mean	Std. Dev.	Min	Max
Volatility of discretionary government expenditure	6,499	-2.95	0.83	-5.91	0.02
Stabilization SWF	7,360	0.08	0.27	0.00	1.00
log (REER)	5,699	4.63	0.35	0.17	7.25
Real GDP growth	6,278	3.62	3.94	-31.01	43.40
Log (GDP)	6,931	11.10	3.71	2.42	43.65
Log(Govsize)	6,931	2.74	0.54	0.13	4.58
Debt to GDP	1,004	44.52	33.85	2.01	199.52
Inflation	6,555	11.4	24.5	-26.3	376.3
Democracy index	6,801	0.56	0.33	0.00	1.00
Commodity ToT	6,556	4.59	0.13	3.78	4.97
Degree of openness	6,651	82.3	49.2	0.2	425.2
Capital Mobility Index	5,979	0.04	1.50	-1.90	2.33

Source: authors' calculations.
Note: with the exception to the SWF dummy variable, all variables are in 5-year moving average format.

Appendix Table 2. Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. Volatility of discretionary government expenditure	1.00								
2. Stabilization SWF	0.07	1.00							
3. Degree of openness	-0.01	-0.04	1.00						
4. Log (GDP)	-0.21	0.07	-0.28	1.00					
5. Log (Govsize)	-0.14	0.08	0.17	-0.05	1.00				
6. Inflation	0.24	-0.04	-0.14	0.34	-0.05	1.00			
7. Log (REER)	0.07	-0.05	-0.08	-0.03	-0.08	0.05	1.00		
8. Democracy index	-0.33	-0.13	0.15	0.02	0.34	-0.10	-0.24	1.00	
9. Log (Commodity Tot)	-0.08	-0.31	0.03	-0.17	0.00	0.02	0.00	0.24	1.00

Source: Authors' calculations.

Appendix Table 3. The Determinants of Fiscal Volatility

	FE	FE	System GMM
Independent Variables	***Dependent Variable** : Log of real government consumption: 1980-2019*		
Log (GDP)	0.995***	0.996***	0.798***
	(85.90)	(86.77)	(11.29)
Inflation	-0.00003	-0.00001	-0.001
	(-0.16)	(-0.09)	(-1.18)
Inflation^2	-0.00	-0.00	-0.00
	(-0.87)	(-0.89)	(-1.06)
Log (GDP per capita)	0.001	0.001	0.08**
	(0.23)	(0.28)	(3.05)
Fiscal rule		0.001	
		(0.22)	
lagged dependent variable			0.22***
			(3.32)
Constant	-0.005	-0.006	-2.3***
	(-0.23)	(-0.31)	(-7.68)
No. of Observations	6,681	6,542	6,542
No. of Groups	**182**	**182**	**182**
R-Squared			
Within	0.92	0.91	….
Between	0.98	0.98	….

Source: Authors' calculations.
1/ Robust t-values are in parentheses.
2/ ***, **, and * indicate statistical significance at 1, 5, and 10 percent levels, respectively.
3/ The dependent variable and log (GDP) in the FE models are in first-differenced.

Appendix Table 4. The Determinants of Establishing a Stabilization Wealth Fund

	Dependent variable *: Stabilization Wealth Fund: 1980-2019 1/*			
Independent Variables	**Full Sample**	**Developing Countries**	**Commodity-Exporters**	**Developing Commodity-Exporters**
Real GDP growth	-0.01 **(-0.39)**	-0.001 **(-0.31)**	-0.01 **(-0.57)**	-0.01 **(-0.33)**
Fiscal Rule	0.321*** **(3.98)**	0.563*** **(6.41)**	0.155 **(1.76)**	0.290** **(2.95)**
Log(REER)	-0.409** **(-3.16)**	-0.402** **(-2.92)**	-0.349* **(-2.45)**	-0.420** **(-2.70)**
Capital account openness	1.326*** **(13.39)**	1.403*** **(13.30)**	1.346*** **(11.00)**	1.470*** **(10.75)**
Reserves in months of imports	0.0329*** **(6.28)**	0.0321*** **(5.86)**	0.0212*** **(3.47)**	0.0199** **(3.26)**
Democracy index	-1.529*** **(-11.82)**	-1.495*** **(-9.90)**	-1.108*** **(-7.44)**	-1.179*** **(-6.57)**
Constant	0.270 **(0.44)**	0.179 **(0.28)**	0.326 **(0.48)**	0.646 **(0.88)**
No. of Observations	**4026**	**3140**	**1608**	**1321**
Wald Test 5/	30.05	20.33	14.88	12.51
P-value	0.000	0.000	0.000	0.000

Source: Authors' calculations.
1/ The dependent variable is a dummy variable equal one if the country has a stabilization wealth fund at time t and zero otherwise.
1/ Models are estimated by full maximum likelihood.
2/ All variables, except fiscal rule and SWF, are measured as 5-year moving average. Models are estimated by pooled Probit regressions.
3/ Robust z-values are in parentheses.
4/ ***, **, and * indicate statistical significance at 1, 5, and 10 percent levels, respectively.
5/ The null hypothesis is that error terms in both equations are uncorrelated.

