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The Saving Abroad at Low Interest While Borrowing at High Interest Dilemma: How Much of a Commodity Windfall Should a Middle-Income Country Save in Its Sovereign Wealth Fund? Empirical Evidence from Mongolia

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Abstract

What share of a commodity windfall should a commodity exporter save abroad, and what share invest at home, when its borrowing costs fall as commodity prices rise? In Mongolia the debate is polarised between spending the sovereign wealth fund at home, because it earns less than the government pays on its bonds, and keeping it untouched. With a commodity price index whose weights follow the changing composition of exports, a 1 log point rise of prices above trend lowers the dollar lending spread by 3.88 percentage points and, excluding 2022, the spread on the government's dollar bonds by 5.63 points. In a small open economy model with public capital calibrated to Mongolia, neither pole is optimal. Welfare is highest when about half of each windfall is saved abroad at these estimates, and 64 percent, close to the 65 percent of the 2024 Law on the Sovereign Wealth Fund, at the higher sensitivity implied by the trade balance; the rest is invested. Rebating windfalls to households is the worst rule. We then add public debt and a fund earning the overnight dollar rate, 1.9 points below the government's bond yields. The low return is costly, but it does not make spending at home better: 80–84 percent of each windfall should then be saved. Whether the saved part should build the fund or retire public debt depends on how steeply borrowing costs rise with debt: the fund is worth its low return only as insurance against expensive borrowing in a bust.

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JEL Classification: E32 , E44 , F32 , F41 , H63 , Q33

1 Introduction

Commodity-exporting emerging economies face a double exposure to world commodity prices. A fall in prices lowers export earnings and fiscal revenue directly, and it also raises the rate at which the country borrows abroad, because commodity income is the collateral behind its external debt. Interest spreads of emerging economies move inversely with commodity prices ([Bastourre et al. 2012](#); [Fernández et al. 2018](#), and S. Shousha, unpublished manuscript, 2016), and [Drechsel and Tenreyro \(2018\)](#) show that this link is what makes the trade balance counter-cyclical in response to commodity price shocks. For fiscal policy the link matters because it makes commodity booms and busts larger. When prices rise, cheap credit adds a private borrowing boom to the fiscal windfall; when they fall, the private sector faces tighter credit just as windfall revenue disappears.

This paper asks how such an economy should divide a commodity windfall between saving abroad and investing at home. The question is usually argued from two poles. In Mongolia one side of the debate holds that it makes little sense to keep a fund in foreign assets that earn little while the government borrows at high interest rates, so that the money should be spent at home; the other holds that the fund should be kept intact and not spent at all. The literature on commodity-dependent spreads compares the same two poles. [Kitano and Takaku \(2023, K&T hereafter\)](#) add public capital to the Drechsel–Tenreyro small open economy and compare a spend-as-you-go (SAYG) rule, which invests every windfall in public capital, with a sovereign wealth fund (SWF) rule, which saves the whole windfall abroad and spends only the fund’s return. Calibrating the model to the average of five Asian commodity exporters (Azerbaijan, Indonesia, Kazakhstan, Malaysia and Mongolia), they find that the welfare gain of the SWF over SAYG rises with the sensitivity χ of the spread to commodity prices. Their analysis shows that the spread link strengthens the case for saving. It does not say what share of a windfall should be saved, which is the decision a government has to take, and it does not tell a particular government how strongly its own borrowing costs respond to commodity prices. Nor can it weigh the argument of the first pole, because in their model the fund earns the rate at which the country borrows and the government has no debt. We determine the division of a windfall that maximises welfare, show how it depends on χ , measure χ for Mongolia, and extend the model to a fund that earns less than the government pays on its debt.

Why the question matters.

The answer matters for four reasons. First, the stakes are large. In commodity exporters fiscal policy has often amplified commodity cycles instead of smoothing them ([Céspedes and Velasco 2012](#)), and in Mongolia fiscal and monetary policy have

responded procyclically to commodity prices (Doojav 2026). In the 2012–2016 bust the spread on Mongolia’s government bonds rose to 9.3 percentage points (pp) while obligations created by the Human Development Fund during the boom were still being repaid (Yeung and Howes 2015). Second, the division of windfalls is a live policy decision. Many commodity exporters have set up SWFs (Aizenman and Glick 2009; Al-Hassan et al. 2018), and the choice between saving windfalls abroad and investing them at home is central to fiscal frameworks for resource-rich countries (Collier et al. 2010; Basdevant et al. 2021). Mongolia’s Law on the Sovereign Wealth Fund (State Great Khural of Mongolia 2024) dates only from 2024, so the rules that will govern future windfalls are being set now. Third, the policy advice depends on a parameter that has not been measured. Because the best saving share rises with χ , a borrowed value of χ can change the advice: at K&T’s value for Mongolia the model implies that 83 percent of a windfall should be saved, whereas at our direct estimates the best share is about one half. Fourth, Mongolia became an upper-middle-income country in 2024 (World Bank 2024). As concessional finance shrinks, more of its borrowing will be priced in markets, where commodity risk shows up in spreads; private external debt already equals 47 percent of gross domestic product (GDP).

Related literature and the research gap.

The paper relates to work on interest rates, commodity prices and emerging-market cycles (Neumeyer and Perri 2005; Uribe and Yue 2006; Fernández et al. 2018; Drechsel and Tenreyro 2018), to work on how resource-rich developing economies should use windfalls (Collier et al. 2010; van der Ploeg and Venables 2011; Berg et al. 2013; Melina et al. 2016; Mohaddes and Raissi 2017) and to work on Mongolia (Doojav and Batmunkh 2018; Doojav and Luvsannyam 2019; Doojav and Gantumur 2023; Doojav et al. 2023). Together these leave four gaps.

- (i) *The best division of a windfall is not known when spreads depend on commodity prices.* The windfall literature favours rules that save part of a windfall and invest the rest at home (van der Ploeg and Venables 2011; Berg et al. 2013), but in models in which borrowing costs do not depend on commodity prices. K&T, who model the spread link, compare only the two polar rules and a symmetric link, and their fund earns the country’s own borrowing rate, so that the cost of holding low-return assets next to high-cost debt, which the literature on international reserves stresses (Rodrik 2006; Bianchi et al. 2018), does not arise. Actual fund laws, including Mongolia’s, lie between the poles, and Mongolia’s Human Development Fund rebated windfalls to households.
- (ii) *The spread sensitivity has not been measured for individual countries.* K&T do not estimate χ ; they use the coefficients of Kitano (2022), estimated on data ending in 2018, directly as values of χ . Their value for Mongolia, 0.3052, implies that a fall in commodity prices of 0.1 log point (about 10 percent) raises the annual borrowing rate by about 12 pp, more than the whole range of Mongolia’s sovereign spread since 2013. Studies of Mongolia show that commodity shocks move bank lending rates (Doojav and Luvsannyam 2019; Doojav et al. 2023), but they do not express the link in units a welfare analysis can use, and none asks whether spreads respond

- equally to booms and busts, although foreign direct investment (FDI) responds asymmetrically (Doojav and Juragat 2026).
- (iii) *The quantitative answer is for an average economy.* An average calibration cannot tell a government how it should divide its windfalls, and it hides which structural features make saving valuable. Mongolia’s net commodity exports relative to GDP are almost twice the five-country average, and its private external debt relative to GDP is about 19 times K&T’s value.
 - (iv) *Mongolia’s fund rules have not been evaluated in a structural model.* Estimated models of Mongolia (Doojav and Batmunkh 2018; Doojav and Gantumur 2023) do not include commodity-dependent spreads or fund rules, and assessments of the funds (Turgenbayar 2020; World Bank 2021) do not compare their welfare effects in general equilibrium.

Data and methodology.

