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Effect of Sovereign Wealth Funds in Commodity-Exporting Economies when Commodity Prices Affect Interest Spreads *

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Abstract

We reconsider the role of a sovereign wealth fund in commodity-exporting economies facing recent volatile fluctuations of commodity prices due to the COVID-19 shock. We examine the welfare-improving effect of a sovereign wealth fund from the new perspective of the link between commodity prices and interest rate spreads, which is unique to emerging economies. We show that a sovereign wealth fund becomes more effective in improving welfare for commodity-exporting economies with a stronger link between their commodity prices and interest rate spreads.

Keywords: sovereign wealth fund, commodity prices, interest rate spreads, DSGE model, financial frictions, emerging economies
JEL Classification: E32, E44, F32, O20, Q48

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1 Introduction

The COVID-19 pandemic affected emerging economies through various channels. One of the most important channels is terms of trade deterioration due to a decline in global demand.[1] Commodity prices sharply fell in early 2020. Since the latter part of 2020, however, commodity prices recovered and surged partly due to the limited supply (Economist, 2021). The sharp fluctuation in the commodity prices of exports may have serious impacts on commodity-exporting economies.[2] The recent literature on the business cycles of emerging economies reports that commodity price shocks have a sizable contribution to business cycle fluctuations (e.g., Drechsel and Tenreyro, 2018). To cope with the sharp fluctuations in the commodity prices of their exports, a sovereign wealth fund (SWF) is likely to be an effective tool for commodity-exporting countries.[3]

Against this background, we reconsider the role of an SWF in commodity-exporting economies facing the recent volatile fluctuations of commodity prices using a dynamic stochastic general equilibrium (DSGE) model. Some prior studies analyze small open DSGE models of commodity-exporting economies with an SWF (e.g., Dagher et al., 2012; Basu et al., 2013; Berg et al., 2013; Melina et al., 2016; Bergholt et al., 2019).[4] Dagher et al. (2012) analyze the impact of oil windfalls on low-income countries and show that an SWF can help achieve macroeconomic stability and improve welfare. Berg et al. (2013) focus the macroeconomic

[1]Hevia and Neumeyer (2020) argue that the COVID-19 pandemic affects emerging economies through three main channels: (i) the direct negative effect of social distancing restrictions on economic activity, (ii) terms of trade deterioration, and (iii) global financial shock.

[2]Kitano (2021) shows that world commodity price shocks may have a significant impact on Asian commodity-exporting economies using a structural vector auto-regression (SVAR) analysis.

[3]Drechsel and Tenreyro (2018) mention that, "sovereign wealth funds may offer a promising avenue for tackling volatility in commodity producing countries" (page 213) in their conclusion.

[4]For a comprehensive literature review of SWFs, see, for example, Alhashel (2015).

effect of public investment financed by natural resource revenues in developing countries, and compare different fiscal policies including an SWF. Motivated by Papua New Guinea's natural resource (LNG) boom, Basu et al. (2013) examine the policy implications of a variety of policy responses to the macroeconomic effects of a resource boom, showing that an SWF is a desirable means of dealing with macroeconomic fluctuations. Melina et al. (2016) compare two approaches: (i) a "spend-as-you-go" (SAYG) approach that invests all resource windfalls each period without saving, and (ii) a "delinked public investment" approach combined with a resource fund (or an SWF). They show that the latter can reduce macroeconomic instability relative to the former. Overall, the literature recommends that policymakers in resource-rich developing countries save a resource windfall in an SWF. Our study contributes to the literature by reexamining the role of SWFs from the new perspective of recent empirical evidence on commodity-exporting countries.

The recent empirical evidence is that world commodity prices strongly affect the interest rate spreads of commodity-exporting countries (Bastourre et al., 2012; Shousha, 2016; Fernández et al., 2018). Specifically, interest rate spreads tend to fall (rise) when world commodity prices increase (decrease), which is unique to emerging economies. Concerning the mechanism behind the link between world commodity prices and interest rate spreads, Drechsel and Tenreyro (2018) argue that "[t]his could come in the form of a borrowing constraint, in which the value of the country's collateral depends directly on commodity prices through export earnings" (lines 15-18, RHS of page 206). That is, a fall (rise) in commodity prices lessens (heightens) the value of the country's collateral. Accordingly, when commodity prices decrease (increase), creditors increase (decrease) the required interest rate spread. In other words, financial frictions are a key mechanism behind the negative relationship between world commodity prices and interest rate spreads. Using a DSGE model, Drechsel and Tenreyro (2018) show that the relation between world commodity prices and interest rate spreads is critical for replicating a counter-cyclical trade balance, which is a distinctive feature of the empirical dynamics of Argentina's economy. Using SVAR and regression analyses, Kitano (2021) finds that among the sample Asian commodity-exporting countries, counter-cyclical trade balances occur only in the countries with a negative sensitivity of the interest rate spread to commodity prices. That is, whether a counter-cyclical trade balance occurs depends on the presence of financial frictions. From the new perspective of the link between commodity prices and interest rate spreads, we examine the welfare-improving effect of SWFs. We find that when the negative sensitivity of interest rate spreads to commodity prices is higher, the welfare-improving effect of SWFs becomes larger compared to that of a conventional fiscal policy. The policy implication of this result is that an SWF may play a more important role in absorbing commodity price shocks in countries under more severe financial frictions.

The intuition of our model is quite straightforward. Commodity-exporting economies with a high sensitivity of interest rate spreads to commodity prices tend to experience volatile business cycle fluctuations, including trade balances, due to volatile interest rate spreads. The role of an SWF in stabilizing fluctuations is, therefore, more important in countries with more severe financial frictions.

The remainder of the paper proceeds as follows. In Section 2, we present a small open economy model of commodity-exporting countries augmented with the key link between commodity prices and interest rate spreads. In Section 3, we compare the welfare-improving effects of an SWF and a conventional fiscal policy under different degrees of sensitivity of interest rate spreads to commodity prices. We present our conclusions in Section 4.

2 Model

The model framework is similar to that of Drechsel and Tenreyro (2018), who embed a commodity sector and a negative association between commodity prices and interest spreads in a standard real-business-cycle model of a small open economy (e.g., Aguiar and Gopinath, 2007; Garcia-Cicco et al., 2010). A small open economy consists of households, firms, and the government. Firms are divided into two sectors, a final goods sector and a commodity sector. Both the final goods and commodity goods are traded internationally. The commodity goods are also used to produce the final goods.

