sustainability

MDPI

Article

Natural Resource Funds: Their Objectives and Effectiveness

Hiroyuki Taguchi * and Javkhlan Ganbayar

Graduate School of Humanities and Social Sciences, Saitama University, 255 Shimo-Okubo, Sakura-ku, Saitama 338-8570, Japan

* Correspondence: htaguchi@mail.saitama-u.ac.jp; Tel.: +81-48-858-3324

Abstract: This study aims to examine the effectiveness of natural resource funds in resource-rich countries according to funds' objectives via an econometric method using panel data (ordinary least squares estimator with fixed-effect model and Poisson pseudo-maximum likelihood estimator). The main contribution of this study is demonstrating fund-specific evaluation. To this end, it classifies funds into three types based on their objectives—stabilization, investment, and savings funds—and evaluates the effectiveness of each fund type by each criterion corresponding to an objective. The econometric estimations identify the effectiveness of stabilization funds in reducing the volatility of government expenditure and the primary balance, as well as the effectiveness of investment funds in increasing investment rates. They also confirm the facilitation of funds' effectiveness under a combination of funds' operations and high governance. The econometric analysis also shows that the operation of stabilization funds reduces the volatility of government expenditure by 13.6%, and their operation under high governance reduces it by 33.2%; meanwhile, the operation of investment funds increases the investment rate by 9.8%, and their operation with high governance raises it by 46.8%. Their practical implications are that the fiscal smoothing under stabilization funds provides a counter-cyclical buffer to mitigate commodity price shocks, thereby contributing to macroeconomic stabilization, and that the increase in investment rates under investment funds alleviates the Dutch disease effect, thereby sustaining economic growth.

Keywords: natural resource funds; stabilization funds; investment funds; savings funds; volatility; resource curse

Citation: Taguchi, H.; Ganbayar, J. Natural Resource Funds: Their Objectives and Effectiveness. *Sustainability* **2022**, *14*, 10986. https://doi.org/10.3390/su141710986

Academic Editors: Hafezali Iqbal Hussain, Fakarudin Kamarudin and Er Meng Joo

Received: 10 August 2022
Accepted: 31 August 2022
Published: 2 September 2022

1. Introduction

Economies rich in natural resources tend to grow at a slower rate and have inferior development outcomes than those without natural resources. This puzzling phenomenon has been referred to as the "resource curse" hypothesis and was initially proposed by Auty [1]. The resource curse was typically observed in many African countries that are rich in minerals but have remained at the least developed stage, whereas East Asian countries have achieved the highest growth performance worldwide without natural resources during the post-World War II period. The resource curse hypothesis has been analyzed empirically and theoretically in a number of studies, with the majority providing evidence to support this hypothesis (e.g., [2–10]).

There have also been debates aiming to explain the factors and channels behind the existence of the resource curse. From a macroeconomic perspective, natural resource development and dependence are considered to crowd out manufacturing activities (referred to as Dutch disease, e.g., [3,4,11–13]) and bring macroeconomic instability into an economy through the volatility of resource prices (e.g., [14,15]). From the aspects of political economy and governance, natural resource abundance accelerates rent-seeking behaviors, corruption, and internal wars (e.g., [16–22]).

To solve the resource curse, theoretical approaches have traditionally been proposed, such as pricing, taxation, and the optimal extraction path of natural resources (e.g., [23–25]). However, these approaches have been criticized for their normative nature and limited

practicability [26]. Alternatively, natural resource funds, as an explicit fiscal tool, have become one of the main targets for policy debates to address the resource curse. Their theoretical purpose is that these funds, by insulating the economy from the fluctuations of resource prices and political pressures, stabilize the macroeconomy and finance the investments and savings necessary for future generations (e.g., [27–31]).

Empirical studies on the effectiveness of resource funds have produced mixed and inconclusive results. Evidence can be divided into the following three categories: arguments supporting the effectiveness of resource funds (e.g., [30,32]), arguments providing conditional support for the effectiveness of resource funds under high governance and robust fiscal rules (e.g., [28,33]), and arguments opposing their effectiveness (e.g., [34,35]).

To enrich the evidence on funds' evaluation, this study aims to reexamine the effectiveness of 54 natural resource funds in 41 resource-rich countries according to funds' objectives via an econometric method using panel data. The natural resource funds are classified into three types based on their objectives: stabilization, investment, and savings funds [29,36]. Accordingly, the research question is how effectively the funds have achieved their own objectives. The biggest contribution of this study is the demonstration of fund-specific evaluation: this study evaluates each fund's effectiveness using each criterion corresponding to each objective. Literature has evaluated funds for specific countries or assessed all funds using a single criterion. Another contribution is to employ an econometric approach. To date, most studies have engaged in the qualitative, conceptual, and comparative assessment of resource funds in selected countries, while a limited number of studies have applied a quantitative approach to funds' roles in fiscal and macroeconomic contexts.

The main conclusions of this study are highlighted as follows. The econometric estimations identify the effectiveness of stabilization funds in reducing the volatility of government expenditure and the primary balance, as well as the effectiveness of investment funds in increasing investment rates. They also confirm the facilitation of funds' effectiveness under a combination of funds' operations and high governance.

The remainder of this paper is organized as follows. Section 2 reviews the literature related to the evaluation of resource funds and further clarifies the contributions of this study to the existing literature. Section 3 presents an empirical analysis of fund evaluation. Further, Section 4 presents and discusses the results, while Section 5 concludes the paper.

2. Literature Review and Contributions

This section reviews the literature on the empirical evaluation of natural resource funds and clarifies the contributions of this study to the literature. As mentioned in Section 1, empirical studies on the effectiveness of resource funds have produced mixed and inconclusive outcomes. The evidence can be classified into three categories: arguments supporting the effectiveness of resource funds, arguments providing conditional support for the effectiveness of resource funds under high governance and robust fiscal rules, and arguments opposing their effectiveness (see Tables 1 and 2).

Table 1. A list of previous studies.

Funds' Effects	Descriptive Analyses	Quantitative Analyses
Favorable Effects	Bortolotti et al. [37], Baena et al. [32], Bagattini [38], Lücke [39], Fasano-Filho [40], Chalk et al. [41]	Tsani [30,31], Sugawara [33], Bagattini [38], Merlevede et al. [42], Shabsigh and Ilahi [43]
Favorable Effects with Institutions & Rules	Gould [44], Le Borgne and Medas [45], Usui [46], Bacon & Tordo [28], Hjort [47], Kalyuzhnova [48], Tsalik [27], Engel & Valdes [49], Fasano-Filho [40]	Allegret et al. [50], Sugawara [33], Bagattini [38], Crain and Devlin [51]
No Effects or Harmful Effetcs	Villafuerte et al. [52], Devlin and Titman [53], Eifert et al. [54], Davis et al. [34]	Ouoba [36], Ossowski et al. [35]

Table 2. A list of quantitative studies.

	Ouoba [36]	**Tsani [30,31]**	**Sugawara [33]**
Dependent Variable **Independent Variable**	**Economic Growth**	**Governance**	**Gov. Expenditure Volatility**
funds	*	*	*
population	*	*	*
economic growth		*	*
inflation	*		*
resource dependence	*	*	*
trade or capital openness	*	*	*
governance	*		*
government size			*
financial market			*
export diversification			*
capital/FDI	*		
terms of trade	*		
political conflicts	*		
political institutions	*	*	*
language		*	
location			*
social & religious factors		*	
oil price			
oil export share			
Samples	28 resource-rich countries	27 resource-rich countries	68 resource-rich countries
Methodology	Driscoll-Kraay, IV-2SLS, GMM	OLS, PCSE, Driscoll-Kraay, Quantile Regression	OLS, PCSE, fixed- effect model, DID
	Bagattini [38]	**Ossowski et al. [35]**	**Shabsigh and Ilahi [43]**
Dependent Variable **Independent Variable**	**Fiscal Perfromance Indicators**	**Primary Balance & Gov. Expenditure**	**Volatility of Money, CPI, REER**
funds	*	*	*
population			
economic growth		*	*
inflation		*	
resource dependence		*	
trade or capital openness			
governance	*	*	
government size		*	
financial market			*
export diversification			
capital/FDI			
terms of trade			
political conflicts			
political institutions	*	*	
language			
location			
social & religious factors			
oil price		*	*
oil export share			*
Samples	12 countries with stabilization funds	21 oil exporting countries	15 oil exporting countries
Methodology	PCSE	OLS, fixed- & random- effect model, Arellano-Bond	OLS, fixed- & random-effect model

Notes: FDI: foreign direct investment; IV-2SLS: instrumental variable two-stage least squares; GMM: generalized method of moments; OLS: ordinary least squares; PCSE: panel corrected standard errors; DID: difference-in-differences; CPI: consumer price index; REER: real effective exchange rate. *: means the existence of independent variables.