We proceed in two steps. First, we build a quarterly commodity price index for Mongolia whose weights follow the changing composition of its exports (Fig. 1a), estimate the process it follows (Table 1), and measure the link between commodity prices and two borrowing premia: the spread on dollar bank loans (Table 2 and Fig. 1b) and a sovereign spread built from market yields on the government’s 11 dollar bonds (Table 3). The two spreads put χ at 0.0097 and 0.0141 in the model’s units, far below K&T’s value, and the sovereign spread rises more in busts than it falls in booms (Table 4). A vector autoregression (VAR) in eight variables shows that a commodity boom raises FDI, imports and inflation, lowers the spread and worsens the trade balance (Fig. 2); the model reproduces the fall of the trade balance at $\chi = 0.144$, a second, indirect and less precise estimate. Second, we calibrate K&T’s model to Mongolia (Table 5), generalise its fiscal rule so that any share of a windfall can be saved, invested or rebated, let the spread respond asymmetrically, and solve the model to second order. We compare the two poles (Table 6 and Fig. 3), trace the difference from K&T’s result to Mongolia’s structure (Table 7), find the best division of a windfall (Table 8 and Fig. 4), and evaluate rebates (Table 9) and an asymmetric spread link (Fig. 5). Because the first pole rests on the difference between what the fund earns and what the government pays, we then add public debt, a fund that earns less than the government pays and the option of retiring debt with windfalls (Table 10). Table 11 reports how the results change with the parameters of the calibration.

Contributions.

The paper makes four contributions, one for each gap. (1) It determines the welfare-maximising division of a windfall when spreads depend on commodity prices. Saving part of each windfall and investing the rest beats both poles at every value of χ ; the best saving share rises with χ , from about one half at the direct estimates to almost two-thirds at the trade-balance estimate; welfare is flat around the optimum, so that avoiding the poles matters more than the exact share; rebates are the worst rule at all our estimates; and an asymmetric link raises the value of saving. This adds a financial channel to the case of van der Ploeg and Venables (2011) for investing part of a windfall at home. When the fund earns the Secured Overnight Financing Rate

(SOFR), 1.9 pp less than the yield on the government’s bonds, and its return reaches households, more of a windfall should be saved, not less (80–84 percent); the saved part is then worth more retiring public debt than building the fund, unless the sovereign’s borrowing cost rises with its debt, in which case the fund is insurance that is worth its cost. (2) It provides country-specific estimates of the spread link from national data, a commodity price index with time-varying export weights and a new market-priced sovereign spread, bounds the plausible range of χ with direct and indirect estimates, and shows that the sovereign spread responds more to busts than to booms. (3) It shows that the gain from saving every windfall instead of investing every windfall, 0.078 to 0.434 percent of consumption across our estimates of χ , is at least five times the five-country gain at the same χ , and decomposes the difference into a larger commodity sector, a greater reliance on mineral revenue for public investment and, when spreads respond strongly, high private external debt, with a more persistent and volatile price cycle working the other way. (4) It evaluates Mongolia’s fund rules: the 65 percent saving share in the 2024 Law is close to optimal at the trade-balance estimate of χ and above the optimum at the direct estimates, at a small welfare cost, and rebates in the style of the Human Development Fund are the worst rule. The lessons apply to other commodity exporters that are moving from concessional to market finance.

Section 2 presents the model and maps Mongolia’s funds into it, Section 3 the empirical evidence, Section 4 the calibration and Section 5 the results. Section 6 concludes.

2 Model

The model is that of K&T, which builds on [Drechsel and Tenreyro \(2018\)](#) and the small open economy real-business-cycle literature ([Schmitt-Grohé and Uribe 2003](#); [Aguiar and Gopinath 2007](#); [García-Cicco et al. 2010](#)). We keep their notation and describe the main equations, with two generalisations: the fiscal rule allows partial saving and rebates, and the spread can respond asymmetrically to commodity prices. Section 2.5 adds public debt and a fund that earns less than the government pays.

2.1 Households and firms

A representative household has preferences of the form proposed by [Greenwood et al. \(1988\)](#) (GHH) over consumption C_t and labour in the final-goods and commodity sectors, N_t^f and N_t^c :

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

It owns the capital stock $K_t = K_t^f + K_t^c$, pays a lump-sum tax T_t^h and borrows abroad at rate r_t :

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

The interest rate combines the world rate r^* , a premium on aggregate debt $\tilde{D}_{t+1}$ and the effect of commodity prices:

$$r_t = r^* + \psi \left(e^{\kappa(\tilde{D}_{t+1} - D)} - 1 \right) - \chi x_t + \frac{\chi_2}{2} x_t^2, \quad x_t = \ln p_t^c - \ln p^c. \quad (3)$$

The debt-elastic premium ensures stationarity (Schmitt-Grohé and Uribe 2003). Because K&T write it in levels, its strength depends on the units of output; we therefore scale the debt deviation by κ , the ratio of steady-state output in K&T's calibration to that in ours, so that a change in debt worth 1 percent of GDP moves the premium equally in every calibration, and $\kappa = 1$ reproduces K&T exactly. A positive χ is the negative link between commodity prices and spreads. The curvature χ_2 is our addition: with $\chi_2 > 0$ the spread rises more when commodity prices fall than it falls when they rise. K&T's model has $\chi_2 = 0$, our benchmark; because the quadratic term has no first-order effect, a second-order solution is needed to capture it. With GHH preferences labour supply depends only on the wage, and the Euler equations for debt and capital are those of K&T.

Final goods are produced with private capital, labour, a commodity input M_t bought at the world price and public capital K_t^g ; commodities with private capital, labour and public capital:

$$\begin{aligned} Y_t^f &= a^f (K_t^f)^{\alpha_k} M_t^{\alpha_m} (N_t^f)^{1 - \alpha_k - \alpha_m} (K_t^g)^{\alpha_g}, \\ Y_t^c &= a^c (K_t^c)^{\alpha_k} (N_t^c)^{1 - \alpha_k} (K_t^g)^{\alpha_g}. \end{aligned} \quad (4)$$

Factors are paid their marginal products, and commodity firms' revenue is taxed at the rate τ^c .

2.2 Government and fiscal rules

The government collects commodity revenue $T_t^c = \tau^c p_t^c Y_t^c$ and the lump-sum tax, spends on consumption G_t^{con} and investment G_t^{inv} , and holds SWF assets F_t abroad that earn r^* :

$$\frac{F_{t+1}}{1 + r^*} + G_t^{inv} + G_t^{con} = F_t + T_t^h + T_t^c. \quad (5)$$

Public capital accumulates with adjustment costs, $K_{t+1}^g = [1 - \frac{\phi^G}{2} (G_t^{inv}/G_{t-1}^{inv} - 1)^2] G_t^{inv} + (1 - \delta^g) K_t^g$. The windfall is revenue above its steady-state level, $W_t = T_t^c - T^c$. The government saves a share s_F of it in the SWF, invests a share s_I in

public capital and rebates a share s_H to households, with $s_F + s_I + s_H = 1$:

$$\begin{aligned} G_t^{inv} &= G^{inv} + s_I W_t, & F_{t+1} &= F + \rho_F(F_t - F) + (1 + r^*)s_F W_t, \\ G_t^{con} &= T^h + \frac{1 + r^* - \rho_F}{1 + r^*}(F_t - F), & T_t^h &= T^h - s_H W_t. \end{aligned} \quad (6)$$

Variables without a time subscript are steady-state values, and τ^c is set so that the steady-state budget balances. K&T's SAYG rule is $s_I = 1$ and their SWF rule $s_F = 1$; in both the fund's extra return is spent on government consumption. The rebate rule is $s_H = 1$, and $s_F = 0.65$, $s_I = 0.35$ is the partial-saving rule implied by the 2024 Law. We set $\rho_F = 0.9999$, which removes the unit root that the SWF rule otherwise creates without affecting the results; the budget constraint holds for any ρ_F whenever the shares sum to one.

2.3 Equilibrium, shocks and welfare

GDP is $Y_t = Y_t^f + p_t^c Y_t^c - p_t^c M_t$, and the trade balance is GDP less private and public absorption. The log commodity price follows a second-order autoregressive (AR(2)) process, $\ln(p_t^c/p^c) = \rho_1 \ln(p_{t-1}^c/p^c) + \rho_2 \ln(p_{t-2}^c/p^c) + \epsilon_t$ with $\epsilon_t \sim N(0, \sigma_{p^c}^2)$. As in K&T, welfare under a rule is measured by the consumption equivalent ξ that equates expected lifetime utility, conditional on starting at the non-stochastic steady state, to that of a deterministic path with consumption $(1 + \xi)C$ and steady-state labour. The steady state is the same under all rules, so differences in ξ measure the welfare effect of the rule. Because first-order approximations can produce spurious welfare rankings (Kim and Kim 2003), we solve the model to second order (Schmitt-Grohé and Uribe 2004). The solver is written in R (R Core Team 2026): exact derivatives are obtained symbolically, the first-order solution uses the generalised Schur decomposition, and welfare includes the second-order constant term. It reproduces the coefficients of three models with known analytical solutions to machine precision.