Data Sources	▪ Definitions of Variables
1. World Penn Table	• **Real government expenditure**. Government consumption at constant national 2017 prices. • **Real GDP.** GDP at constant national 2017 prices. • **Total population**
2. Sovereign Wealth Fund Institute and the International Forum of Sovereign Wealth Funds	• **Data on SWFs.** The dummy variable equals one if a country has a stabilization SWF at time t and zero otherwise.
3. The World Bank *World Development Indicators, 2021*	• **Openness:** The sum of exports and imports of goods and services measured as a share of GDP. • **Inflation rate**: consumer price index (annual %). •
4. International Monetary Fund's *World Economic Outlook database, 2021*	• **CAB/GDP**: Current Account Balance as a percentage of GDP. • **Fiscal balance/GDP**: Overall fiscal balance as a percentage of GDP • **Terms of Trade**: Terms of goods and services Trade index. • **REER**: real effective exchange rate • **Public debt**; central government's gross debt as a percentage of GDP
5. Gruss, B. and S. Kebhaj, 2019	• **Commodity Terms of Trade index.** For each country, the change in the commodity ToT index (CTT) corresponds to the weighted sum of annual variations in global prices of commodities, weighted by the country's net exports of each commodity as a share of GDP.
6. Eyraud, Debrun, Hodge, Lledó, and Pattillo, 2018	• **Fiscal Rule.** A dummy variable equals one if a country has a fiscal rule at time t and zero otherwise. **Fiscal Rules Dataset 1985-2015.**
7. Chinn and Ito 2018	• **Capital mobility index.** The Chinn-Ito index (KAOPEN) is an index measuring a country's degree of capital account openness. The index was initially introduced in Chinn and Ito (Journal of Development Economics, 2006). KAOPEN is based on the binary dummy variables that codify the tabulation of restrictions on cross-border financial transactions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER).
8. Freedom House database, 2021	• **Democratic institutions**: our own compilation based on data for political rights and civil liberties. Countries are ranked from 1 (most free) to 7 (least free) in both indices. Our index is defined as [14 - (political rights + civil rights) / 12] and so it ranges from 0 (least free) to 1 (most free).

Appendix Table 5. Country Sample

Albania	Congo, Republic of* /	India	Morocco	Spain
Algeria* /	Costa Rica	Indonesia*	Mozambique*	Sri Lanka
Angola* /	Croatia	Iran* /	Myanmar	St. Kitts and Nevis
Antigua and Barbuda	Cote d'Ivoire*	Iraq*	Namibia	St. Lucia
Argentina*	Cyprus	Ireland	Nepal	St. Vincent and the Grenadines
Armenia*	Czech Republic	Italy	Netherlands*	Sudan* /
Aruba	Denmark*	Jamaica*	New Zealand	Suriname*
Australia*	Djibouti	Japan	Nicaragua	Sweden
Austria	Dominica	Jordan	Niger*	Switzerland
Azerbaijan* /	Dominican Republic	Kazakhstan*/	Nigeria* /	Syria*
Bahamas, The	Ecuador*	Kenya	Norway* /	Tajikistan*
Bahrain*	Egypt*	Kiribati /	Oman* /	Tanzania
Bangladesh	El Salvador	Korea	Pakistan	Thailand
Barbados	Equatorial Guinea*	Kosovo	Palau /	Timor-Leste* /
Belarus*	Eritrea*	Kuwait* /	Panama /	Togo*
Belgium	Estonia*	Kyrgyz Republic	Papua New Guinea*	Tonga
Belize*	Eswatini	Lao P.D.R.*	Paraguay	Trinidad and Tobago* /
Benin	Ethiopia	Latvia	Peru* /	Tunisia*
Bhutan	Fiji	Lebanon	Philippines	Turkey
Bolivia*	Finland	Lesotho	Poland	Turkmenistan* /
Botswana*	France	Liberia*	Portugal	Tuvalu
Brazil*	Gabon*	Libya*	Qatar* /	Uganda* /
Brunei Darussalam*	Gambia, The	Lithuania*	Romania	Ukraine
Bulgaria	Georgia	Luxembourg	Russia* /	United Arab Emirates*
Burkina Faso*	Germany	Madagascar	Rwanda /	United Kingdom
Burundi	Ghana* /	Malawi	Samoa	United States
Cabo Verde	Greece	Malaysia*	Saudi Arabia* /	Uruguay
Cambodia	Grenada	Maldives	Senegal*	Uzbekistan*
Cameroon*	Guatemala	Mali*	Serbia	Vanuatu
Canada*	Guinea*	Malta	Seychelles	Venezuela* /
Central African Republic*	Guinea-Bissau	Marshall Islands /	Sierra Leone	Vietnam*
Chad*	Guyana*	Mauritania*	Singapore*	Yemen*
Chile* /	Haiti	Mauritius	Slovak Republic	Zambia*
China	Honduras	Mexico* /	Slovenia	Zimbabwe
Colombia* /	Hong Kong SAR	Moldova	São Tomé and Príncipe*	
Comoros	Hungary	Mongolia* /	Solomon Islands	
Congo, Democratic Republic of the*	Iceland*	Montenegro, Rep. of	South Africa*	

* Commodity-exporting countries.
/ Countries with stabilization SWF.

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