The first category, which represents arguments supporting resource funds, comprises both qualitative and quantitative studies. Regarding qualitative studies, specific stabilization and savings funds in selected countries are examined and cited as successful examples: Kuwait [41]; Kuwait, Norway, Chile, and the state of Alaska in [40]; Kazakhstan, Azerbaijan, and Norway [39]; and the states of Alaska and Alberta [32]. For quantitative studies, econometric approaches using panel data are applied to identify the effectiveness of funds using the criteria of monetary performance [43], fiscal performance [33,38], governance [30,31], and financial resilience [37]. A macroeconomic general equilibrium model also identifies the effectiveness of stabilization funds in the Russian Federation [42]. Among the studies above, the representative one is Tsani [30,31] proving the association between resource funds, governance and institutional quality in resource-rich countries. They suggest that resource funds provide a useful insulation tool against the resource curse in the hands of the policy makers.

The second category represents the argument that resource funds have worked well under high governance and robust fiscal rules. In the qualitative analyses, the role of institutional capacity in funds' success is emphasized in developing countries [28,45,47], and fiscal discipline and rules have been found to be the prerequisites for funds' workability [40,46,49], while ensuring transparency is essential for fund management [27,44,48]. In their quantitative study, Crain and Devlin [51] conduct an econometric analysis using panel data and show that fund establishment reduces fiscal volatility in Chile and Norway, whereas it increases volatility in oil-exporting countries; they speculate that the difference comes from the fiscal policy framework. Allegret et al. [50] construct a dynamic stochastic general equilibrium model and show that the combination of oil stabilization funds and policy rules contributes to preventing the Dutch disease effect. In this category, the representative study is Sugawara [33] identifying the interaction effects between funds' operations and political institutions and between funds' operations and fiscal rules. It clearly shows that political institutions and fiscal rules in managing stabilization funds are significant factors in reducing the government expenditure volatility.

In the third category, which represents arguments opposing resource funds, Davis et al. [34], using both econometric evidence and country case studies, argue that the establishment of a resource fund does not have an identifiable impact on government spending, while countries with more prudent expenditure policies tend to establish a fund, rather than the fund itself leading to an increased expenditure restraint. They also highlight the fund's limited ability to coordinate with the budgetary process and the duplication of expenditures in the case of weak monitoring. These arguments are followed by case studies and qualitative analyses, such as those of Eifert et al. [54], Devlin and Titman [53], and Villafuerte et al. [52]. Based on econometric analyses using panel data, Ossowski et al. [35] show that the introduction of oil funds has had no impact on fiscal outcomes, while emphasizing the importance of sound institutions and public financial management systems. Ouoba [36] demonstrates that resource funds have a negative and significant effect on economic growth.

The main contribution of this study is that, using an econometric approach, it adds to the existing quantitative evidence on the effectiveness of resource funds, the findings on which have been inconclusive in previous studies. Resource funds have been developed relatively recently, and this short timeframe has put practical limitations on econometric approaches. Therefore, enriching quantitative evidence is important for reaching robust conclusions.

The biggest contribution of this study is the demonstration of fund-specific evaluation. Resource funds are classified into three types based on their objectives: stabilization, investment, and savings funds, and the research question of this study is how effectively the funds have achieved their own objectives. This question is unique and different from the previous studies because the previous studies have evaluated individual funds for specific countries or assessed all funds using a single criterion such as fiscal performance, monetary performance, economic growth, or governance.

3. Material and Methods

This section conducts an econometric analysis of the evaluation of resource funds. It starts by describing the variables and data for the estimation and then clarifies the estimation methodology.

3.1. Variables and Data Collection

This subsection describes the variables and data collection for the subsequent econometric estimation. The estimation equation includes four dependent variables (the indicators for evaluating the effectiveness of funds according to their objectives), three explanatory dummies for the operations of the three types of funds (stabilization, investment, and savings), and other six explanatory variables for controlling time-varying country-specific effects. The variables used to estimate the effectiveness of the funds are listed, along with their measurement and data sources, in Table 3, and their descriptive statistics are presented in Table 4. A detailed description of each variable is provided after Table 4.

Table 3. A list of variables.

Variables	Description	Sources
Dependent Variable		
g_exp	*General government total expenditure, percent of GDP, absolute value of the deviation from the period average*	WEO
g_pbl	*General government primary net lending/borrowing, percent of GDP, absolute value of the deviation from the period average*	
inv	*Total investment, percent of GDP*	
sav	*Gross national savings, percent of GDP*	
Explanatory Variables		
f_sta	*Stabilization fund dummy: taking a value of 1 if the fund exists in $t-5$*	
f_inv	*Investment fund dummy: taking a value of 1 if the fund exists in $t-5$*	
f_sav	*Saving fund dummy: taking a value of 1 if the fund exists in $t-5$*	
gdp	*Gross domestic product as constant prices, percent change, one lagged*	WEO
inf	*Inflation by average consumer prices, percent change, one lagged*	
pop	*Population by millions of persons, log term, one lagged*	
top	*Sum of exports and imports of goods and services, percent of GDP, one lagged*	WDI
nrr	*Total natural resource rents, percent of GDP, one lagged*	
gov	*Worldwide governance indicators (WGI, average), from −2.5 (weak) to 2.5 (strong)*	WGI
voa	*Voice and accountability*	
pos	*Political stability and absence of violence/terrorism*	
gve	*Government effectiveness*	
req	*Regulatory quality*	
rol	*Rule of law*	
cor	*Control of corruption*	

Source: Authors' description, Notes: The data sources are as follows: WEO: World Economic Outlook Databases, International Monetary Fund, WDI: World Development Indicators, World Bank, WGI: Worldwide Governance Indicators, World Bank, GDP: gross domestic product.

Table 4. Descriptive statistics.

Variables	Obs.	Median	Std. Dev.	Min.	Max
For the estimation on stabilization funds by the volatility of government expenditure					
g_exp	794	2.983	5.964	0.004	76.854
gdp	794	3.958	4.963	−27.995	28.082
inf	794	4.251	17.323	−4.870	325.029
pop	794	2.724	1.761	−2.538	5.587
top	794	74.172	36.614	1.219	220.407
nrr	794	14.595	14.836	0.026	87.577
gov	794	−0.370	0.767	−2.000	1.822
voa	794	−0.734	0.850	−2.259	1.738
pos	787	−0.245	1.000	−3.006	1.610
gve	791	−0.332	0.821	−2.230	2.081
req	791	−0.255	0.876	−2.347	1.816
rol	794	−0.528	0.856	−1.916	2.037
cor	791	−0.487	0.878	−1.664	2.294
For the estimation on stabilization funds by the volatility of primary balance					
g_pbl	765	3.106	6.781	0.012	74.885
gdp	765	3.915	4.794	−27.995	28.082
inf	765	4.019	17.396	−4.870	325.029
pop	765	2.764	1.781	−2.538	5.587
top	765	73.950	35.903	1.219	220.407
nrr	765	14.137	14.117	0.026	81.913
gov	765	−0.344	0.758	−2.000	1.822
voa	765	−0.710	0.823	−1.983	1.738
pos	758	−0.292	1.013	−3.006	1.610
gve	762	−0.281	0.812	−2.230	2.081
req	762	−0.213	0.835	−2.347	1.816
rol	765	−0.508	0.846	−1.916	2.037
cor	762	−0.468	0.872	−1.664	2.294
For the estimation on investment funds					
inv	780	17.175	13.638	0.012	74.885
gdp	780	3.907	4.768	−27.995	28.082
inf	780	4.099	17.289	−4.870	325.029
pop	780	2.744	1.773	−2.538	5.587
top	780	73.548	35.818	1.219	220.407
nrr	780	13.785	14.059	0.026	81.913
gov	780	−0.356	0.757	−2.000	1.822
voa	780	−0.714	0.821	−1.983	1.738
pos	773	−0.308	1.007	−3.006	1.610
gve	777	−0.298	0.809	−2.230	2.081
req	777	−0.227	0.835	−2.347	1.816
rol	780	−0.514	0.846	−1.916	2.037
cor	777	−0.479	0.871	−1.664	2.294
For the estimation on savings funds					
sav	704	27.054	11.605	0.706	64.717
gdp	704	4.103	4.460	−17.005	28.082
inf	704	4.531	17.854	−4.870	325.029
pop	704	2.869	1.495	−0.669	5.587
top	704	69.938	35.798	1.378	220.407
nrr	704	13.176	13.075	0.214	58.893
gov	704	−0.359	0.749	−2.000	1.822
voa	704	−0.719	0.790	−1.907	1.738
pos	704	−0.369	0.963	−3.006	1.610
gve	704	−0.247	0.791	−2.230	2.081
req	704	−0.151	0.792	−1.815	1.816
rol	704	−0.522	0.844	−1.916	2.037
cor	704	−0.484	0.882	−1.664	2.294

Note: The statistics of six individual governance indicators have the different number of observation due to the existence of missing data. Source: Authors' description.