2.4 Mongolia's resource funds and the fiscal rules

Mongolia has tried almost every type of resource fund. The Human Development Fund distributed mineral revenue to all citizens in cash and in kind in 2009–2016, at times beyond the revenue actually received, and the obligations it created were repaid only years later (Yeung and Howes 2015; Namkhajantsan and Mihalyi 2020); in the model it is the rebate rule. The Fiscal Stability Fund (2010) saves revenue earned when mineral prices are above their structural level. The Future Heritage Fund (FHF), created in 2016 (State Great Khural of Mongolia 2016), is a savings fund that invests only in assets traded abroad, may not spend before 2030 and then transfers 10 percent of its net investment income to the budget; it held about USD 1.5 billion in deposits and cash at the end of 2025 (Sovereign Wealth Fund of Mongolia 2026) and corresponds to the SWF rule. The 2024 Law (State Great Khural of Mongolia 2024) placed the FHF under an umbrella fund with a Savings Fund, which finances citizens' health, education and housing accounts much as a rebate does, and a Development Fund, which receives half of the extra revenue from prices above the budget reference price

when the structural budget balance is in surplus and finances development projects, much as SAYG does. At the margin, 65 percent of an increase in royalties goes to the FHF and the rest is available to the budget, so we use $s_F = 0.65$ as the legal benchmark. This is an approximation: the share applies to royalties net of the Fiscal Stability Fund and local-development allocations, royalties are only part of commodity revenue, and the FHF spends less of its return than the model assumes. In terms of the debate described in the Introduction, using mineral revenue at home as it arrives is the SAYG rule and keeping it in the fund is the SWF rule; the share s_F spans the choices between them.

2.5 An extension: public debt and the return on the fund

The first pole of the debate rests on a comparison that this model cannot make. Its fund earns r^* , the rate at which the country borrows in the steady state; its government has no debt; and the fund's return is spent on government consumption, which does not enter utility, so that households are indifferent to what the fund earns. In Section 5.6 we therefore change the model in four ways. First, the fund earns $r^F = r^* - \omega$, where $\omega \geq 0$ is the gap between the government's borrowing rate and the return on the fund. Second, the government has external debt B_t with one period to maturity, on which it pays the sovereign rate

$$r_t^g = r^* + \psi_g \left(e^{\kappa(B_{t+1}-B)} - 1 \right) - \chi_g x_t, \quad (7)$$

so that its budget constraint becomes

$$\frac{F_{t+1}}{1+r^F} + G_t^{inv} + G_t^{con} + B_t = F_t + T_t^h + T_t^c + \frac{B_{t+1}}{1+r_t^g}. \quad (8)$$

Third, a share s_B of the windfall retires public debt, $B_{t+1} = B + \rho_B(B_t - B) - (1 + r^*)s_B W_t$ with $\rho_B = \rho_F$, and $s_F + s_I + s_H + s_B = 1$. Like the rule for the fund, this rule is symmetric: debt is retired when revenue is above its steady-state level and issued when it is below. Fourth, the government's net financial income in deviation from the steady state,

$$N_t = \frac{1+r^F - \rho_F}{1+r^F} (F_t - F) + s_B W_t - \left(B_t - \frac{B_{t+1}}{1+r_t^g} - \frac{r^*}{1+r^*} B \right), \quad (9)$$

the payout of the fund less the service of the debt, lowers the lump-sum tax, $T_t^h = T^h - s_H W_t - N_t$, instead of raising government consumption, which stays at its steady-state level. Households and firms have the steady state of the benchmark model: in the steady-state budget, the interest on public debt and the lower return of the fund replace part of government consumption. With $\omega = 0$, $B = 0$ and N_t spent on government consumption the extended model is the benchmark model, and as long as N_t is spent on government consumption neither the return gap nor the debt affects households.

3 Empirical evidence

3.1 A commodity price index for Mongolia and its process

Following [Kitano \(2022\)](#) and K&T we measure the commodity price Mongolia faces by an export-weighted index of world prices. Monthly prices of coal (Australian), copper, gold, iron ore, zinc and crude oil are from the World Bank Pink Sheet ([World Bank 2026](#)), and the weights are the shares of the six commodities in Mongolia’s export value from the National Statistics Office (NSO; [National Statistics Office of Mongolia 2026](#)). These shares have changed too much for one set of weights to describe the price Mongolia faced in every year: coal made up 4 percent of the export value of the six commodities in 2005 and 66 percent in 2023, and copper 95 percent in 2000 and 20 percent in 2023. We therefore let the weights change every year. As in the time-varying indices of [Gruss and Kebhaj \(2019\)](#), the weights of a year are the average export shares of the three preceding years, so that they follow the composition of exports but do not depend on the prices of the year itself. The weight of coal rises from 2 percent in 2005 to 62 percent in 2025, and that of copper falls from 53 to 23 percent. The index is chain-linked: the monthly log changes of the six prices are weighted and cumulated. It is deflated by the US consumer price index ([Federal Reserve Bank of St. Louis 2026](#)) and averaged to quarters. It rose steeply in the 2000s, fell in 2008–09 and again in 2012–2016, and was highest in 2011 and in 2022, when coal prices surged. [Fig. 1a](#) plots the quarterly index, its trend and the fixed-weight version introduced next. As a robustness check we use the same index with fixed weights, the average export shares of 2010–2025 (coal 40.8 percent, copper 32.9, gold 9.2, iron ore 8.1, crude oil 6.2 and zinc 2.8); the cyclical components of the two indices have a correlation of 0.94. The NSO publishes its export price index only as percentage changes (on the previous month, the same month of the previous year and the end of the previous year); from 2021 to July 2026 the year-on-year change in our index has a correlation of 0.88 with it and 0.85 with its mineral-products component. Over these recent years the two sets of weights are close, and the fixed-weight index does about as well (0.87 and 0.84).

Table 1 reports AR(2) estimates on the cyclical component of the log real index. On the benchmark sample, 2005Q1–2026Q2 with the Hodrick–Prescott (HP) filter ([Hodrick and Prescott 1997](#)), $\rho_1 = 1.2543$, $\rho_2 = -0.4956$ and $\sigma_{p^c} = 0.0819$. Compared with K&T’s five-country average, Mongolia’s price cycle is more hump-shaped, more persistent ($\rho_1 + \rho_2 = 0.759$ against 0.692) and more volatile, reflecting the heavy weight of coal and copper, whose prices overshot in 2008, 2011 and 2021–22. With fixed weights the process is similar, with a somewhat larger shock ($\rho_1 = 1.2369$, $\rho_2 = -0.5054$, $\sigma_{p^c} = 0.0868$).

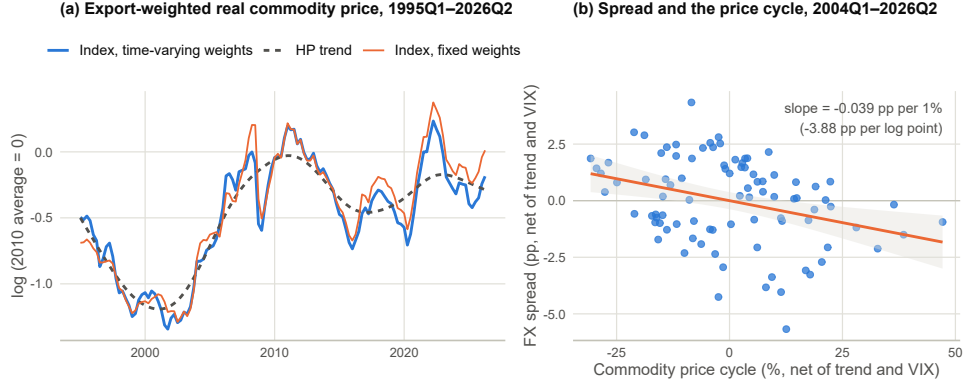


Fig. 1 Mongolia’s commodity price and the lending spread. *Notes:* (a) Log of the export-weighted real commodity price index with time-varying weights (2010 average = 0), its Hodrick–Prescott (HP) trend ($\lambda = 1600$) and the same index with fixed weights. (b) Partial regression plot of Table 2, specification (2): the dollar lending spread and the cyclical component of the log real commodity price, both after removing a linear trend and the Chicago Board Options Exchange Volatility Index (VIX), with the ordinary least squares fit and a 95 percent band