2.1 Households

The household's expected lifetime utility is

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left[C_t - \frac{\theta}{\eta^f}(N_t^f)^{\eta^f} - \frac{\theta}{\eta^c}(N_t^c)^{\eta^c}\right]^{1-\gamma} - 1}{1-\gamma}, \tag{1}$$

where E_0 denotes the mathematical expectations operator conditional on the information available at time 0, C_t is final goods consumption, and N_t^f and N_t^c are the labor supply to the final goods sector and the commodity sector, respectively. The parameters $\beta \in (0,1)$, $\gamma\,(>0)$, $\theta\,(>0)$, η^f, and η^c denote the discount factor, the inverse of the intertemporal elasticity of substitution, curvature parameters on labor, and the labor coefficient, respectively.

The household's budget constraint is

$$C_t + K_{t+1} + D_t + T_t^h + \frac{\phi}{2}\left(\frac{K_{t+1}}{K_t} - 1\right)^2 K_t = r_t^f K_t^f + r_t^c K_t^c + w_t^f N_t^f$$
$$+ w_t^c N_t^c + (1-\delta)K_t + \frac{D_{t+1}}{1+r_t}, \quad (2)$$

where D_t is foreign debt and T_t^h is a lump-sum tax. r^f and r^c denote real rental rates of capital in the final goods and commodity sectors, respectively. w^f and w^c denote the real wages in each respective sector. δ and ϕ represent capital depreciation rate and adjustment cost parameter, respectively. K_t denotes aggregate capital in the two sectors:

$$K_t = K_t^f + K_t^c. \quad (3)$$

The aggregate (private) capital stock evolves according to

$$K_{t+1} = (1-\delta)K_t + I_t, \quad (4)$$

where I_t is private investment. The interest rate on foreign borrowing r_t consists of three parts: the (exogenous) world interest rate r^*, the country premium on foreign debt, and the effect of commodity prices on interest rate spreads:

$$r_t = r^* + \psi(e^{\tilde{D}_{t+1} - \tilde{D}} - 1) - \chi(\ln p_t^c - \ln p^c), \quad (5)$$

where p_t^c and p^c denote the commodity price and its steady-state level, respectively. $\tilde{D}_t$ and $\tilde{D}$ denote the aggregate (per-capita) level of foreign debt and its steady-state level, respectively. As in related studies, we assume that the country premium is an increasing function of foreign debt to assure the stationarity of foreign debt.[5] Following Drechsel and Tenreyro (2018), we introduce the last term to represent the effect of commodity prices on interest rate spreads. The parameter χ represents the sensitivity of interest rate spreads to commodity prices. As we argued in Section 1, according to the recent empirical evidence, interest rate spreads tend to rise (fall) when world commodity prices decrease (increase), which means a positive value of χ in Eq.(5). Since commodity prices affect the commodity-exporting country's borrowing constraint, it also implies that a higher value of χ indicates a higher degree of financial friction. We will examine how the key parameter χ affects the dynamics of commodity-exporting countries in response to commodity price shocks in Section 3.

The household's first-order optimality conditions with respect to C_t, N_t^f, N_t^c, D_{t+1}, K_{t+1}^f, and K_{t+1}^c are

$$\left[C_t - \frac{\theta}{\eta^f}(N_t^f)^{\eta^f} - \frac{\theta}{\eta^c}(N_t^c)^{\eta^c}\right]^{-\gamma} = \lambda_t, \tag{6}$$

$$\left[C_t - \frac{\theta}{\eta^f}(N_t^f)^{\eta^f} - \frac{\theta}{\eta^c}(N_t^c)^{\eta^c}\right]^{-\gamma} \theta (N_t^f)^{\eta^f - 1} = \lambda_t w_t^f, \tag{7}$$

$$\left[C_t - \frac{\theta}{\eta^f}(N_t^f)^{\eta^f} - \frac{\theta}{\eta^c}(N_t^c)^{\eta^c}\right]^{-\gamma} \theta (N_t^c)^{\eta^c - 1} = \lambda_t w_t^c, \tag{8}$$

$$\lambda_t = \beta(1 + r_t)E_t\{\lambda_{t+1}\}, \tag{9}$$

[5] The small open economy model with incomplete asset markets features equilibrium dynamics that possess a random walk component. See Schmitt-Grohé and Uribe (2003) for details.

$$\lambda_t \left[1 + \phi \left(\frac{K_{t+1}}{K_t} - 1\right)\right]$$
$$= \beta E_t \left\{ \lambda_{t+1} \left[r^f_{t+1} + 1 - \delta + \phi \left(\frac{K_{t+2}}{K_{t+1}} - 1\right) \frac{K_{t+2}}{K_{t+1}} - \frac{\phi}{2} \left(\frac{K_{t+2}}{K_{t+1}} - 1\right)^2 \right] \right\}, \quad (10)$$

and

$$\lambda_t \left[1 + \phi \left(\frac{K_{t+1}}{K_t} - 1\right)\right]$$
$$= \beta E_t \left\{ \lambda_{t+1} \left[r^c_{t+1} + 1 - \delta + \phi \left(\frac{K_{t+2}}{K_{t+1}} - 1\right) \frac{K_{t+2}}{K_{t+1}} - \frac{\phi}{2} \left(\frac{K_{t+2}}{K_{t+1}} - 1\right)^2 \right] \right\}, \quad (11)$$

respectively, where λ_t is the Lagrange multiplier on Eq.(2). As we assume that households are identical, the aggregate (per-capita) debt level is equal to the individual's debt level:

$$\tilde{D}_t = D_t. \quad (12)$$

2.2 Final goods sector

Unlike Drechsel and Tenreyro (2018), our model assumes that firms use public capital as a factor of production. The production function in the final goods sector is

$$Y^f_t = a^f_t (K^f_t)^{\alpha^f_k} (M_t)^{\alpha^f_m} (N^f_t)^{1-\alpha^f_k-\alpha^f_m} (K^g_t)^{\alpha^f_g}, \quad (13)$$

where Y^f_t, a^f_t, M_t, and K^g_t denote the output of final goods, total factor productivity in the final goods sector, commodity inputs, and public capital, respectively. The parameters α^f_k, α^f_m, and α^f_g respectively denote capital share, commodity share, and output elasticity with respect to public capital. Following prior studies using models with public capital, we assume constant returns to scale in private production inputs but increasing returns to scale in public capital.