The dependent variables specify four types of indicators to evaluate the effectiveness of funds according to their objectives. Data for all indicators are retrieved from the World Economic Outlook (WEO) Database of the International Monetary Fund (IMF). This study, based on IMF's [29] classification of sovereign wealth funds into four types—(1) stabilization funds, (2) pension reserve funds, (3) reserve investment funds, and (4) savings funds—classifies funds into three types by merging types (2) and (4) above based on their objectives, as in Ouoba [36]. As previously mentioned, the types of funds considered here are stabilization, investment, and savings funds, with the list of analyzed funds comprising 54 funds in 41 resource-rich countries (see Table 5). The first two indicators are used to evaluate stabilization funds. The first indicator, *g_exp*, represents the volatility of government expenditure, expressed by the absolute value of the deviation from the period average of "general government total expenditure as a percentage of gross domestic product (GDP)." The second indicator, *g_pbl*, denotes the volatility of government primary balance, expressed by the absolute value of the deviation from the period average of "general government primary net lending/borrowing as a percentage of GDP." The third and fourth indicators, *inv* and *sav*, examine the investment and savings funds, and represent "total investment" and "gross national savings" as a percentage of GDP, respectively.

The three explanatory dummies denote the operations for the three types of funds: *f_sta* for stabilization funds, *f_inv* for investment funds, and *f_sav* for savings funds. The effectiveness of funds can be identified when the coefficient on *f_sta* is significantly negative and those on *f_inv* and *f_sav* are significantly positive. As in Sugawara [33], this study assumes that it takes five years for a fund to operate substantially and have a tangible effect after its establishment. Therefore, when the fund is established in year t, the dummy takes a value of 1 in year $t + 5$, and 0 otherwise.

The other explanatory variables for controlling time-varying country-specific effects are represented by six indicators: economic growth, inflation, population, openness, resource dependence, and governance. These indicators are selected from those commonly used in more than three out of the six previous econometric studies listed in Table 2 (the time-invariant country-specific variables such as political institutions in Table 2 are dealt with by country fixed effects in this study). The first three indicators, taken from WEO, are "GDP in constant prices as percent change" (*gdp*), "average consumer prices as percent change" (*inf*), and "population by millions of persons as logarithm" (*pop*); the population data are transformed into logarithms to avoid scaling problems in the estimation. The other two indicators, retrieved from the World Development Indicators (WDI) of the World Bank (https://data.worldbank.org/, accessed on 1 July 2022), are "sum of exports and imports of goods and services as a percentage of GDP" (*top*) and "total natural resource rents as a percentage of GDP" (*nrr*). The last indicator represents the governance of a country's managing funds, whose data are taken from the World Governance Indicators (WGI) of the World Bank (http://info.worldbank.org/governance/WGI/, accessed on 1 July 2022). This indicator includes the following six indexes: voice and accountability (*voa*), political stability and absence of violence/terrorism (*pos*), government effectiveness (*gve*), regulatory quality (*req*), rule of law (*rol*), and control of corruption (*cor*). This study also computes the average of the six indexes above as a total index (*gov*). The index ranges from −2.5 (weak governance) to 2.5 (strong governance), with the world average being approximately zero. All explanatory variables in this category are lagged by one year. As they might be endogenous to the model, there is a need to avoid the issue of reverse causality with the dependent variables.

Table 5. A list of natural resource funds.

Countries	Names of Funds	Date
	Stabilization Funds	
Algeria	Revenue Regulation Fund	2000
Azerbaijan	State Oil Fund	1999
Bahrain	Bahrain Mumtalakat Holding Company	2006
Botswana	Revenue Stabilization Fund	1972
Cameroon	Stabilization Fund for Hydrocarbon Prices	1974
Chad	Revenue Management Plan	1999
Chile	Copper Stabilization Fund	1985
Colombia	Oil Stabilization Fund	1995
Ecuador	Oil Stabilization Fund	1999
Ghana	Stabilization Fund	2011
Iran	Oil Stabilization Fund	1999
Kazakhstan	National Fund	2000
Kiribati	Revenue Equalization Reserve Fund	1956
Kuwait	General Reserve Fund	1960
Libya	Oil Reserve Fund	1995
Mauritania	National Fund for Hydrocarbon Reserves	2006
Mexico	Oil Revenues Stabilization Fund	2000
Mongolia	Fiscal Stabilization Fund	2011
Nauru	Phosphate Royalties Trust Fund	1968
Nigeria	Petroleum Trust Fund	1995
Oman	State General Reserve Fund	1980
Papua New Guinea	Mineral Resources Stabilization Fund	1974
Peru	Fiscal Stabilization Fund	1999
Qatar	Stabilization Fund	2000
Russian Federation	Stabilization Fund	2004
Sao Tomeand Principe	Oil Fund	2004
Saudi Arabia	Monetary Agency	1974
Sudan	National Revenue Fund	2004
Timor-Leste	Petroleum Fund	2005
Trinidad and Tobago	Interim Revenue Stabilization Fund	2000
Turkmenistan	Stabilization Fund	2008
Tuvalu	Trust Fund	1987
Venezuela	Macroeconomic Stabilization Fund	1998
	Investment Funds	
Angola	Oil for Infrastructure Fund	2011
Botswana	Pula Fund	1996
Brunei	Investment Agency	1983
Ecuador	Special Account for Social and Productive Investment, Scientific Development, and Fiscal Stabilization	2005
Ghana	Infrastructure Investment Fund	2014
Indonesia	Government Investment Unit	2006
Libya	Investment Authority	2006
Malaysia	Investment Authority	2008
Nauru	Phosphate Royalties Trust Fund	1968
Nigeria	Sovereign Investment Authority	2004
Oman	State General Reserve Fund	1980
Qatar	Investment Authority	2003
Timor Leste	Petroleum Fund	2005
United Arab Emirates	Investment Authority	1976
Venezuela	Macroeconomic Stabilization Fund	1998
Yemen	Social Development Fund	1997
	Savings Funds	
Gabon	Fund for Future Generations	1997
Kuweit	Reserve Fund for Future Generations	1952
Chile	Pension Reserve Fund	2006
Mongolia	Future Heritage Fund	2016
Norway	Government Pension Fund	1990

Source: Created by the authors based on Tsani [30], Sugawara [33], and Ouoba [36].

3.2. Panel Data Setting

Based on the above setting of the variables, this study constructs panel data using annual data for 1996–2020 for 54 natural resource funds in 41 resource-rich economies

(see Table 4). The sample period starts from 1996 because this study considers the governance index of the country managing the funds, and the WGI database representing the governance index is available only after 1996.

For the subsequent estimation, the study investigates the stationary property of the constructed panel data by employing panel unit root tests: the Levin, Lin, and Chu test [55] as a common unit root test and the Fisher–Augmented Dickey-Fuller (ADF), Fisher–Phillips–Perron [56,57], and Im, Pesaran, and Shin tests [58] as individual unit root tests. The common unit root test assumes the existence of a common unit root process across cross-sections, whereas the individual unit root test allows individual unit root processes that differ across cross-sections. These tests are conducted based on the null hypothesis that a series of panel data in levels has a unit root by including the "intercept" and "trend and intercept" in the test equations. Table 6 shows that the Levin, Lin, and Chu test rejects the null hypothesis of a unit root at the conventional significance level for all the variables in both test equations. The individual unit root tests do not necessarily reject the null hypothesis in all cases; however, the Fisher–ADF test rejects it at the conventional level for all variables in the test equation, including the intercept. Therefore, we assume there is no serious problem with the existence of unit roots in the panel data and use the panel data in levels for the estimation.

Table 6. A panel unit of root tests.