Table 1 AR(2) estimates of the commodity price process

Detrending, sample	ρ_1	ρ_2	σ	$\rho_1 + \rho_2$	N
HP cycle, 2005Q1–2026Q2	1.254 (0.096)	−0.496 (0.096)	0.0819	0.759	84
Linear detrended, 2005Q1–2026Q2	1.343 (0.096)	−0.480 (0.094)	0.0869	0.863	84
HP cycle, 1995Q1–2026Q2	1.227 (0.080)	−0.473 (0.080)	0.0764	0.753	124
Linear detrended, 1995Q1–2026Q2	1.387 (0.081)	−0.450 (0.080)	0.0846	0.938	124
Fixed weights, HP cycle, 2005Q1–2026Q2	1.237 (0.096)	−0.505 (0.096)	0.0868	0.731	84
K&T (2023), five-country average	1.181	−0.489	0.0733	0.692	–

Notes: $\ln(p_t^c/p^c) = \rho_1 \ln(p_{t-1}^c/p^c) + \rho_2 \ln(p_{t-2}^c/p^c) + \epsilon_t$, estimated by ordinary least squares on the cyclical component of the log real export-weighted commodity price. The weights of the index are the average export shares of the three preceding years (the trade data start in 1995, so the weights of 1995 are that year’s own shares and those of 1996 and 1997 use the years available), except in the row with fixed weights (average shares of 2010–2025). Standard errors in parentheses. The first row is the benchmark. K&T’s average is from their Table 2.

3.2 Commodity prices and the interest spreads

Our first measure of the borrowing premium is the spread between the average rate on banks’ foreign-currency loans and the US 3-month Treasury bill rate (National Statistics Office of Mongolia 2026; Federal Reserve Bank of St. Louis 2026). It reflects the cost of dollar funding for Mongolian banks and firms and avoids the inflation and devaluation premia in tugrik rates. Over 2004Q1–2026Q2 it averaged 10.9 pp and ranged from 4.5 to 19.8 pp. Table 2 regresses it on the commodity price with Newey–West standard errors (Newey and West 1987). Mongolia is a price taker in world commodity

markets, so we treat the commodity price as exogenous to its spread; because the two-sided HP filter uses future prices, the regressions measure co-movement over the cycle, which is what χ captures, not a forecasting relationship. In every specification a higher commodity price lowers the spread. In our benchmark, specification (2), which uses the HP cycle of the price and controls for a trend and global risk aversion, measured by the Chicago Board Options Exchange Volatility Index (VIX), a 1 log point rise of the price above trend lowers the spread by 3.88 pp (standard error 1.22, $p = 0.002$; Fig. 1b). The effect on the tugrik spread is larger. In first differences the coefficient is about half as large and significant only at the 10 percent level ($p = 0.06$), consistent with the weak and slow pass-through to Mongolian bank lending rates (Doojav and Kalirajan 2016), and the long-run effect in the dynamic specification, $\chi = 0.0182$, is about twice the static estimate. With fixed export weights the benchmark coefficient is 2.68 pp ($p = 0.008$), about two-thirds of the estimate with time-varying weights, as one would expect if weights that do not match the exports of the time add noise to the index.

Table 2 Commodity prices and the dollar lending spread

Specification	Coef. (pp)	NW s.e.	p	χ (annual)	χ (model)	N
(1) FX spread; log price level, trend	-1.68	1.02	0.105	0.0168	0.0042	90
(2) FX spread; HP price cycle, trend, VIX	-3.88***	1.22	0.002	0.0388	0.0097	90
(3) FX spread; first differences, VIX	-2.01*	1.06	0.061	0.0201	0.0050	89
(4) MNT spread; HP price cycle, trend, VIX	-7.13***	2.25	0.002	0.0713	0.0178	90
(5) FX spread; dynamic, long run	-1.30***	0.45	0.005	0.0727	0.0182	89
(2) with fixed export weights	-2.68***	0.98	0.008	0.0268	0.0067	90

Notes: Quarterly data, 2004Q1–2026Q2. FX: foreign currency; MNT: Mongolian tugrik. Dependent variable: average rate on foreign-currency (1–3, 5) or tugrik (4) bank loans minus the US 3-month Treasury bill rate, pp per year. Regressor: log real export-weighted commodity price (level in 1, HP cycle in 2, 4, 5, first difference in 3). NW s.e.: Newey–West standard errors with 4 lags. χ (annual) = $-\text{Coef.}/100$; χ (model) = $-\text{Coef.}/400$. In specification 5 both χ columns are long-run effects, computed with $\text{Coef.}/(1 - \text{coefficient on the lagged spread})$ in place of Coef. The last row repeats specification (2) with the fixed-weight index. *, **, ***: significant at 10, 5 and 1 percent.

The second measure is a sovereign spread. Since the Chinggis bonds of December 2012 the government has issued 11 dollar bonds in international markets. We take their daily mid yields to maturity, subtract the US Treasury yield at the same remaining maturity, interpolated between constant-maturity yields (Federal Reserve Bank of St. Louis 2026), and average across the bonds with at least a year to maturity. Over 2013Q1–2026Q2 the spread averaged 4.2 pp. It peaked at 9.3 pp in 2016Q1, when commodity prices bottomed, at 8.0 pp in 2020Q2 and at 7.7 pp in 2022Q4, and fell to 1.6 pp by 2026Q2. Its correlation with the lending spread is 0.55.

Table 3 repeats specification (2) with the sovereign spread. We exclude 2022 from the benchmark because in that year the world price index overstates the windfall Mongolia received: our index rose by 42 percent, driven by a 150 percent rise in the Australian coal price during the European energy crisis, whereas the NSO’s export price index rose by only 22 percent; at the same time the spread widened as US rates rose and foreign reserves fell. In the benchmark, specification (6), a 1 log point rise of

the price above trend lowers the sovereign spread by 5.63 pp ($p = 0.002$). With 2022 included the coefficient shrinks to -2.15 and is insignificant ($p = 0.22$). Controlling for the US Baa corporate spread also makes it insignificant ($p = 0.16$); that spread itself moves with world commodity prices and global risk, so the data cannot tell Mongolia’s own commodity link apart from the global credit cycle, a difficulty also found by [Doojav et al. \(2023\)](#). Over the same quarters the lending-spread coefficient is small and insignificant, so after 2013 the market-priced spread is the more sensitive. With fixed export weights the benchmark coefficient is 5.33 pp ($p = 0.002$).

Table 3 Commodity prices and the sovereign spread

Specification	Coef. (pp)	NW s.e.	p	χ (annual)	χ (model)	N
(6) Sovereign spread; HP price cycle, trend, VIX	-5.63^{***}	1.70	0.002	0.0563	0.0141	50
(7) Sovereign spread; as (6), including 2022	-2.15	1.74	0.221	0.0215	0.0054	54
(8) Sovereign spread; as (6), to 2021Q4	-6.55^{***}	2.21	0.006	0.0655	0.0164	36
(9) Sovereign spread; as (6), US Baa spread	-2.65	1.86	0.160	0.0265	0.0066	50
(10) FX lending spread; as (6), same quarters	-1.57	1.21	0.199	0.0157	0.0039	50
(6) with fixed export weights	-5.33^{***}	1.58	0.002	0.0533	0.0133	50

Notes: Quarterly data, 2013Q1–2026Q2, excluding 2022 except in (7). Dependent variable: average spread of Mongolian government dollar bonds over US Treasuries at the same remaining maturity (6–9) or the dollar lending spread (10). All specifications include a linear trend and the VIX; (9) adds Moody’s Baa corporate spread. The last row repeats specification (6) with the fixed-weight index. Other notes as in Table 2.