The first-order conditions with respect to K^f_{t+1}, N^f_t, and M_t for the profit maximization problem are

$$r^f_t = \alpha^f_k a^f_t (K^f_t)^{\alpha^f_k - 1}(M_t)^{\alpha^f_m}(N^f_t)^{1-\alpha^f_k-\alpha^f_m}(K^g_t)^{\alpha^f_g}, \tag{14}$$

$$w^f_t = (1-\alpha^f_k-\alpha^f_m) a^f_t (K^f_t)^{\alpha^f_k}(M_t)^{\alpha^f_m}(N^f_t)^{-\alpha^f_k-\alpha^f_m}(K^g_t)^{\alpha^f_g}, \tag{15}$$

and

$$p^c_t = \alpha^f_m a^f_t (K^f_t)^{\alpha^f_k}(M_t)^{\alpha^f_m - 1}(N^f_t)^{1-\alpha^f_k-\alpha^f_m}(K^g_t)^{\alpha^f_g}, \tag{16}$$

respectively.

2.3 Commodity sector

The production function in the commodity sector is

$$Y^c_t = a^c_t (K^c_t)^{\alpha^c_k}(N^c_t)^{1-\alpha^c_k}(K^g_t)^{\alpha^c_g}, \tag{17}$$

where Y^c_t is the output of commodities and a^c_t is total factor productivity in the commodity sector. Both the commodity and final goods sectors use public capital. The parameters α^c_k and α^c_g respectively denote capital share and output elasticity with respect to public capital (in the commodity production). As we argue in Section 2.4, commodity firms' incomes are taxed at the rate of τ^c. The first-order conditions with respect to K^c_t and N^c_t for the profit maximization problem are then

$$r^c_t = (1-\tau^c)\alpha^c_k p^c_t a^c_t (K^c_t)^{\alpha^c_k - 1}(N^c_t)^{1-\alpha^c_k}(K^g_t)^{\alpha^c_g}, \tag{18}$$

and

$$w_t^c = (1-\tau^c)(1-\alpha_k^c)p_t^c a_t^c (K_t^c)^{\alpha_k^c}(N_t^c)^{-\alpha_k^c}(K_t^g)^{\alpha_g^c}. \tag{19}$$

2.4 Government

The government taxes households and commodity firms, makes government expenditures, and manages an SWF. The government's budget constraint is

$$\frac{F_{t+1}}{1+r^*} + G_t = F_t + T_t^h + T_t^c, \tag{20}$$

where F_t is the asset value of the SWF. T_t^c denotes the tax revenue from the commodity sector:

$$T_t^c = \tau^c p_t^c Y_t^c. \tag{21}$$

G_t is government spending, which consists of government consumption (G_t^{con}) and government investment (G_t^{inv}):

$$G_t = G_t^{inv} + G_t^{con}. \tag{22}$$

The public capital then evolves according to

$$K_{t+1}^g = \left[1 - \frac{\phi^g}{2}\left(\frac{G_t^{inv}}{G_{t-1}^{inv}} - 1\right)^2\right] G_t^{inv} + (1-\delta^g)K_t^g, \tag{23}$$

where δ^g is the depreciation rate of public capital and ϕ^g is the investment adjustment cost parameter. To simplify the model, we assume a constant level of government consumption (i.e., $G_t^{con} = G^{con}$).

We define a resource windfall as extra revenue from the commodity sector that is beyond its steady-state level, $T_t^c - T^c$. We analyze two approaches to managing the resource windfall: the SAYG and SWF approaches.[6]

Under the SAYG approach, the government spends all the resource windfall on government investment, and maintains the sovereign resource fund at its steady-state level:

$$G_t^{inv} = G^{inv} + (T_t^c - T^c), \tag{24}$$

and

$$F_{t+1} = F. \tag{25}$$

Under the SWF approach, the government saves all the resource windfall in the SWF, and maintains government investment at its steady-state level:

$$F_{t+1} = F_t + (1 + r^*)(T_t^c - T^c), \tag{26}$$

and

$$G_t^{inv} = G^{inv}. \tag{27}$$

2.5 Equilibrium

As the economy consists of two sectors (and the final goods sector uses commodity inputs), GDP is

$$Y_t = Y_t^f + p_t^c Y_t^c - p_t^c M_t. \tag{28}$$

From the household's budget constraint (2) and the government's budget constraint (20) (along with Eqs. (4), (13), (14), (15), (16), (17), (18), (19), (21), and

[6]Following the literature (e.g., Melina et al., 2016; Basdevant et al., 2021), we use the terminology SAYG.

(22)), we obtain the trade balance:

$$TB_t = Y_t - C_t - I_t - G_t^{con} - G_t^{inv} - \frac{\phi}{2}\left(\frac{K_{t+1}}{K_t} - 1\right)^2 K_t. \tag{29}$$

The world commodity price p_t^c exogenously evolves according to the following shock process:

$$\ln\left(\frac{p_t^c}{p^c}\right) = \rho^1 \log\left(\frac{p_{t-1}^c}{p^c}\right) + \rho^2 \log\left(\frac{p_{t-2}^c}{p^c}\right) + \epsilon_t^{p^c}, \;\; \epsilon_t^{p^c} \sim i.i.d.\mathcal{N}(0, \sigma_{p^c}^2). \tag{30}$$

2.6 Calibration

Kitano (2021) identifies world commodity price shocks using an SVAR model with a standard Cholesky decomposition for five Asian commodity-exporting economies (Azerbaijan, Indonesia, Kazakhstan, Malaysia, and Mongolia). The first to third rows in Table 1 respectively represent the identified values of ρ^1, ρ^2, and σ_{p^c} in Eq. (30) for the five countries. In this study, we set ρ^1, ρ^2, and σ_{p^c} to the average number of the five countries (i.e., 1.1814, -0.4895, and 0.0733), respectively.