	Levin, Lin and Chu		**Fisher-ADF**		**Fisher-PP**		**Im, Pesaran and Shin**	
	Int.	**Int. & Tre.**	**Int.**	**Int. & Tre.**	**Int.**	**Int. & Tre.**	**Int.**	**Int. & Tre.**
g_exp	−4.127 ***	−1.991 ***	207.9 ***	151.5 ***	266.9 ***	206.9 ***	−7.592 ***	−4.541 ***
g_pbl	−8.693 ***	−6.177 ***	264.5 ***	201.8 ***	367.2 ***	379.2 ***	−10.66 ***	−7.939 ***
inv	−6.945 ***	−5.893 ***	220.1 ***	185.1 ***	247.1 ***	252.8 ***	−8.635 ***	−6.916 ***
sav	−3.104 ***	−6.926 ***	118.3 ***	93.42 **	156.4 ***	74.65	−3.799 ***	−2.433 ***
gdp	−8.947 ***	−9.476 ***	274.9 ***	224.3 ***	290.0 ***	274.6 ***	−10.82 ***	−8.808 ***
inf	−26.19 ***	−16.62 ***	692.3 ***	434.7 ***	458.1 ***	707.2 ***	−17.93 ***	−13.55 ***
pop	−15.228 ***	−9.414 ***	284.4 ***	333.2 ***	119.1 ***	82.31	−0.961	0.759
top	−1.813 **	−1.805 **	113.2 ***	119.4 ***	108.9 ***	119.9 ***	−2.422 ***	−2.036 **
nrr	−3.133 ***	−2 393 ***	99.82 **	56.97	96.36 *	49.83	−2.758 ***	0.870
gov	−2.475 ***	−2 854 ***	117.3 ***	114.3 **	93.80	84.42	−1.616 *	−1.634 *
voa	−7.226 ***	−3.626 ***	193.4 ***	209.2 ***	80.48	74.67	−5.325 ***	−4.483 ***
pos	−2.617 ***	−5.980 ***	137.8 ***	176.5 ***	117.9 ***	130.0 ***	−3.425 ***	−6.106 ***
gve	−1.859 **	−5.018 ***	137.3 ***	147.4 ***	120.1 ***	115.6 ***	−2.217 **	−4.480 ***
req	−2.410 ***	−1.854 **	108.7 **	124.2 ***	99.59 *	85.52	−1.291 *	−2.537 ***
rol	−1.700 **	−1.739 **	108.2 **	129.8 ***	93.26	105.3 **	−1.585 *	−2.651 ***
cor	−2.383 ***	−1.881 **	99.59 *	116.8 ***	101.5 *	103.3 *	−1.337 *	−2.273 **

Notes: *, **, and *** denote rejection of the null hypothesis at the 90, 95, and 99% levels of significance.

3.3. Model Specification and Estimation Method

The equation for the econometric estimation, following Sugawara [33] and Ouoba [36], is as follows:

$$effect_{i,t} = \alpha_0 + \alpha_1 fund_{i,t-5} + \alpha_2 X_{i,t-1} + \alpha_3 gov_{i,t} fund_{i,t-5} + f_i + f_t + \varepsilon_{i,t.} \quad (1)$$

Subscripts i and t denote the sample country and year, respectively. *effect* represents the indicators of funds' evaluation and comprises volatility of government expenditure (*g_exp*), primary balance (*g_pbl*), investment rate (*inv*), and saving rate (*sav*). *fund* shows funds' operation and comprises the funds for stabilization (*f_sta*), investment (*f_inv*), and saving (*f_sav*). Indicators *g_exp* and *g_pbl* correspond to the evaluation of *f_sta*, in which coefficient α_1 is expected to have a negative sign because the stabilization fund is supposed to reduce the volatility of government expenditure and the primary balance. Indicators *inv* and *sav* correspond to *f_sta* and *f_inv*, respectively, and in this combination, coefficient α_1 is

expected to be positive because the investment and savings funds are supposed to increase investment and saving rates, respectively.

X denotes the control variables and includes indicators of economic growth (*gdp*), inflation (*inf*), population (*pop*), trade openness (*top*), resource dependence (*nrr*), and governance (*gov*). f_i and f_t show time-invariant country-specific fixed effects and country-invariant time-specific fixed effects, respectively; ε denotes the residual error term and $\alpha_{0\ldots3}$ stand for the estimated coefficients.

The equation contains the interaction term of governance (*gov*) and funds' operation *fund* as in Sugawara [33]. This interaction term, reflecting the arguments of the previous studies in Section 2, shows that resource funds work well under the conditions of high governance and robust fiscal rules and differentiates fund effectiveness with and without quality governance. Coefficient α_3, similar to α_1, is expected to be negative in the estimation of stabilization funds and positive in those of investment and savings funds.

This panel estimation is controlled by country-specific and time-specific fixed effects represented by f_i and $f_{t,}$ respectively. From a statistical perspective, the Hausman specification test is generally utilized to choose between the fixed-effect and random-effect models [59]. However, this study applies the fixed-effects model because it places a premium on the existence of exogenous country- and time-specific factors, where adopting the fixed-effects model contributes to alleviating the endogeneity problem by absorbing unobserved time-invariant heterogeneity among sample countries. As shown by the previous quantitative studies in Table 2, factors such as political institutions are assumed to be correlated with funds' effectiveness (not distributed randomly among sample countries). In the time series, external shocks, such as the global financial crisis of 2008–2009, might affect fund performance. As a specification ignoring these effects leads to inefficient estimation, they should be controlled for by incorporating country- and time-specific fixed effects into the specification.

Before the panel estimation, we investigate multicollinearity among the explanatory variables. Table 7 reports the bivariate correlations and variance inflation factors (VIF), which is a method of measuring the level of collinearity between regressors. This reveals that the total governance index (*gov*) and its six components (*voa*, *pos*, *gve*, *req*, *rol*, and *cor*) have a high bivariate correlation in each combination and high VIF values that are far beyond the criteria of collinearity, namely, 10 points. Therefore, the equation includes governance indicators as independent regressors.

Regarding the estimation technique, this study applies the ordinary least squares (OLS) and Poisson pseudo-maximum likelihood (PPML) estimators. The reason for applying the PPML estimator is that the sample data, including those of developing countries, would be plagued by heteroskedasticity and autocorrelation; in which cases, the OLS estimator leads to bias and inconsistency in estimates. The PPML estimator corrects for heteroscedastic error structure across panels and the presence of autocorrelation with panels, as Silva and Tenreyro [60] and Kareem et al. [61] suggest. Therefore, both estimators are applied to ensure the robustness of the estimations. We use EViews (version 12) as software to process the data and conduct all the estimations in this study.

Table 7. A correlation matrix and variance inflation factors.

	gdp	***inf***	***pop***	***top***	***nrr***	***gov***
gdp	1.000					
inf	−0.059	1.000				
pop	−0.010	0.199	1.000			
top	0.110	−0.106	−0.519	1.000		
nrr	0.230	0.035	−0.198	0.200	1.000	
gov	−0.033	−0.293	−0.408	0.390	−0.189	1.000
voa	−0.065	−0.121	−0.116	0.045	−0.470	0.705
pos	0.040	−0.284	−0.665	0.502	0.112	0.787
gve	−0.037	−0.279	−0.248	0.382	−0.204	0.936
req	−0.045	−0.285	−0.226	0.328	−0.225	0.899
rol	−0.053	−0.284	−0.423	0.406	−0.122	0.964
cor	−0.025	−0.269	−0.297	0.349	−0.135	0.953
VIF	1.674	1.423	4.371	3.711	4.619	7.305×10^6
	voa	***pos***	***gve***	***req***	***rol***	***cor***
gdp						
inf						
pop						
top						
nrr						
gov						
voa	1.000					
pos	0.420	1.000				
gve	0.542	0.647	1.000			
req	0.572	0.562	0.903	1.000		
rol	0.592	0.734	0.915	0.863	1.000	
cor	0.601	0.699	0.915	0.836	0.953	1.000
VIF	3.041×10^5	3.150×10^5	2.119×10^5	2.418×10^5	2.436×10^5	2.541×10^5

Notes: VIF: variance inflation factors.

4. Results and Discussion

Tables 8 and 9 report the estimation results for evaluating stabilization funds in terms of the volatility of government expenditure and primary balance, respectively, and Tables 10 and 11 show those for evaluating investment and savings funds, respectively. All tables include the results of the OLS and PPML estimations with the total governance index and PPML estimations with each component of the governance index. The usage of the PPML estimator is justified, because the Durbin-Watson statistics in the OLS estimations do not meet the criterion to reject the existence of autocorrelation and the PPML estimator corrects the autocorrelation problem.