In the model χ is the change in the *quarterly* interest rate per log point of the commodity price, so our estimates are the coefficients divided by -400 : $\chi = 0.0097$ for the lending spread and $\chi = 0.0141$ for the sovereign spread. K&T use the coefficients of [Kitano \(2022\)](#) directly as values of χ ; their value for Mongolia, 0.3052, means that a fall in commodity prices of 0.1 log point (about 10 percent) raises the annual borrowing rate by about 12 pp, whereas Mongolia’s sovereign spread ranged from 1.6 to 9.3 pp over 2013–2026. The most commodity-sensitive credit, however, may be intercompany and project lending to mining companies, which has no market price, so we report results over K&T’s full range $0 \leq \chi \leq 0.4$.

3.3 Booms and busts

Commodity prices affect FDI in Mongolia asymmetrically, with falls mattering more than rises ([Doojav and Juragat 2026](#)). Table 4 allows the spreads to respond differently to booms and busts. The sovereign spread falls by an insignificant 2.30 pp per log point when prices are above trend ($p = 0.27$) but rises by 7.87 pp per log point when they are below it ($p = 0.002$). With separate slopes the difference is not estimated precisely: equal slopes are rejected only when 2022 is included ($p = 0.001$, against $p = 0.113$ without 2022). A quadratic in the price cycle is sharper. Its linear term is -4.34 and its squared term 18.22, both significant at the 1 percent level, so the fitted spread moves by no more than 0.26 pp when prices are up to 23 log points above trend, but is 4.2 pp higher when they are 37 log points below it. Both terms remain significant with 2022 included. In the model’s units the estimates correspond to a slope

at trend of $\chi = 0.0108$ and a curvature of $\chi_2 = 0.091$. With fixed export weights the asymmetry is stronger: the slopes are -0.38 above and -8.66 below trend, and equal slopes are rejected ($p = 0.029$). The lending spread shows no asymmetry.

Table 4 Booms and busts: asymmetric responses of the spreads to commodity prices

	Sovereign spread, excl. 2022	Sovereign spread, all quarters	FX lending spread, 2004Q1–2026Q2
<i>Piecewise</i>			
Price above trend	−2.30 (2.05)	3.53* (1.92)	−4.77* (2.80)
Price below trend	−7.87*** (2.43)	−8.36*** (2.63)	−2.94 (2.41)
p , equal slopes	0.113	0.001	0.692
<i>Quadratic</i>			
Price cycle, x	−4.34*** (1.25)	−2.90** (1.35)	−3.88*** (1.21)
Price cycle squared, x^2	18.22*** (4.89)	21.79*** (5.36)	0.46 (6.36)
Implied χ (model)	0.0108	0.0072	0.0097
Implied χ_2 (model)	0.091	0.109	0.002
N	50	54	90

Notes: Coefficients in pp per year per log point of the commodity price cycle x ; Newey–West standard errors in parentheses. All regressions include a linear trend and the VIX. Piecewise: separate slopes for $x > 0$ and $x < 0$. Quadratic: spread = $b_1x + b_2x^2 + \dots$, so that $\chi = -b_1/400$ and $\chi_2 = b_2/200$. *, **, ***: significant at 10, 5 and 1 percent.

3.4 VAR evidence

We estimate a quarterly VAR with two lags (Sims 1980) over 2009Q1–2026Q2 (70 quarters). It contains the four variables that the model explains, the commodity price cycle, the dollar lending spread, the GDP cycle and the balance of trade in goods and services (percent of GDP), and four that describe how a commodity price shock is transmitted in Mongolia: goods imports and FDI inflows from the balance of payments (both in percent of GDP), the quarterly change of the tugrik’s exchange rate against the dollar, and consumer price inflation over four quarters (National Statistics Office of Mongolia 2026). Following Kitano (2022), commodity price shocks are identified by a Cholesky decomposition with the price ordered first: for a small economy, world prices are exogenous within the quarter, and the responses to this shock do not depend on the order of the other variables. Fig. 2 shows the responses to a one-standard-deviation shock, which raises the price by 6.6 percent: the spread falls gradually, by up to 0.34 pp after 4 quarters, and real GDP rises by up to 0.49 percent after 6 quarters. The boom brings capital inflows and imports: FDI inflows rise by up to 4.5 percent of GDP after 2 quarters and goods imports by 1.27 percent of GDP on impact and 1.87 percent in the next quarter, and inflation rises by up to 1.34 pp after 3 quarters. The tugrik does not appreciate: it depreciates by 0.54 percent in the quarter of the shock, and its later responses are not significant. The trade balance falls by 2.22 percent of GDP on impact and stays more than 1 percent of GDP lower for the next six quarters.

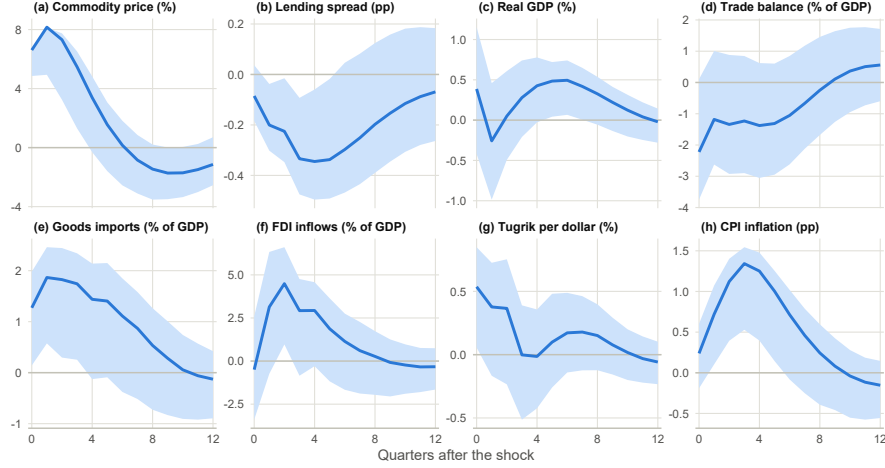


Fig. 2 VAR responses to a commodity price shock. *Notes:* Responses to a one-standard-deviation commodity price shock, identified by a Cholesky decomposition with the commodity price ordered first. VAR(2) in the commodity price cycle, the dollar lending spread, the GDP cycle, the trade balance, goods imports and inflows of foreign direct investment (FDI) in percent of GDP, the quarterly change of the tugrik's exchange rate against the dollar (a rise is a depreciation) and consumer price index (CPI) inflation over four quarters, 2009Q1–2026Q2. Panels (a) and (c) are percent deviations from trend. Shaded areas: 90 percent bootstrap bands (1,000 replications)

The counter-cyclical trade balance is the pattern [Drechsel and Tenreyro \(2018\)](#) explain with the spread link, and [Kitano \(2022\)](#) finds it only in Asian exporters whose spreads respond to commodity prices. It is not estimated precisely, however. The 90 percent band of the impact response, from -3.75 to 0.11 percent of GDP, includes zero by a small margin, as do the bands at later horizons, and the response depends on the specification: the fall is 2.72 percent of GDP (band -4.40 to -0.47) in a VAR of the first four variables alone, 1.66 percent with one lag, the choice of the Schwarz and Hannan–Quinn criteria, 1.40 percent with an impulse dummy for each quarter of 2022, and 1.00 percent when the exchange rate enters as an HP cycle instead of a growth rate. On impact, moreover, neither the spread nor GDP has moved significantly, whereas imports have, so the fall also reflects channels other than the spread, such as import prices that move with world commodity prices. With the sovereign spread in place of the lending spread, in a VAR of the first four variables over 2013–2026 with 2022 dummied out (the sample is too short for the larger system), the spread falls by 0.41 pp on impact, as a market price should, and the trade balance falls by a smaller and insignificant 0.95 percent of GDP.

4 Calibration

We calibrate the model twice: once to reproduce K&T, whose five-country averages serve as the benchmark, and once to Mongolia. Parameters that are not country-specific are set as in K&T. Table 5 compares the country-specific values. Net

commodity exports, measured as mineral exports less fuel imports, averaged 38.8 percent of GDP in 2010–2025, almost twice K&T’s average. Government consumption (13.9 percent of GDP) and budget capital expenditure (7.6 percent) are also higher. The discount factor, 0.9774, matches the average real tugrik lending rate of 9.25 percent a year; like K&T, we read the domestic real rate as the rate at which households discount the future. Private external debt, that of banks and other sectors, was USD 12.2 billion at the end of 2025, or 47 percent of annual GDP, about 19 times K&T’s value relative to GDP. This excludes government debt and intercompany lending related to FDI, the largest component of Mongolia’s gross external debt. The FHF’s USD 1.5 billion is 12.3 percent of that debt, or 5.7 percent of annual GDP.