We also set the steady-state ratio of net exports of commodities relative to GDP, TB^c/Y, to 0.2068, which is the average across the five countries (fourth row in Table 1).[7] We set the discount factor β to 0.9792 using the five countries' average real interest rates (fifth row in Table 1).[8]

Regarding the parameters related to the government sector, we obtain their

[7]We obtain this number using International Financial Statistics (IFS) and the World Integrated Trade Solution (WITS) database. Azerbaijan, 2001Q1-2016Q4; Indonesia, 1997Q1-2018Q3; Kazakhstan 1993Q4-2019Q4; Malaysia 1991Q1-2018Q4; Mongolia 2005Q1-2018Q3.

[8]We calculate real rates using lending rates and GDP deflators from the IFS. Azerbaijan, 2001q1-2016q4; Indonesia, 1997q1-2018q3; Kazakhstan, 1993q4-2019q4; Malaysia, 1991q4-2018q4; Mongolia, 2005Q1-2018Q3.

Table 1: Calibration (Sample countries' data)

	Azerbaijan	Indonesia	Kazakhstan	Malaysia	Mongolia	Average
ρ^1	0.9250	1.2150	1.2930	1.1620	1.3120	1.1814
ρ^2	-0.3414	-0.4896	-0.4717	-0.4530	-0.6920	-0.4895
σ_{p^c}	0.0937	0.0629	0.0830	0.0518	0.0748	0.0733
TB^c/Y	0.4059	0.0571	0.2624	0.1001	0.2086	0.2068
β	0.9679	0.9797	0.9941	0.9884	0.9659	0.9792
G^{inv}/Y	0.0352	n.a.	0.0232	0.1090	0.0349	0.0506
G^{con}/Y	0.1110	0.0841	0.1246	0.1215	0.1291	0.1141
F/D	0.6907	0.2244	0.2626	n.a.	0.2214	0.3498
χ	—	0.2183	—	0.0368	0.3052	—

Note) Source: Kitano (2021), World Development Indicators

empirical average for the five countries and set the steady-state ratio of government consumption to GDP, G^{con}/Y, to 0.1141.[9] Again, from the average across the five countries, we set the steady-state ratio of government investment to GDP, G^{inv}/Y, to 0.0506.[10] We set the steady-state ratio of the SWF to foreign debt, F/D, to 0.3498 as it is the average foreign reserves for the five sample countries.[11] This is because the SWFs that we examine in this study are only experimental.[12] Using the steady-state levels of G^{con}/Y, G^{inv}/Y, and F/D, we set the (constant) tax rate on commodity production, τ^c ($= 0.1664$) to satisfy the government's budget constraint (20) in the steady state (Table 2).

Table 2 summarizes all the parameter values we use in our analysis. Regarding

[9]The data source is IFS. Azerbaijan, 2001q1-2016q4; Indonesia, 1997q1-2018q3; Kazakhstan, 1993q4-2019q4; Malaysia, 1991q4-2018q4; Mongolia, 2005Q1-2018Q3.

[10]The data source is the World Development Indicators. Azerbaijan, 1993-2007; Kazakhstan, 1992-2006; Malaysia, 1990-2019; Mongolia, 1995-2007. Data for Indonesia are not available.

[11]The data source is the World Development Indicators. Azerbaijan, 1993-2019; Indonesia, 1971-2019; Kazakhstan, 1993-2019; Mongolia, 1992-2019. Data for Malaysia are not available.

[12]Although all these countries have them, their SWFs are still underdeveloped. See, for example Park and Estrada (2009), Borst (2015), and Mohaddes and Raissi (2017) for Asian SWFs.

the other parameters not mentioned above, we choose the standard values from the related literature. We set the inverse of the intertemporal elasticity of substitution γ to 2 (as in, e.g., Aguiar and Gopinath (2007)). Following Drechsel and Tenreyro (2018), we set the parameters related to labor (θ^f, θ^c, η^f, and η^c) to 1.6. Following Shousha (2016), we set capital share in production (α_k^f and α_k^c) and commodity share in final goods production (α_m^f) to 0.32 and 0.05, respectively. In line with Garcia-Cicco et al. (2010), we set the depreciation rate of capital (δ and δ^g) to 0.1255/4. We set the adjustment cost parameter ϕ to 9 to obtain the impulse responses of trade balance (ratio to GDP) to a commodity price shock in Figure 1. Following Aguiar and Gopinath (2007), we set the coefficient on the interest rate premium term (ψ) and the steady-state level of debt to GDP (D/Y) to 0.001 and 0.1, respectively. As in Melina et al. (2016), we set the output elasticity with respect to public capital (α_g^f and α_g^c) to 0.15. We set the parameter for the adjustment cost of government investment ϕ^G to 2.06 so that the welfare levels under the SAYG and SWF cases become equal in the benchmark case of $\chi = 0$.

In Section 3, we examine how the negative sensitivity of interest rate spreads to commodity prices affects the impulse responses of the main variables and the welfare levels in commodity-exporting economies. In this sense, the parameter for the sensitivity of interest rate spreads to commodity prices, χ, is the most important parameter in our analysis. Kitano (2021) regresses the interest rate spread of each country on the country-specific commodity price index. The last row of Table 1 represents the estimated coefficient χ for each country.[13] In Section 3, we therefore use the range of χ between 0 to 0.4, which includes these estimated values.

[13]The coefficients for Azerbaijan and Kazakhstan are not significant.