The main conclusions are as follows. Regarding the estimation of stabilization funds in Table 8 (with the indicator of *g_exp*) and Table 9 (*g_pbl*), the coefficients on the fund (*f_sta*) are significantly negative for both the OLS and PPML estimations with the total governance index and in the majority of the PPML estimations with the components of the governance index. In the interaction term with the governance index (*f_sta*gov*), all coefficients are significantly negative, except in the case of *g_exp* for the OLS estimation. As expected, these results suggest that stabilization funds effectively reduce the volatility of government expenditure and primary balance, and that higher governance facilitates fund effectiveness. Focusing on the PPML estimation with the total governance index, the operation of stabilization funds reduces the volatility of government expenditure by 13.6, and their operation under high governance reduces it by 33.2%.

Table 8. The estimation results on stabilization funds: Volatility of government expenditure.

g_exp	(i) OLS_FE	(ii) PPML	(iii) PPML	(iv) PPML	(v) PPML	(vi) PPML	(vii) PPML	(viii) PPML
f_sta	−1.239 *	−0.758 ***	−0.133	−0.035	−0.466 ***	−0.316 **	−1.379 **	−0.736 ***
	(−1.679)	(−4.365)	(−0.211)	(−0.179)	(3.145)	(−2.148)	(−2.334)	(−4.016)
gdp	0.042	−0.071 ***	−0.085 **	−0.079 ***	−0.075 ***	−0.073 ***	−0.082 **	−0.070 ***
	(1.201)	(−4.546)	(−2.030)	(−4.998)	(−4.896)	(−4.726)	(−1.979)	(−4.532)
inf	−0.023 **	−0.013 ***	−0.001	−0.012 **	−0.014 ***	−0.016 ***	−0.016	−0.011 **
	(−2.192)	(−3.001)	(−0.104)	(−2.268)	(−3.078)	(−3.782)	(−1.389)	(−2.183)
pop	−1.975	−0.991 ***	−0.996 ***	−1.116 ***	−0.832 ***	−0.818 ***	−1.216 ***	−1.030 ***
	(−1.470)	(−20.823)	(−6.907)	(−21.524)	(−17.904)	(−17.010)	(−8.693)	(−20.889)
top	−0.005	−0.005 **	−0.015 **	−0.005 **	−0.001	−0.002	−0.004	−0.007 ***
	(−0.519)	(−2.140)	(−2.275)	(−2.262)	(−0.266)	(−0.746)	(−0.548)	(−3.345)
nrr	−0.002	0.034 ***	0.062 ***	0.058 ***	0.034 ***	0.030 ***	0.043 ***	0.047 ***
	(−0.099)	(5.568)	(3.751)	(9.973)	(5.529)	(4.877)	(2.993)	(7.837)
gov	−5.184 ***	−1.251 ***						
	(5.263)	(−10.611)						
voa			0.146					
			(0.451)					
pos				−1.300 ***				
				(−10.149)				
gve					−1.098 ***			
					(−10.060)			
req						−1.278 ***		
						(−12.274)		
rol							−1.267 ***	
							(−4.054)	
cor								−0.993 ***
								(−10.078)
*f_sta*gov*	−0.294	−1.091 ***						
	(−0.367)	(−4.666)						
*f_sta*voa*			−1.037 *					
			(−1.806)					
*f_sta*pos*				0.369 **				
				(2.106)				
*f_sta*gve*					−1.156 ***			
					(−5.811)			
*f_sta*req*						−0.662 ***		
						(−3.735)		
*f_sta*rol*							−2.274 ***	
							(−3.592)	
*f_sta*cor*								−0.970 ***
								(−4.599)
Countries	37	37	37	37	37	37	37	37
Periods	1997−2020	1997−2020	1997−2020	1997−2020	1997−2020	1997−2020	1997−2020	1997−2020
Observation	794	794	794	787	791	791	794	791
R-squared	0.599	-	-	-	-	-	-	-
Durbin-Watson	1.228	-	-	-	-	-	-	-

Notes: ***, **, and * denote rejection of the null hypothesis at the 99%, 95%, and 90% levels, respectively. PPML: Poisson pseudo-maximum likelihood; OLS_FE: Fixed-effect model with ordinary least squares. The number of the observation lacks in the product of countries and periods and differs in each estimation owing to the existence of missing data.

Table 9. The estimation results on stabilization funds: Volatility of primary balance.

g_pbl	(i) OLS_FE	(ii) PPML	(iii) PPML	(iv) PPML	(v) PPML	(vi) PPML	(vii) PPML	(viii) PPML
f_sta	−2.699 ***	−1.997 ***	−0.605 ***	−0.905 ***	−0.759 ***	−0.557 ***	−1.315 ***	−1.351 ***
	(2.973)	(−3.047)	(−3.728)	(−4.787)	(−5.654)	(−4.186)	(−6.926)	(−7.446)
gdp	−0.017	−0.116 **	−0.112 ***	−0.111 ***	−0.126 ***	−0.121 ***	−0.110 ***	−0.110 ***
	(−0.382)	(−2.501)	(−6.585)	(−6.453)	(−7.022)	(−6.713)	(−6.182)	(−6.114)
inf	0.008	−0.023 *	−0.010 ***	−0.010 ***	−0.015 ***	−0.015 ***	−0.012 ***	−0.012 ***
	(0.626)	(−1.723)	(−2.749)	(−2.626)	(−4.179)	(−4.587)	(−3.309)	(−3.470)
pop	1.213	−1.300 ***	−0.975 ***	−1.000 ***	−0.936 ***	−0.944 ***	−1.016 ***	−1.020 ***
	(0.729)	(−8.479)	(−21.444)	(−20.088)	(−20.613)	(−20.699)	(−21.789)	(−21.599)
top	0.043 ***	0.001	−0.008 ***	−0.007 ***	−0.003	−0.003	−0.005 **	−0.008 ***
	(3.179)	(0.130)	(−3.191)	(−2.882)	(−1.171)	(−1.153)	(−2.039)	(−3.091)
nrr	0.040	0.120 ***	0.118 ***	0.127 ***	0.115 ***	0.112 ***	0.117 ***	0.122 ***
	(1.258)	(7.287)	(15.696)	(19.965)	(17.287)	(16.466)	(17.988)	(18.577)
gov	−1.573	−0.241						
	(−1.284)	(−0.611)						
voa			−0.023					
			(−0.188)					
pos				0.022				
				(0.198)				
gve					−0.283 **			
					(−2.161)			
req						−0.427 ***		
						(−3.343)		
rol							−0.116	
							(−0.869)	
cor								−0.106
								(−0.843)
*f_sta*gov*	−2.298 **	−3.290 ***						
	(−2.243)	(−4.295)						
*f_sta*voa*			−0.688 ***					
			(−3.322)					
*f_sta*pos*				−0.681 ***				
				(−4.073)				
*f_sta*gve*					−1.193 ***			
					(−5.631)			
*f_sta*req*						−0.839 ***		
						(−4.290)		
*f_sta*rol*							−1.494 ***	
							(−6.266)	
*f_sta*cor*								−1.544 ***
								(−6.778)
Countries	36	36	36	36	36	36	36	36
Periods	1997–2020	1997–2020	1997–2020	1997–2020	1997–2020	1997–2020	1997–2020	1997–2020
Observation	765	765	765	758	762	762	765	762
R-squared	0.535	-	-	-	-	-	-	-
Durbin-Watson	1.456	-	-	-	-	-	-	-

Notes: ***, **, and * denote rejection of the null hypothesis at the 99%, 95%, and 90% levels, respectively. The number of the observation lacks in the product of countries and periods and differs in each estimation owing to the existence of missing data.