Table 5 Calibration: K&T and Mongolia

	Description	K&T average	K&T Mongolia	This paper	Source (this paper)
β	Discount factor (quarterly)	0.9792	0.9659	0.9774	Real MNT lending rate, 2010–2025
TB^c/Y	Net commodity exports / GDP	0.2068	0.2086	0.3885	Mineral exports less fuel imports, 2010–2025
G^{con}/Y	Government consumption / GDP	0.1141	0.1291	0.1387	GDP by expenditure, 2010–2025
G^{inv}/Y	Government investment / GDP	0.0506	0.0349	0.0762	Budget capital expenditure, 2010–2025
D/Y	Private external debt / quarterly GDP	0.1000	–	1.8698	Banks and other sectors, 2025Q4 (0.467 of annual GDP)
F/D	SWF assets / private external debt	0.3498	0.2214	0.1229	FHF USD 1.5 bn / private debt USD 12.2 bn
ρ_1	AR(2) coefficient	1.1814	1.3120	1.2543	Table 1, HP cycle, 2005Q1–2026Q2
ρ_2	AR(2) coefficient	–0.4895	–0.6920	–0.4956	Table 1
σ_{p^c}	s.d. of commodity price shock	0.0733	0.0748	0.0819	Table 1
χ	Spread sensitivity to commodity prices	0–0.4	0.3052	0.0097	Table 2, specification (2)
ϕ^G	Public investment adjustment cost	2.06	–	2.147	Equal SWF and SAYG welfare at $\chi = 0$

Notes: K&T values from [Kitano and Takaku \(2023, Tables 2 and 3\)](#). Mongolian values from NSO data unless stated; the last column gives the source. D/Y : private external debt (banks and other sectors) over quarterly GDP, 2025Q4. F/D : FHF assets over that debt. ϕ^G : set so that the SWF and SAYG yield equal welfare at $\chi = 0$ in K&T’s calibration.

K&T choose the adjustment cost of public investment so that the SWF and SAYG yield the same welfare when $\chi = 0$; the gain at $\chi > 0$ then isolates the role of the spread. Our solver gives $\phi^G = 2.147$ in their calibration (K&T report 2.06), and we use the same value for Mongolia. The Mongolian gain at $\chi = 0$ is therefore not zero: it measures how Mongolia’s structure alone changes the ranking of the rules. The commodity tax rate that balances the budget is 0.169 in Mongolia against 0.202 in K&T’s calibration.

The extension of Section 2.5 needs three more numbers. Because the FHF holds its assets in deposits and cash, we assume that the fund earns SOFR, the benchmark overnight dollar rate ([Federal Reserve Bank of St. Louis 2026](#)), and that the government pays the average yield on its dollar bonds with at least a year to maturity, the

bonds of the sovereign spread. The gap between the two has varied widely, and we take its recent level as a forward-looking value: over 2024Q1–2026Q2 the yield averaged 6.4 percent and SOFR 4.5 percent, so that the return gap is $\omega = 1.9$ pp a year. The gap was larger in earlier years. Over all the quarters for which SOFR is published, 2018Q2–2026Q2, it averaged 3.5 pp, and over 2013Q1–2026Q2 it is 4.7 pp if the effective federal funds rate, which has differed from SOFR by less than 0.01 pp on average since 2018, stands in for SOFR before 2018; Section 5.6 reports results for both. Public debt is the external debt of the general government at the end of 2025, USD 8.8 billion or 34 percent of GDP; the model prices all of it at the sovereign rate, although part of it is concessional. The sensitivity of the sovereign rate to commodity prices is the sovereign-spread estimate, $\chi_g = 0.0141$, whatever the value of χ for private borrowers, and unless stated the sovereign rate does not depend on the amount of public debt ($\psi_g = 0$).

5 Results

We first show how the spread link changes a commodity boom and what value of χ the trade balance implies (Section 5.1), and compare the two poles of the debate, saving every windfall and investing every windfall (Section 5.2). Section 5.3 then lets the government divide a windfall in any proportion and gives the main result of the paper. The remaining sections consider rebates to households, the asymmetric spread link, the low return of the fund next to the cost of public debt (Section 5.6) and robustness.

5.1 How the spread link shapes a commodity boom

Under K&T’s calibration our solver reproduces their main result: the SWF’s advantage rises with χ at an increasing rate, to 0.115 percent of steady-state consumption at $\chi = 0.2$ and 0.309 percent at $\chi = 0.4$, against about 0.10 and 0.28 in K&T. In the Mongolian calibration a one-standard-deviation positive commodity price shock raises GDP by 5.5 percent on impact whatever χ is, because capital is predetermined and labour supply depends only on the wage (model GDP values commodity output at current prices, so this response is not comparable with real GDP in the VAR). What χ changes is the composition of demand. With $\chi = 0$ part of the boom is saved abroad and the trade balance improves by 0.7 percent of GDP. With a positive χ the boom also lowers the borrowing rate, households borrow to consume and invest, and the trade balance turns counter-cyclical once χ exceeds 0.029 (−1.7 percent of GDP at $\chi = 0.1$). The spread link turns a commodity boom into a credit boom and a bust into a credit crunch. Under SAYG the windfall also raises public investment, so total investment rises more and the trade balance falls further than under the SWF, which absorbs part of the windfall abroad.

This gives a second, indirect estimate of χ . At the lending-rate estimate the model predicts a trade surplus on impact (0.5 percent of GDP), whereas the VAR shows a deficit of 2.22 percent. Scaling the model’s shock to the VAR’s, the model under SAYG matches the VAR’s impact response at $\chi = 0.144$, about half of K&T’s value for Mongolia and 10 to 15 times the direct estimates. The estimate inherits the imprecision of the VAR: the 90 percent band of the response maps into $\chi \in [0.024, 0.223]$, the

variants of the VAR in Section 3.4 give values between 0.09 and 0.17, and the sovereign-spread VAR gives 0.080. Two explanations of the distance from the direct estimates are plausible and not mutually exclusive: the spreads we observe may understate the cost of the credit that finances the boom, much of which is unpriced lending to mining companies, and part of the trade-balance response may come from channels outside the model, such as the imports that accompany FDI, which would make the indirect estimate too high. We treat the direct estimates as the low end of the plausible range and the trade-balance estimate as a high but plausible value.

5.2 The two poles: saving everything or investing everything

Table 6 and Fig. 3 compare the two poles of the debate: the SWF rule, which saves every windfall, and SAYG, which invests every windfall. The gain of the SWF over SAYG rises with χ in the Mongolian calibration too, from 0.056 percent of consumption at $\chi = 0$ to 1.378 percent at $\chi = 0.4$, and it is larger than in K&T’s average economy at every χ , by a factor of 4.8 at $\chi = 0.3$ and of 5.8 at the trade-balance estimate. Which pole is better, and by how much, depends heavily on the estimate of χ one believes: at the lending-rate estimate the gain is 0.078 percent, at the sovereign-spread estimate 0.089 percent, at the trade-balance estimate 0.434 percent and at K&T’s value for Mongolia 0.983 percent. At the direct estimates most of the gain comes from Mongolia’s structure rather than from the spread link, and it is small enough for its sign to depend on parameters that are not well known (Section 5.7). A gain of 0.434 percent of consumption every year, in contrast, is large by the standards of business-cycle welfare calculations (Lucas 1987), and it is obtained only by changing how windfalls are used, not their size.

Table 6 Welfare gain of the SWF over SAYG (percent of steady-state consumption)

χ	K&T calibration	Mongolian calibration
0	0.000	0.056
0.0097 (lending-rate estimate)	0.004	0.078
0.0141 (sovereign-spread estimate)	0.006	0.089
0.1	0.048	0.308
0.2	0.115	0.609
0.3	0.201	0.963
0.4	0.309	1.378
0.144 (trade-balance match)	0.075	0.434
0.3052 (K&T value for Mongolia)	–	0.983

Notes: χ in model units (change in the quarterly interest rate per log point of the commodity price).