Table 2: Calibration

	Description	Value
	Household parameters	
γ	Inverse of intertemporal elasticity of substitution	2
β	Discount factor	0.9792
θ^f, θ^c	Labor coefficient	1.6
η^f, η^c	Curvature parameter on labor	1.6
	Production parameters	
α_k^f, α_k^c	Capital share in production	0.32
α_m^f	Commodity input share in final goods production	0.05
α_g^f, α_g^c	Output elasticity with respect to public capital	0.15
δ	Depreciation rate of capital	0.1255/4
ϕ	Parameter for adjustment cost on investment	9
	Open economy parameters	
TB^c/Y	Steady-state ratio of net exports of commodities relative to GDP	0.2068
D/Y	Steady-state ratio of (private) foreign debt to GDP	0.1
ψ	Interest rate premium parameter with respect to foreign debt	0.001
	Government parameters	
G^{con}/Y	Steady-state ratio of government consumption to GDP	0.1141
G^{inv}/Y	Steady-state ratio of government investment to GDP	0.0506
F/D	Steady-state ratio of SWF to foreign debt	0.3498
τ^c	Tax rate on commodity production	0.1664
ϕ^G	Parameter for adjustment cost of government investment	2.06
	Commodity shock parameters	
ρ^1	Coefficient	1.1814
ρ^2	Coefficient	-0.4895
σ_{p^c}	Standard deviation	0.0733

3 Numerical experiment results

In this section, we present numerical experiments that shed light on the role of an SWF for commodity-exporting economies. As we argued in Section 1, commodity price shocks have a sizable contribution to the business cycle fluctuations of emerging economies (e.g., Drechsel and Tenreyro, 2018). At the same time, world commodity prices strongly affect interest rate spreads of commodity-exporting countries (Bastourre et al., 2012; Shousha, 2016; Fernández et al., 2018). Interest rate spreads tend to fall (rise) when world commodity prices increase (decrease), which is a unique observation for emerging economies. We therefore consider commodity price shocks as an exogenous shock in our numerical experiments.

As Drechsel and Tenreyro (2018) show, the negative sensitivity of interest rate spreads to commodity prices is critical for replicating a counter-cyclical trade balance. We first show how the sensitivity of interest rate spreads to commodity prices affects the impulse response of the trade balance in commodity-exporting economies. In this numerical experiment, we assume that the government adopts neither the SAYG nor the SWF approach. Figure 1 shows the impulse responses of the trade balance (ratio to GDP) to commodity price shocks under different values of $\chi(= 0, 0.2, \text{ and } 0.4)$ in Eq.(5). As we stated in Section 2, the parameter χ represents the sensitivity of interest rate spreads to commodity prices. A higher value of χ indicates a larger response of interest rate spreads to a commodity price shock.

In Figure 1, we depict the corresponding impulse responses to positive commodity price shocks with $\chi = 0$, 0.2, and 0.4 by the solid curve, dashed-dotted curve, and dashed curve, respectively. On impact, in the first case with $\chi = 0$, the trade balance becomes a surplus. In the second and third cases with $\chi = 0.2$ and 0.4, however, the trade balance becomes a deficit. Comparing the three cases with $\chi = 0$, 0.2, and 0.4, we can see that the impulse response of the trade balance depends on χ and that a higher value of χ is associated with a larger deficit in the trade balance in response to a positive commodity price shock. The result in

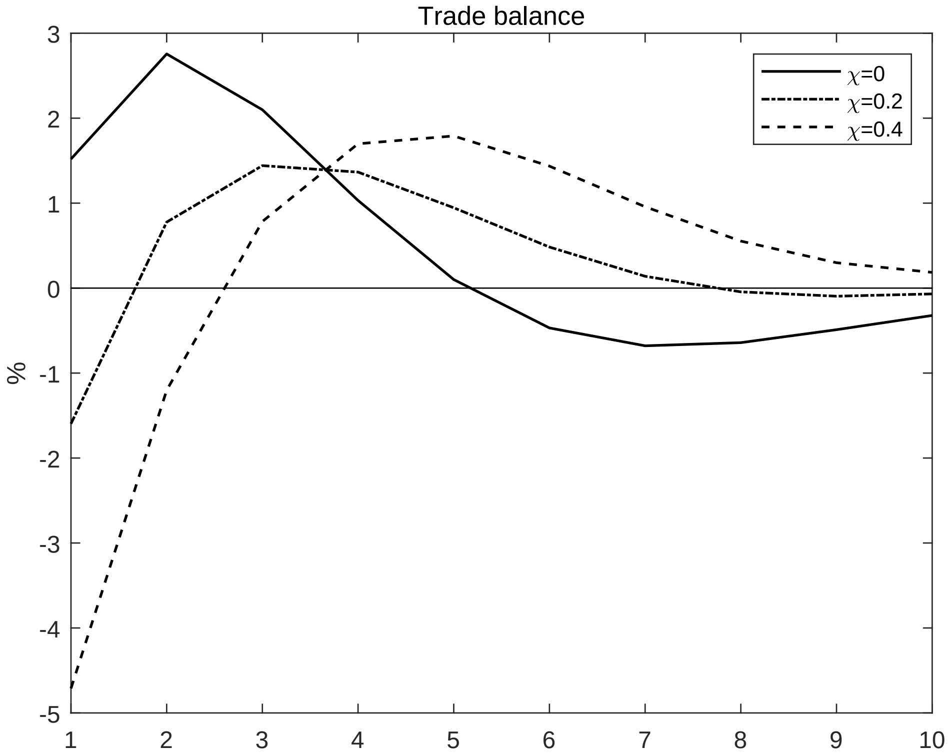

Figure 1: Impulse responses of the trade balance (ratio to GDP) to a 1-SD positive commodity price shock under different values of $\chi(= 0, 0.1,$ and $0.2)$: Baseline model without SAYG or SWF

Figure 1 is in line with prior studies (Drechsel and Tenreyro, 2018; Kitano, 2021) in the sense that the negative sensitivity of interest rate spreads (i.e., a positive value of χ) is associated with a counter-cyclical trade balance. The intuitive mechanism behind this result is as follows. Without the negative sensitivity of interest rate spreads, a positive commodity price shock raises the export prices, which causes a positive trade balance. However, in the case with the negative sensitivity of interest rate spreads, a positive commodity price shock reduces borrowing rates and increases present consumption and investment, which leads to a negative trade balance.

Based on a model consistent with those in previous studies, we first show how the sensitivity of interest rate spreads to commodity prices affects the main macroeconomic variables (GDP, consumption, investment, and trade balance) under the SAYG approach. Figure 2 shows the impulse responses of GDP, consumption, investment, and the trade balance (ratio to GDP) under different values of $\chi(=0, 0.2,$ and $0.4)$ in the SAYG case.[14] The impulse response of the trade balance is similar to that in Figure 1. That is, the trade balance depends on χ, and a higher value of χ is associated with a larger deficit of the trade balance on impact. Regarding GDP, consumption, and investment, the dashed curve deviates the most and the solid curve deviates the least from zero on impact, which implies that a higher value of χ is associated with larger responses of GDP, consumption, and investment.