Table 10. The estimation results on investment funds.

inv	**(i) OLS_FE**	**(ii) PPML**	**(iii) PPML**	**(iv) PPML**	**(v) PPML**	**(vi) PPML**	**(vii) PPML**	**(viii) PPML**
f_inv	1.029	1.559 ***	3.957 ***	2.415 ***	0.443	−0.261	0.933 *	0.793 *
	(0.819)	(3.280)	(7.680)	(5.072)	(0.966)	(−0.569)	(1.927)	(1.742)
gdp	0.134 **	0.108 ***	0.059 *	0.123 ***	0.111 ***	0.166 ***	0.123 ***	0.128 ***
	(2.363)	(3.130)	(1.932)	(3.616)	(3.130)	(4.630)	(3.506)	(3.623)
inf	0.021	0.006	0.036 ***	0.010	0.010	0.001	0.010	0.011
	(1.243)	(0.666)	(3.509)	(0.988)	(1.031)	(0.079)	(1.125)	(1.179)
pop	−1.091	−1.266 ***	−1.113 ***	−1.855 ***	−1.059 ***	−1.243 ***	−1.163 ***	−1.129 ***
	(−0.505)	(−10.866)	(−9.838)	(−14.806)	(−9.319)	(−10.581)	(−10.021)	(−9.643)
top	0.091 ***	−0.040 ***	−0.051 ***	−0.049 ***	−0.035 ***	−0.033 ***	−0.039 ***	−0.042 ***
	(4.962)	(−6.843)	(−8.581)	(−8.709)	(−6.004)	(−5.376)	(−6.554)	(−7.091)
nrr	−0.049	0.053 ***	0.062 ***	0.100 ***	0.062 ***	0.028 **	0.066 ***	0.062 ***
	(−1.238)	(4.107)	(4.443)	(8.338)	(4.828)	(2.187)	(5.250)	(4.901)
gov	0.440	−3.545 ***						
	(0.284)	(−15.111)						
voa			−2.742 ***					
			(−12.513)					
pos				−3.338 ***				
				(−14.644)				
gve					−2.581 ***			
					(−11.162)			
req						−3.031 ***		
						(−14.914)		
rol							−2.433 ***	
							(−11.060)	
cor								−2.471 ***
								(−12.412)
*f_inv*gov*	−2.020	5.916 ***						
	(−1.494)	(11.939)						
*f_inv*voa*			10.339 ***					
			(20.092)					
*f_inv*pos*				5.959 ***				
				(15.387)				
*f_inv*gve*					3.885 ***			
					(7.621)			
*f_inv*req*						2.415 ***		
						(5.064)		
*f_inv*rol*							3.710 ***	
							(7.507)	
*f_inv*cor*								4.068 ***
								(8.472)
Countries	36	36	36	36	36	36	36	36
Periods	1997–2020	1997–2020	1997–2020	1997–2020	1997–2020	1997–2020	1997–2020	1997–2020
Observation	780	780	780	773	777	777	780	777
R-squared	0.810	-	-	-	-	-	-	-
Durbin-Watson	0.961	-	-	-	-	-	-	-

Notes: ***, **, and * denote rejection of the null hypothesis at the 99%, 95%, and 90% levels, respectively. The number of the observation lacks in the product of countries and periods and differs in each estimation owing to the existence of missing data.

Table 11. The estimation results on savings funds.

sav	**(i) OLS_FE**	**(ii) PPML**	**(iii) PPML**	**(iv) PPML**	**(v) PPML**	**(vi) PPML**	**(vii) PPML**	**(viii) PPML**
f_sav	−0.752	1.036	−0.910	0.426	1.200	1.807	1.743	1.650
	(−0.373)	(0.947)	(−0.851)	(0.277)	(1.119)	(1.617)	(1.559)	(1.533)
gdp	0.065	0.159 ***	0.125 ***	0.147 ***	0.172 ***	0.140 ***	0.201 ***	0.151 ***
	(1.156)	(3.549)	(2.740)	(3.258)	(3.814)	(3.020)	(4.410)	(3.320)
inf	−0.023	−0.035 ***	−0.069 ***	−0.053 ***	−0.031 **	−0.058 ***	−0.035 ***	−0.040 ***
	(−1.570)	(−2.990)	(−7.227)	(−4.979)	(−2.522)	(−4.945)	(−2.931)	(−3.324)
pop	1.204	1.614 ***	0.822 ***	1.807 ***	0.938 ***	0.863 ***	1.592 ***	1.767 ***
	(0.677)	(9.643)	(5.216)	(10.237)	(5.777)	(5.284)	(9.473)	(10.523)
top	0.087 ***	0.043 ***	0.080 ***	0.055 ***	0.031 ***	0.059 ***	0.040 ***	0.057 ***
	(4.697)	(5.799)	(11.677)	(7.689)	(3.962)	(7.780)	(5.341)	(7.706)
nrr	0.311 ***	0.543 ***	0.580 ***	0.466 ***	0.533 ***	0.507 ***	0.499 ***	0.507 ***
	(6.407)	(30.160)	(31.334)	(27.178)	(29.541)	(27.318)	(27.967)	(28.403)
gov	8.049 ***	7.170 ***						
	(5.525)	(20.621)						
voa			4.839 ***					
			(17.609)					
pos				4.605 ***				
				(17.779)				
gve					6.555 ***			
					(20.346)			
req						3.589 ***		
						(11.587)		
rol							6.322 ***	
							(19.839)	
cor								6.219 ***
								(21.036)
*f_sav*gov*	−2.741	−10.223 ***						
	(−2.278)	(−7.658)						
*f_sav*voa*			−5.740 ***					
			(−5.165)					
*f_sav*pos*				0.971				
				(0.195)				
*f_sav*gve*					−8.805 ***			
					(−7.587)			
*f_sav*req*						−5.254 ***		
						(−4.759)		
*f_sav*rol*							−9.674 ***	
							(−7.912)	−9.179 ***
*f_sav*cor*								(−8.788)
Countries	31	31	31	31	31	31	31	31
Periods	1997–2020	1997–2020	1997–2020	1997–2020	1997–2020	1997–2020	1997–2020	1997–2020
Observation	704	704	704	704	704	704	704	704
R-squared	0.801	-	-	-	-	-	-	-
Durbin-Watson	0.758	-	-	-	-	-	-	-

Notes: *** and ** denote rejection of the null hypothesis at the 99% and 95% levels, respectively. The number of the observation lacks in the product of countries and periods and differs in each estimation owing to the existence of missing data.

In the estimation of investment funds in Table 10 (*inv*), the fund coefficients (*f_inv*) are significantly positive in the PPML estimation (positive but insignificant in the OLS estimation) with the total governance index and in the majority of the PPML estimations with the components of the governance index. In the interaction term with the governance index (*f_inv*gov*), all coefficients are significantly positive in the PPML estimation with all governance indexes. These results imply that investment funds effectively raise the

investment rate, and that higher governance facilitates their effectiveness. There seem to be multiple channels through which investment funds increase the investment rate: the government itself could increase public investment, while public investment in infrastructure, for instance, could induce private investment. Focusing on the PPML estimation with the total governance index, the operation of investment funds increases the investment rate by 9.8%, and their operation with high governance increases it by 46.8%.

In the estimation of savings funds in Table 11 (*sav*), the fund coefficients (*f_sav*) are insignificant in all estimations, and those on the interaction term are negative in the majority of the estimations, which is against this study's expectations. These results seem to come from the limitation of sample size: only Chile and Gabon's funds are considered as estimation targets in the sample period from 1996 to 2020.

The estimation results for the control variables are as follows. Economic growth (*gdp*) has negative effects on fiscal volatility and positive effects on investment and saving rates. It is speculated that economic growth leads to a lower fiscal stimulus and an increase in investments and savings. Inflation (*inf*) has ambiguous effects on fiscal volatility and negative effects on investment and saving rates, probably because it increases economic uncertainty. Population size (*pop*) has a negative impact on fiscal volatility due to insensitivity to shocks in large economies, but ambiguous impacts on investment and saving rates. Trade openness (*top*) shows mixed results. Meanwhile, resource dependence (*nrr*) has positive effects on fiscal volatility and investment rates, which might reflect the possible existence of the resource curse in resource-rich economies. Governance (*gov*, *voa*, *pos*, *gve*, *req*, *rol*, and *cor*) has negative effects on fiscal volatility and investment rates, and positive effects on saving rates.

Table 12 summarizes the results for fund effectiveness.

In summary, the estimation identifies the effectiveness of stabilization funds in reducing the volatility of government expenditure and primary balance and the effectiveness of investment funds in increasing investment rates. It also confirms the facilitation of fund effectiveness by the combination of fund operations and high governance. These outcomes are consistent with those of previous studies from the first and second categories (the arguments supporting the effectiveness of resource funds and those providing conditional support for the effectiveness of resource funds under high governance and robust fiscal rules) in Section 2, in particular with Bagattini [38], Sugawara [33] and Crain and Devlin [51] on the effectiveness of stabilization funds in terms of fiscal performances. However, the main contribution of this study is demonstrating fund-specific evaluation and identifying the effectiveness of funds according to their objectives, particularly the effectiveness of investment funds in increasing investment rates.