Table 7 moves from K&T’s calibration to Mongolia’s one block of parameters at a time. Mongolia’s discount factor hardly matters. Its more persistent and volatile price cycle *lowers* the gain, to -0.323 at the lending-rate χ : when booms last longer, public

capital built during a boom is still in place while prices are high, and a smoother windfall means lower adjustment costs of public investment, both of which favour SAYG. Its larger commodity share raises the gain (to 0.061; 0.324 at $\chi = 0.3$), because a larger commodity sector makes income and, through the spread, borrowing costs more exposed to the price. Its higher public investment, financed in the model by the commodity tax, raises the size of windfalls relative to GDP and the gain (0.129). Its high private external debt and a fund that is small relative to it lower the gain when χ is small (0.078) but raise it sharply when χ is large, from 0.478 to 0.963 at $\chi = 0.3$: with debt of 47 percent of GDP, swings in the borrowing rate have large income effects, and the SWF dampens the credit boom that SAYG feeds.

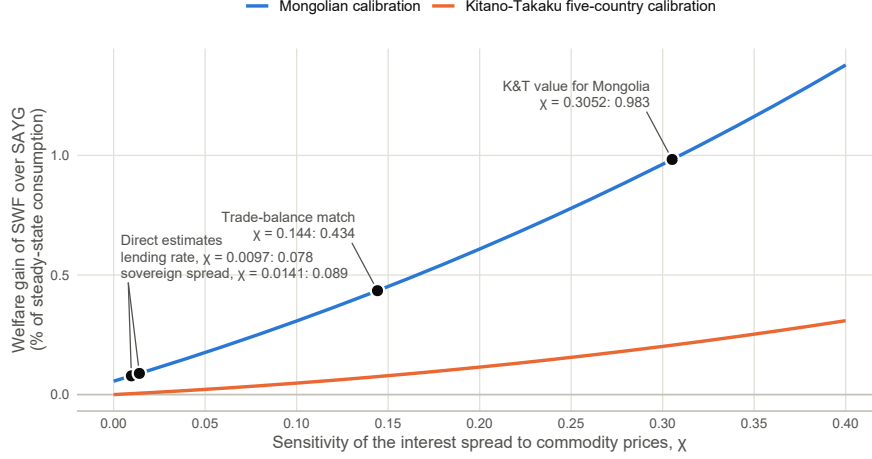


Fig. 3 Welfare gain of the SWF over SAYG as a function of χ . *Notes:* Difference between the consumption-equivalent welfare under the SWF and under SAYG, percent of steady-state consumption. Markers: lending-rate and sovereign-spread estimates of χ , the trade-balance match and K&T's value for Mongolia

Table 7 From K&T's calibration to Mongolia: welfare gain of the SWF over SAYG

Cumulative change of calibration	$\chi = 0$	$\chi = 0.0097$	$\chi = 0.3$
K&T average	0.000	0.004	0.201
+ discount factor	0.003	0.007	0.193
+ commodity price process	-0.328	-0.323	0.050
+ commodity share (TB^c/Y)	0.060	0.061	0.324
+ government spending shares	0.126	0.129	0.478
+ external debt and SWF (D/Y , F/D)	0.056	0.078	0.963

Notes: Each row adds the Mongolian values of the parameters named to those of the previous row, starting from K&T's five-country calibration. Percent of steady-state consumption.

5.3 How much of a windfall to save

The comparison of the poles leaves out the rules that matter in practice: the 2024 Law saves 65 percent of royalties, not all or nothing. Table 8 and Fig. 4 let the government save a share s_F of each windfall and invest the rest, and show that a mix does better than either pole at every χ . At the lending-rate χ , saving half the windfall and investing the other half gains 0.372 percent of consumption over SAYG, against 0.078 percent for the pure SWF, and the 65 percent rule gains 0.344 percent. Moving from either pole to an even split is thus worth several times as much as moving from one pole to the other. Because the adjustment cost of public investment is quadratic in its growth rate, investing a third of the windfall costs about a ninth as much as investing all of it, yet keeps much of the benefit of building public capital when commodity revenue is high.

Table 8 Welfare gain of partial-saving rules over SAYG

Share saved s_F (rest: public investment)	$\chi = 0.0097$	$\chi = 0.1$	$\chi = 0.3$
0% (SAYG)	0.000	0.000	0.000
25%	0.283	0.348	0.539
50%	0.372	0.497	0.860
65% (SWF Law)	0.344	0.503	0.961
75%	0.295	0.475	0.993
100% (pure SWF)	0.078	0.308	0.963

Notes: Percent of steady-state consumption. The rest of the windfall, $1 - s_F$, is spent on public investment.

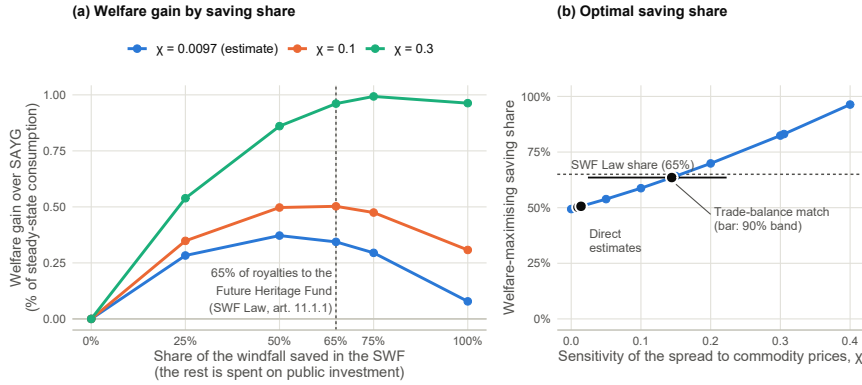


Fig. 4 Partial saving: welfare gain over SAYG and the welfare-maximising saving share. *Notes:* Rules with saving share s_F and public investment share $1 - s_F$. (a) Welfare gain over SAYG, percent of steady-state consumption. (b) Share that maximises welfare for each χ ; black markers: the two direct estimates of χ and the trade-balance match; bar: the 90 percent band of the trade-balance χ

The welfare-maximising share rises with χ (Fig. 4b), from 49 percent at $\chi = 0$ and 50 percent at the lending-rate χ to 59 percent at $\chi = 0.1$ and 82 percent at $\chi = 0.3$: the stronger the spread link, the more of the windfall should be kept out of the domestic economy. At the sovereign-spread estimate the best share is 51 percent, and at the trade-balance estimate 64 percent (52–73 percent over that estimate’s band and 57–67 percent across the variants of the VAR). Over the whole range of our estimates the answer to the question of how much to save therefore lies between about one half and two-thirds, and the 65 percent share in the Law is at the upper end of this range. At the direct estimates the Law saves more than is optimal, but the loss is small (0.351 against 0.378 at the sovereign-spread χ). Welfare is flat around the optimum: at the lending-rate χ , saving a quarter or three quarters of the windfall gains 0.283 and 0.295 percent, most of the 0.372 percent of the best share, whereas the two poles gain nothing and 0.078 percent. Avoiding the poles matters more than choosing the exact share.

5.4 Rebates to households

Rebating windfalls to households, as the Human Development Fund did, is a third way of using a windfall; Table 9 compares it with SAYG and the SWF. Without a spread link the rebate is about as good as SAYG (0.009 percent better at $\chi = 0$): households can save the windfall themselves by paying down debt at an almost constant interest rate, and they avoid the adjustment costs of public investment. When spreads fall in booms, however, rebates add to household income just when credit is cheap and so amplify the credit boom. The rebate falls behind SAYG once χ exceeds 0.003, which is below our direct estimates, and it is behind the pure SWF at every χ . At the lending-rate estimate it is worse than SAYG by 0.026 percent, at $\chi = 0.1$ by 0.338 percent and at $\chi = 0.3$ by 0.990 percent. At all our estimates of χ it is the worst of the rules we consider.

Table 9 Rebate rule: welfare comparisons

χ	SWF vs SAYG	Rebate vs SAYG	SWF vs rebate
0.0	0.056	0.009	0.047
0.0097	0.078	−0.026	0.104
0.0141	0.089	−0.041	0.130
0.1	0.308	−0.338	0.645
0.2	0.609	−0.668	1.277
0.3	0.963	−0.990	1.953
0.4	1.378	−1.308	2.686

Notes: Percent of steady-state consumption. Rebate: $s_H = 1$, the windfall is returned to households as a lump-sum transfer. Positive numbers favour the first rule named.