We next show how the sensitivity of interest rate spreads to commodity prices affects the main macroeconomic variables under the SWF approach. Figure 3 shows the impulse responses of GDP, consumption, investment, and the trade balance (ratio to GDP) under different values of $\chi(=0, 0.2,$ and $0.4)$ in the SWF case. Regarding the trade balance, the implication is again similar to that of Figure 1 (i.e., a higher value of χ is associated with a larger deficit of trade balance on impact). Regarding GDP, consumption, and investment, as in the SAYG case, a

[14] Investment includes private and government investment (i.e., $I_t + G_t^{inv}$).

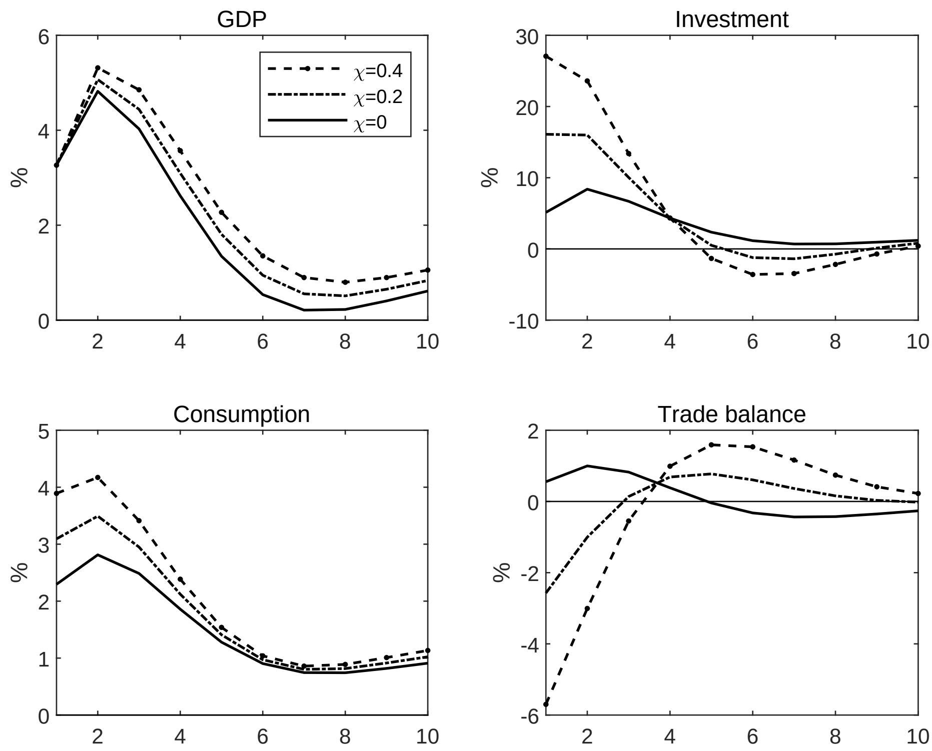

Figure 2: Impulse responses to a 1-SD commodity price shock in the SAYG case under different values of $\chi(= 0, 0.2,$ and $0.4)$

higher value of χ is associated with larger responses in these variables.

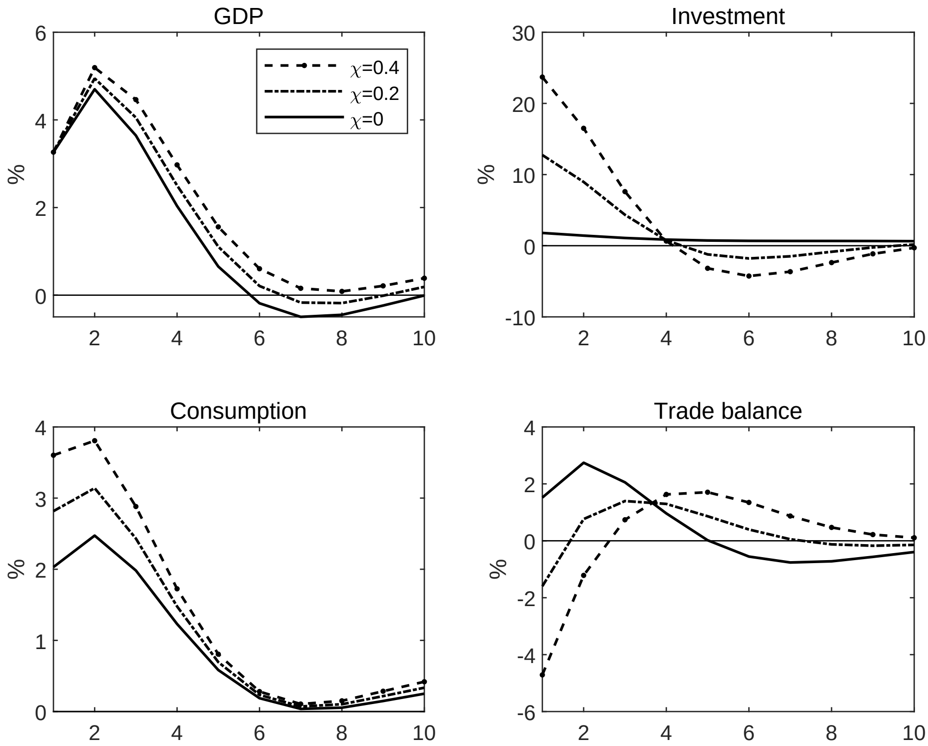

Figure 3: Impulse responses to a 1-SD commodity price shock in the SWF case under different values of $\chi (= 0, 0.2,$ and $0.4)$

Comparing Figures 2 and 3, we note that the impulse responses have similar shapes. We next check whether the cases have similar impulse response sizes. Figure 4 compares the impulse response of each variable in Figure 3 with that in Figure 2 when χ is 0.4. In Figure 4, the solid curve is closer to zero than the dashed-dotted curve, which implies that the government is able to stabilize the economy against commodity price shocks more effectively if it adopts the SWF approach rather than the SAYG approach.