The practical implications of the obtained results can be discussed as follows. Regarding stabilization funds combined with robust fiscal rules, the reduction of fiscal volatility leads to the stabilization of resource-rich economies. The resource curse for resource-rich economies contains their macroeconomic instabilities caused by abrupt fluctuations of commodity prices in the world market. Further, their governments lacking institutional qualities fall into the "voracity effect", which means that a positive shock in government revenues (e.g., windfall gains from natural resources) results in a more-than-proportional increase in discretionary spending (Tornell and lane [62]). The voracity effect accelerates pro-cyclically boom-and-bust cycles of the economies. However, the fiscal smoothing under the operation of stabilization funds provides a counter-cyclical buffer to mitigate commodity price shocks, thereby contributing to the stabilization of resource-rich economies.

As for investment funds with high governance, the increase in investment rates mitigates the Dutch disease effect, thereby contributing to sustainable growth for resource-rich economies. Dutch disease, one of the resource curse phenomena, demonstrates that natural resource development crowds out manufacturing activities (Corden and Neary [11]). As a counterargument to the Dutch disease hypothesis, Sachs [12] argues that Dutch disease could be reversed if natural resource earnings were used not for consumption but for public investment, because the positive benefits of increased public investment on the non-

energy traded sector through productivity improvement would outweigh any negative consequences of Dutch disease. Thus, the increase in investment rates under the operation of investment funds, meaning capital accumulation through public investment and induces private investment, alleviates the Dutch disease effect, thereby sustaining economic growth of resource-rich economies.

Table 12. A summary of results.

Dependent Var.	*WGI*	*Fund*	*Fund*WGI*
g_exp (OLS)	*gov*	*negative **	*negative*
g_exp (PPML)	*gov*	*negative ****	*negative ****
	voa	*negative*	*negative **
	pos	*negative*	*positive **
	gve	*negative ****	*negative ****
	req	*negative **	*negative ****
	rol	*negative **	*negative ****
	cor	*negative ****	*negative ****
g_pbl (OLS)	*gov*	*negative ****	*negative **
g_pbl (PPML)	*gov*	*negative ****	*negative ****
	voa	*negative ****	*negative ****
	pos	*negative ****	*negative ****
	gve	*negative ****	*negative ****
	req	*negative ****	*negative ****
	rol	*negative ****	*negative ****
	cor	*negative ****	*negative ****
inv (OLS)	*gov*	*positive*	*negative*
inv (PPML)	*gov*	*positive ****	*positive ****
	voa	*positive ****	*positive ****
	pos	*positive ****	*positive ****
	gve	*positive*	*positive ****
	req	*ngative*	*positive ****
	rol	*positive **	*positive ****
	cor	*positive **	*positive ****
sav (OLS)	*gov*	*negative*	*negative*
sav (PPML)	*gov*	*positive*	*negative ****
	voa	*negative*	*negative ****
	pos	*positive*	*positive*
	gve	*positive*	*negative ****
	req	*positive*	*negative ****
	rol	*positive*	*negative ****
	cor	*positive*	*negative ****

Notes: ***, **, and * denote rejection of the null hypothesis at the 99%, 95%, and 90% levels, respectively.

5. Conclusions

This study aims to examine the effectiveness of natural resource funds in resource-rich countries according to funds' objectives, using an econometric method and panel data. The main contribution of this study is that it demonstrates fund-specific evaluation.

The study classifies funds into three types based on their objectives: stabilization, investment, and savings funds, and then evaluates the effectiveness of each fund type using each criterion corresponding to each objective. The econometric estimations identify the effectiveness of stabilization funds in reducing the volatility of government expenditure and primary balance, as well as the effectiveness of investment funds in raising investment rates. They also confirm the facilitation of fund effectiveness under the combination of a fund's operations and high governance. For instance, the operation of stabilization funds reduces the volatility of government expenditure by 13.6%, and their operation with high

governance reduces it by 33.2%; further, that of investment funds pushes up the investment rate by 9.8%, and their operation with high governance increases it by 46.8%.

The practical implications of the obtained results are that the fiscal smoothing under the operation of stabilization funds provides a counter-cyclical buffer to mitigate commodity price shocks, thereby contributing to the stabilization of resource-rich economies, and that the increase in investment rates under the operation of investment funds alleviates the Dutch disease effect, thereby sustaining economic growth of resource-rich economies.

A limitation of this study is that, although the effectiveness of investment funds is verified by an econometric estimation, its effectiveness should be supported by case studies in selected countries. Additionally, the effectiveness of savings funds is not confirmed in this study due to the lack of sample data. Future research should thus demonstrate the significance of investment and savings funds.

Author Contributions: Conceptualization, H.T. and J.G.; methodology, H.T. and J.G.; software, H.T.; validation, H.T. and J.G.; investigation, J.G.; resources, J.G.; data curation, H.T.; writing—original draft preparation, H.T. and J.G.; writing—review and editing, H.T. and J.G.; supervision, H.T.; project administration, H.T. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Auty, R. *Sustaining Development in Mineral Economies: The Resource Curse Thesis*; Oxford University Press: New York, NY, USA, 1993.
2. Gelb, A.H. *Windfall Gains: Blessing or Curse?* Oxford University Press: New York, NY, USA, 1988.
3. Sachs, J.D.; Warner, A.M. *Natural Resource Abundance and Economic Growth*; National Bureau of Economic Research Working Paper No. 5398; National Bureau of Economic Research: Cambridge, MA, USA, 1995.
4. Sachs, J.D.; Warner, A.M. The curse of natural resources. *Eur. Econ. Rev.* **2001**, *45*, 827–838. [CrossRef]
5. Gylfason, T.; Herbertsson, T.T.; Zoega, G. A mixed blessing: Natural resources and economic growth. *Macroecon. Dyn.* **1999**, *3*, 204–225. [CrossRef]
6. Sala-i-Martin, X.; Subramanian, A.A. Addressing the Natural Resource Curse: An Illustration from Nigeria. *J. Afr. Econ.* **2013**, *22*, 570–615. [CrossRef]
7. Manzano, O.; Rigobon, R. *Resource Curse or Debt Overhang*; National Bureau of Economic Research Working Paper No. 8390; National Bureau of Economic Research: Cambridge, MA, USA, 2008.
8. Brückner, M. Natural resource dependence, non-tradables, and economic growth. *J. Comp. Econ.* **2010**, *38*, 461–471. [CrossRef]
9. van der Ploeg, F. Natural resources: Curse or blessing? *J. Econ. Lit.* **2011**, *49*, 366–420. [CrossRef]
10. Fleming, D.A.; Measham, T.G.; Paredes, D. Understanding the resource curse (or blessing) across national and regional scales: Theory, empirical challenges and an application. *Aust. J. Agric. Resour. Econ.* **2015**, *59*, 624–639. [CrossRef]
11. Corden, W.M.; Neary, J.P. Booming sector and de-industrialisation in a small open economy. *Econ. J.* **1982**, *92*, 825–848. [CrossRef]
12. Sachs, J.D. How to handle the macroeconomics of oil wealth. In *Escaping the Resource Curse*; Hamphreys, M., Sachs, J.D., Stiglitz, J.E., Eds.; Columbia University Press: New York, NY, USA, 2007.
13. Harding, T.; Venables, A.J. The implications of natural resource exports for nonresource trade. *IMF Econ. Rev.* **2016**, *64*, 268–302. [CrossRef]
14. Ramey, G.; Ramey, V.A. Cross-country evidence on the link between volatility and growth. *Am. Econ. Rev.* **1995**, *85*, 1138–1151.
15. van der Ploeg, F. *Africa and Natural Resources: Managing Natural Resources for Sustainable Growth*; OxCarre, Oxford University and European University Institute: Florence, Italy, 2007.
16. Karl, T.L. *The Paradox of Plenty: Oil Booms and Petro-States*; University of California Press: Berkeley, CA, USA, 1997; Volume 26.
17. Ross, M.L. Does oil hinder democracy? *World Pol.* **2001**, *53*, 325–361. [CrossRef]
18. Jensen, N.; Wantchekon, L. Resource wealth and political regimes in Africa. *Comp. Pol. Stud.* **2004**, *37*, 816–841. [CrossRef]
19. Collier, P.; Hoeffler, A. *Democracy and Natural Resource Rents*; Working Paper No. GPRG-WPS-016; Department of Economics, Oxford University: Oxford, UK, 2005.
20. Bulte, E.H.; Damania, R.; Deacon, R.T. Resource intensity, institutions, and development. *World Dev.* **2005**, *33*, 1029–1044. [CrossRef]