As we argued above, Figure 4 shows that the SWF approach is better than the

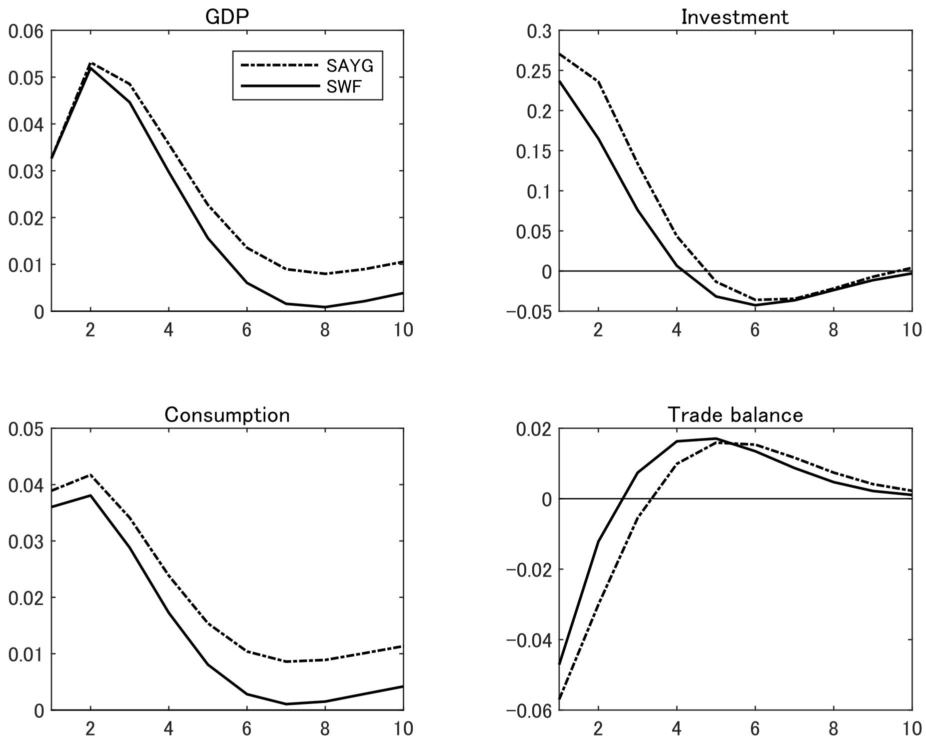

Figure 4: Impulse responses to a 1-SD commodity price shock in the SWF and SAYG cases ($\chi = 0.4$)

SAYG approach in stabilizing the economy. This result implies that the economy's welfare level achieved by the SWF approach is highly likely to be greater than that achieved by the SAYG approach. To confirm this finding, we formally measure by how much the SWF approach improves the economy's welfare level compared to the SAYG approach. We also examine whether (and how) the key parameter χ (i.e., the sensitivity of interest rate spreads to commodity prices) affects the welfare-improving effect of the SWF approach. The welfare associated with different values of χ under the two approaches (SWF or SAYG) is

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, N_t^f, N_t^c) = E_0 \sum_{t=0}^{\infty} \beta^t U((1+\xi)C, N^f, N^c), \tag{31}$$

where C, N^f, and N^c are their non-stochastic steady states. Using the perturbation method, we perform a second-order approximation of the model and calculate the expected welfare conditional on the initial state.[15] We can evaluate the welfare-improving effect of the SWF approach by comparing ξ under the SWF approach to that under the SAYG approach for different values of χ.[16] Figure 5 shows the difference between the welfare levels under the SWF and SAYG cases associated with different values of χ. In Figure 5, the horizontal axis is χ, while the vertical axis denotes the difference between ξ in the SWF and SAYG cases for the corresponding values of χ. The difference between them indicates the extent to which the SWF approach improves the economy's welfare level compared to the SAYG approach. In Figure 5, we can see that the difference in welfare levels between the

[15]As linearization may generate spurious welfare reversals when long-run distortions exist in the model, second-order solutions are necessary (Kim and Kim, 2003). We conduct the second-order computation with Dynare (see Adjemian et al. (2011)).

[16]The non-stochastic steady-state levels of C, N^f, and N^c are identical in the SWF and SAYG cases.

two approaches increases as the value of χ increases. This result implies that if an economy is facing a higher sensitivity of interest spreads to commodity prices, the economy benefits more from adopting the SWF approach than the SAYG approach.