21. Rosser, A. *The Political Economy of the Resource Curse: A Literature Survey*; Working Paper No. 268; Institute of Development Studies (IDS) Centre for Future State: Brighton, UK, 2006.
22. Kolstad, I.; Søreide, T. Corruption in natural resource management: Implications for policy makers. *Resour. Policy* **2009**, *34*, 214–226. [CrossRef]
23. Hotelling, H. The economics of exhaustible resources. *J. Polit. Econ.* **1931**, *39*, 137–175. [CrossRef]
24. Dixit, A.K.; Newbery, D.M.G. Setting the price of oil in a distorted economy. *Econ. J.* **1985**, *95*, 71–82. [CrossRef]
25. Hartwick, J.M.N. Intergenerational equity and investing rents from exhaustible resources. *Am. Econ. Rev.* **1977**, *66*, 972–974.
26. van der Ploeg, F. Aggressive oil extraction and precautionary saving: Coping with volatility. *J. Public Econ.* **2010**, *94*, 421–433. [CrossRef]
27. Tsalik, S. *Caspian Oil Windfalls: Who Will Benefit?* Open Society Institute: New York, NY, USA, 2003.
28. Bacon, R.; Tordo, S. *Experience with Oil Funds: Institutional and Financial Aspects*; World Bank: Washington, DC, USA, 2006.
29. IMF. *Global Financial Stability Report: The Quest for Lasting Stability*; International Monetary Fund: Washington, DC, USA, 2012.
30. Tsani, S. Natural resources, governance and institutional quality: The role of resource funds. *Resour. Policy* **2013**, *38*, 181–195. [CrossRef]
31. Tsani, S. On the relationship between resource funds, governance and institutions: Evidence from quantile regression analysis. *Resour. Policy* **2015**, *44*, 94–111. [CrossRef]
32. Baena, C.; Sévi, B.; Warrack, A. Funds from non-renewable energy resources: Policy lessons from Alaska and Alberta. *Energy Policy* **2012**, *51*, 569–577. [CrossRef]
33. Sugawara, N. *From Volatility to Stability in Expenditure: Stabilization Funds in Resource-Rich Countries*; IMF Working Paper No. WP/14/43; International Monetary Fund: Washington, DC, USA, 2014.
34. Davis, J.; Ossowski, R.; Daniel, J.; Barnett, S. *Stabilisation and Saving Funds for Nonrenewable Resources*; IMF Occasional Paper 205; International Monetary Fund: Washington, DC, USA, 2001.
35. Ossowski, R.; Villafuerte, M.; Medas, P.; Thomas, T. *Managing the Oil Revenue Boom: The Role of Fiscal Institutions*; IMF Occasional Paper 260; International Monetary Fund: Washington, DC, USA, 2008.
36. Ouoba, Y. Natural resources: Funds and economic performance of resource-rich countries. *Resour. Policy* **2016**, *50*, 108–116. [CrossRef]
37. Bortolotti, B.; Fotak, V.; Hogg, C. *Sovereign Wealth Funds and the COVID-19 Shock: Economic and Financial Resilience in Resource-Rich Countries*; Working Paper Series No. 147; Centre for Applied Research on International Markets, Banking, Finance and Regulation, University of Bocconi: Milan, Italy, 2020. [CrossRef]
38. Bagattini, G.Y. *The Political Economy of Stabilisation Funds: Measuring their Success in Resource-Dependent Countries*; IDS Working Paper No. 356; Institute of Development Studies, University of Sussex: Brighton, UK, 2011; Volume 2011, pp. 1–60. [CrossRef]
39. Lücke, M. *Stabilization and Savings Funds to Manage Natural Resource Revenues: Kazakhstan and Azerbaijan vs. Norway*; Kiel Working Paper No. 1652; Kiel Institute for the World Economy: Kiel, Germany, 2010.
40. Fasano-Filho, U. *Review of the Experience with Oil Stabilization and Savings Funds in Selected Countries*; IMF Working Paper No. WP/00/112; International Monetary Fund: Washington, DC, USA, 2000. [CrossRef]
41. Chalk, N.A.; El-Arian, M.A.; Fennell, S.J.; Kireyev, A.P.; Wilson, J.F. *From Reconstruction to Accumulation for Future Generations: Kuwait*; Occasional Paper No. 150; International Monetary Fund: Washington, DC, USA, 1997.
42. Merlevede, B.; Schoors, K.; van Aarle, B.V. Russia from bust to boom and back: Oil price, Dutch disease and stabilisation fund. *Comp. Econ. Stud.* **2009**, *51*, 213–241. [CrossRef]
43. Shabsigh, G.; Ilahi, N. *Looking beyond the Fiscal: Do Oil Funds Bring Macroeconomic Stability?* IMF Working Paper No. 07/96; International Monetary Fund: Washington, DC, USA, 2007.
44. Gould, M. Managing manna from below: Sovereign wealth funds and extractive industries in the Pacific. *Econ. Round Up* **2010**, *1*, 63–86.
45. Le Borgne, E.; Medas, P. *Sovereign Wealth Funds in the Pacific Island Countries: Macro-fiscal Linkages*; IMF Working Paper No. 07/297; International Monetary Fund: Washington, DC, USA, 2007.
46. Usui, N. *How Effective Are Oil Funds? Managing Resource Windfalls in Azerbaijan and Kazakhstan*; Asian Development Bank Policy Brief Series No. 50; Asian Development Bank: Mandaluyong, Philippines, 2007.
47. Hjort, J. Citizen funds and Dutch disease in developing countries. *Resour. Policy* **2006**, *31*, 183–191. [CrossRef]
48. Kalyuzhnova, Y. Overcoming the curse of hydrocarbon: Goals and governance in the oil funds of Kazakhstan and Azerbaijan. *Comp. Econ. Stud.* **2006**, *48*, 583–613. [CrossRef]
49. Engel, E.; Valdés, R. *Optimal Fiscal Strategy for Oil Exporting Countries*; IMF Working Paper No. 00/118; International Monetary Fund: Washington, DC, USA, 2000.
50. Allegret, J.P.; Benkhodja, M.T.; Razafindrabe, T. *Monetary Policy, Oil Stabilization Fund and the Dutch Disease*; GREDEG Working Paper No. 2018-06; Groupe de REcherche en Droit, Economie, Gestion (GREDEG CNRS), Université Côte d'Azur: Nice, France, 2018.
51. Crain, W.M.; Devlin, J. *Nonrenewable Resource Funds: A Red Herring for Fiscal Stability?* Annual Meeting of the American Political Science Association: Philadelphia, PA, USA, 2003.
52. Villafuerte, M.; Lopez-Murphy, P.; Ossowski, R. *Riding the Roller Coaster: Fiscal Policies of Nonrenewable Resource Exporters in Latin America and the Caribbean*; IMF Working Paper No. 10/251; International Monetary Fund: Washington, DC, USA, 2010.

53. Devlin, J.; Titman, S. Managing oil price risk in developing countries. *World Bank Res. Obs.* **2004**, *19*, 119–139. [CrossRef]
54. Eifert, B.; Gelb, A.; Tallroth, N.B. *The Political Economy of Fiscal Policy and Economic Management in Oil Exporting Countries*; The World Bank Policy Research Working Paper No. 2899; The World Bank: Washington, DC, USA, 2002.
55. Levin, A.; Lin, C.F.; James Chu, C. Unit root tests in panel data: Asymptotic and finite-sample properties. *J. Econ.* **2002**, *108*, 1–24. [CrossRef]
56. Choi, I. Unit root tests for panel data. *J. Int. Money Financ.* **2001**, *20*, 249–272. [CrossRef]
57. Maddala, G.S.; Wu, S. A comparative study of unit root tests with panel data and a new simple test. *Oxf. Bull. Econ. Stat.* **1999**, *61*, 631–652. [CrossRef]
58. Im, K.S.; Pesaran, M.H.; Shin, Y. Testing for unit roots in heterogeneous panels. *J. Econ.* **2003**, *115*, 53–74. [CrossRef]
59. Hausman, J.A. Specification tests in econometrics. *Econometrica* **1978**, *46*, 1251–1271. [CrossRef]
60. Silva, J.M.C.S.; Tenreyro, S. The log of gravity. *Rev. Econ. Stat.* **2006**, *88*, 641–658. [CrossRef]
61. Kareem, F.O.; Martinez-Zarzoso, I.; Brümmer, B. *Fitting the Gravity Model When Zero Trade Flows are Frequent: A Comparison of Estimation Techniques Using Africa's Trade Data*; Global Food Discussion Papers No. 77; Georg-August-Universitaet Goettingen, Global Food, Department of Agricultural Economics and Rural Development: Göttingen, Germany, 2016.
62. Tornell, A.; Lane, P.R. The Voracity Effect. *Am. Econ. Rev.* **1999**, *89*, 22–46. [CrossRef]