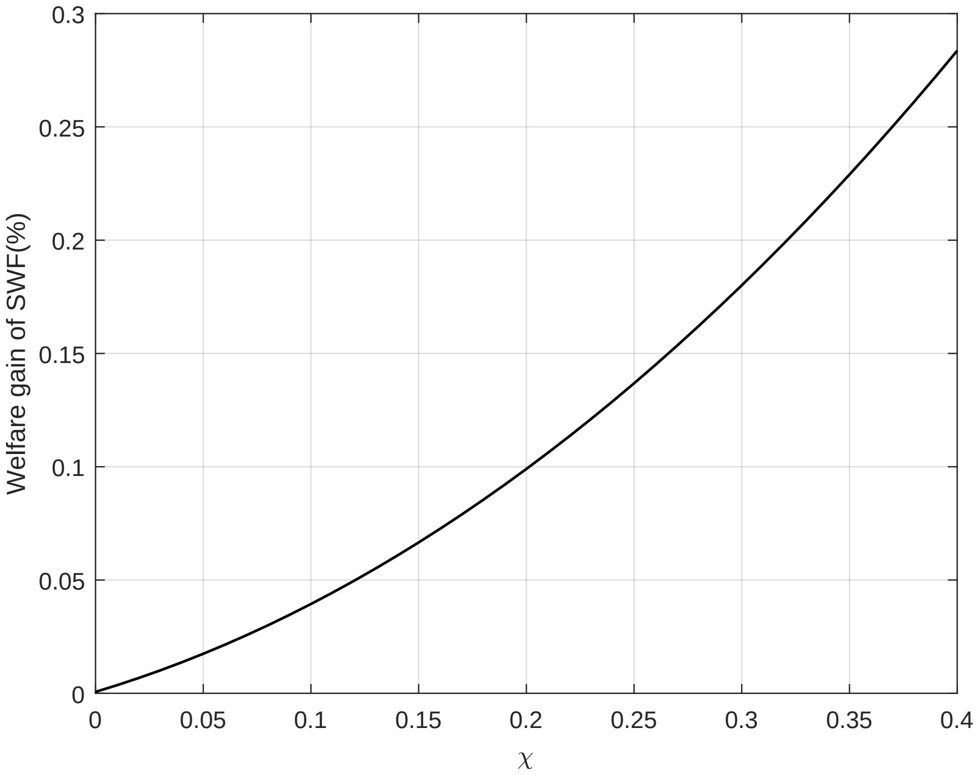

Figure 5: Difference in welfare levels between the SWF and SAYG cases

4 Conclusion

In this study, we examined the two main approaches that commodity-exporting countries can adopt to mitigate the exogenous shock of volatile fluctuations in commodity prices in the aftermath of the COVID-19 pandemic. Fluctuating commodity prices make the government's revenues on exporting commodities unstable. A conventional approach that the government can take for balancing revenue and expenditure is to adjust its spending on government investment. The other potential approach is to let an SWF absorb fluctuations in the government's revenues from exporting commodities (and let its spending on government investment remain stable). Comparing the impulse responses and welfare levels under the two approaches, we show that SWFs can contribute to stabilizing commodity-exporting economies facing volatile fluctuations in commodity prices. Our result on the stabilization role of SWFs is in line with previous studies. Nonetheless, we contribute to the literature by showing that the welfare-improving effect of SWFs is larger as the elasticity of interest spreads to commodity prices increases. This result implies that if a country suffers from a higher degree of financial frictions, then SWFs may play a more important role for absorbing commodity price shocks.

The intuition of our model is quite straightforward. Commodity-exporting economies with a high sensitivity of interest rate spreads to commodity prices tend to experience volatile business cycle fluctuations, including trade balances, due to volatile interest rate spreads. The role of an SWF in stabilizing fluctuations is, therefore, more important in countries with more severe financial frictions.

References

Adjemian, Stéphane, Houtan Bastani, Michel Juillard et al. (2011) "Dynare: Reference Manual, Version 4," Dynare Working Papers 1, CEPREMAP.

Aguiar, Mark and Gita Gopinath (2007) "Emerging Market Business Cycles: The Cycle Is the Trend," *Journal of Political Economy*, Vol. 115, pp. 69–102.

Alhashel, Bader (2015) "Sovereign Wealth Funds: A literature review," *Journal of Economics and Business*, Vol. 78, pp. 1–13.

Basdevant, Olivier, Eslem Imamoglu, and John Hooley (2021) "How to Design a Fiscal Strategy in a Resource-Rich Country," IMF Fiscal Affairs Department 2021/001, International Monetary Fund.

Bastourre, Diego, Jorge Carrera, Javier Ibarlucia, and Mariano Sardi (2012) "Common Drivers in Emerging Market Spreads and Commodity Prices," BCRA Working Paper Series 201257, Central Bank of Argentina, Economic Research Department.

Basu, Suman S., J. Gottschalk, Werner Schule, Nikhil Vellodi, and Susan Yang (2013) "The Macroeconomic Effects of Natural Resource Extraction: Applications to Papua New Guinea," *IMF Working Paper*.

Berg, Andrew, Rafael Portillo, Shu-Chun Yang, and Luis-Felipe Zanna (2013) "Public Investment in Resource-Abundant Developing Countries," *IMF Economic Review*, Vol. 61, No. 1, pp. 92–129.

Bergholt, Drago, Vegard H. Larsen, and Martin Seneca (2019) "Business cycles in an oil economy," *Journal of International Money and Finance*, Vol. 96, pp. 283 – 303.

Borst, Nicholas (2015) "The rise of Asian sovereign wealth funds," Asia Focus, Federal Reserve Bank of San Francisco.

Dagher, Jihad, Jan Gottschalk, and Rafael Portillo (2012) "The Short-run Impact of Oil Windfalls in Low-income Countries: A DSGE Approach," *Journal of African Economies*, Vol. 21, No. 3, pp. 343–372.

Drechsel, Thomas and Silvana Tenreyro (2018) "Commodity booms and busts in emerging economies," *Journal of International Economics*, Vol. 112, pp. 200 – 218.

Economist (2021) "The mountaineers," January 12th, https://www.economist.com/finance-and-economics/2021/01/12/commodity-prices-are-surging.

Fernández, Andrés, Andrés González, and Diego Rodriguez (2018) "Sharing a ride on the commodities roller coaster: Common factors in business cycles of emerging economies," *Journal of International Economics*, Vol. 111, pp. 99 – 121.

Garcia-Cicco, Javier, Roberto Pancrazi, and Martín Uribe (2010) "Real Business Cycles in Emerging Countries?" *American Economic Review*, Vol. 100, No. 5, pp. 2510–31, December.

Hevia, Constantino and Andy Neumeyer (2020) "A conceptual framework for analyzing the economic impact of covid-19 and its policy implications," UNDP LAC C19 PDS No.1, UNDP Latin American and the Cribbean.

Kim, Jinill and Sunghyun Henry Kim (2003) “Spurious Welfare Reversals in International Business Cycle Models,” *Journal of International Economics*, Vol. 60, No. 2, pp. 471–500.

Kitano, Shigeto (2021) “How do world commodity prices affect Asian commodity exporting economies?: The role of financial frictions,” *Applied Economics Letters*, DOI:10.1080/13504851.2021.1887446.

Melina, Giovanni, Shu-Chun S. Yang, and Luis-Felipe Zanna (2016) “Debt sustainability, public investment, and natural resources in developing countries: The DIGNAR model,” *Economic Modelling*, Vol. 52, pp. 630 – 649.

Mohaddes, Kamiar and Mehdi Raissi (2017) “Do Sovereign Wealth Funds Dampen the Negative Effects of Commodity Price Volatility?,” Cambridge Working Papers in Economics 1710, Faculty of Economics, University of Cambridge.

Park, Donghyun and Gemma Estrada (2009) “Developing Asia’s Sovereign Wealth Funds and Outward Foreign Direct Investment,” ADB Economics Working Paper Series 169, Asian Development Bank.

Schmitt-Grohé, Stephanie and Martín Uribe (2003) “Closing Small Open Economy Models,” *Journal of International Economics*, Vol. 61, No. 1, pp. 163–185.

Shousha, Samer (2016) “Macroeconomic effects of commodity booms and busts: The role of financial frictions,” unpublished manuscript.