5.5 An asymmetric spread link

We next add the estimated curvature, $\chi = 0.0108$ and $\chi_2 = 0.091$. Fig. 5a shows the responses to a boom and a bust of one standard deviation: after the boom the spread falls by at most 0.41 pp, and after the bust it rises by up to 0.73 pp. The asymmetry makes saving more valuable: the gain of the SWF over SAYG rises from 0.081 to 0.161 percent of consumption, and adding the same curvature to any value of χ raises the gain by 0.06–0.08 pp (Fig. 5b); at the trade-balance estimate it becomes 0.508 percent. The mechanism works through averages. The curvature raises the average spread by 0.16–0.18 pp a year, which lowers average investment, output and commodity revenue. Under SAYG public investment falls with revenue, so average public capital declines by 0.3 percent and average consumption falls by 0.7 percent, against 0.5 percent under the SWF, where the fund absorbs the lower revenue and public capital is unchanged. The asymmetry also widens the lead of the SWF over the rebate, from 0.111 to 0.181 percent, and it raises the best saving share from 50 to 53 percent, which brings the 65 percent rule closer to the optimum (0.398 against 0.415). A symmetric spread link therefore understates how much of a windfall should be saved if, as the sovereign spread suggests, borrowing costs rise mainly in busts.

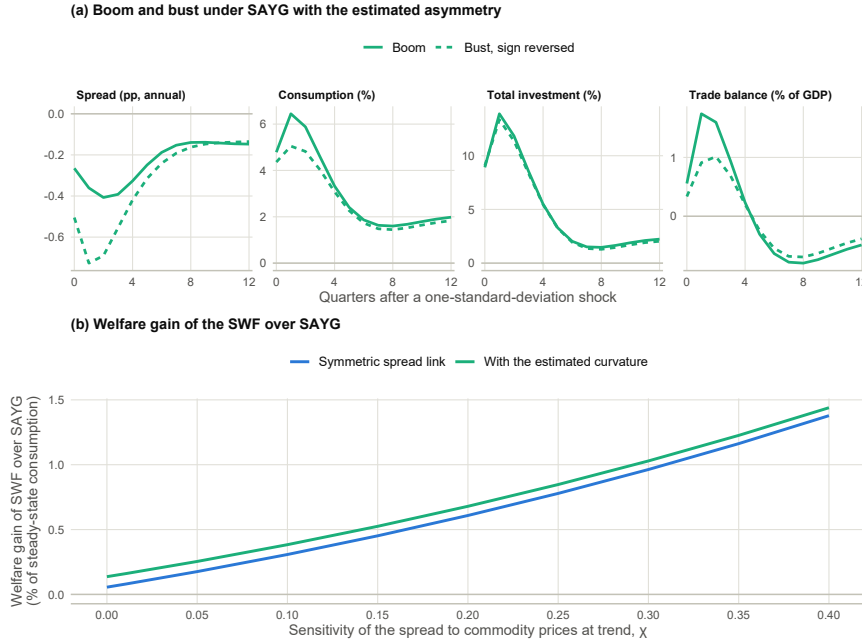


Fig. 5 An asymmetric spread link. *Notes:* (a) Second-order responses under SAYG to a one-standard-deviation boom and bust with $\chi = 0.0108$ and $\chi_2 = 0.091$; the response to the bust has its sign reversed. (b) Welfare gain of the SWF over SAYG without and with the estimated curvature; χ is the slope of the spread at trend

5.6 A low-return fund and high-cost public debt

The first pole of the debate argues from the return of the fund: it earns less than the government pays on its debt. The cost is easy to state. With the fund earning SOFR, on average 1.9 pp less than the government's bonds have yielded since 2024, holding the FHF's USD 1.5 billion while public debt of more than that amount is outstanding costs about USD 29 million a year, 0.11 percent of GDP. The benchmark model is silent on this cost, and in it the return of the fund does not matter at all: it is spent on government consumption, which households do not value, so that the fund is worth having only because it keeps windfalls out of the economy when credit is cheap. Table 10 reports the extended model of Section 2.5, in which what the fund earns and what the debt costs reach households. All gains are relative to investing every windfall, the SAYG rule.

Table 10 Public debt and the return on the fund: welfare gains over investing every windfall

	$\chi = 0.0097$	$\chi = 0.0141$	$\chi = 0.144$
<i>The whole windfall is</i>			
saved in the fund, no return gap	0.881	0.881	0.905
saved in the fund, gap of 1.9 pp	0.747	0.749	0.842
used to retire public debt	0.845	0.846	0.871
rebated to households	-0.074	-0.089	-0.528
<i>Best division</i>			
fund and investment: share saved	80	80	84
its gain	0.794	0.795	0.871
share saved without the gap	85	85	87
debt retirement and investment: share	84	84	85
its gain	0.877	0.877	0.897
65 percent in the fund, 35 invested	0.767	0.768	0.829
<i>The fund equals debt retirement if</i>			
the return gap is (pp a year)	0.5	0.5	1.1
the sovereign rate's χ_g is	0.047	0.047	0.024
10 percent of GDP of debt adds (pp)	0.16	0.16	0.04

Notes: Extended model of Section 2.5: the payout of the fund and the service of public debt reach households through the lump-sum tax; public debt is 34 percent of GDP and the sovereign rate has $\chi_g = 0.0141$ and $\psi_g = 0$; χ is the sensitivity of the private borrowing rate. The fund earns SOFR, 1.9 pp a year less than the yield on the government's dollar bonds (2024Q1–2026Q2). Gains in percent of steady-state consumption over the rule that invests every windfall. Shares in percent of the windfall; in the divisions the rest is invested. Last row: K&T's premium function applied to public debt; rise of the sovereign spread, in the second-order approximation, when debt rises by 10 percent of annual GDP.

Once households receive the return on what is saved, saving is worth more than in the benchmark, not less. Commodity revenue is convex in the price, so windfalls are positive on average (after ten years, 12 percent of steady-state commodity revenue), and a rule that saves them accumulates assets on average. Their return, which the benchmark model spends on government consumption, now lowers taxes. Saving every windfall in a fund without a return gap gains 0.881 percent of consumption at the lending-rate χ , against 0.078 percent in the benchmark, and the best division saves 85 percent of a windfall.

The low return is costly, but it does not reverse this result. With the gap of 1.9 pp the gain from saving every windfall in the fund falls to 0.747 percent at the lending-rate χ and 0.842 percent at the trade-balance χ , and the best share to save falls to 80 and 84 percent. These shares are still higher than in the benchmark (50 and 64 percent), and the 65 percent of the Law gains 0.767 percent, almost as much as the best division (0.794). The model thus gives no support to spending the money at home because the fund earns little.

What the low return does change is the best use of the money that is saved. Using every windfall to retire public debt, and issuing debt in busts, gains 0.845 percent, 0.098 percent of consumption more than the fund at the lending-rate χ and 0.029 more at the trade-balance χ . The best division gives 84 percent of a windfall to debt retirement and the rest to public investment, and moving part of it to the fund lowers welfare. In exchange for its low return the fund offers a return that does not move with commodity prices, whereas debt is retired when the sovereign rate is low and issued when it is high. At the measured sensitivity of the sovereign spread this advantage is worth a return gap of only 0.5 pp a year (1.1 pp at the trade-balance χ), less than the gap of 1.9 pp; for the fund to match debt retirement at the lending-rate χ , the sovereign rate would have to be 3.4 times as sensitive to commodity prices as we estimate ($\chi_g = 0.047$). This is the reasoning of [van der Ploeg and Venables \(2011\)](#), in whose model a capital-scarce country should repay debt before it accumulates a fund, and of the cost of reserves in [Rodrik \(2006\)](#).

This conclusion depends on the assumption that the government can borrow in a bust at a rate that depends on commodity prices but not on how much it borrows. If the sovereign rate rises with public debt as K&T assume for private debt ($\psi_g = \psi$, which in the second-order solution adds 3.9 pp to the spread when debt rises by 10 percent of GDP), the debt that builds up in a long bust becomes so expensive that using debt as the buffer is far worse than the fund, and worse than investing every windfall (−1.29 percent against 0.747). The curvature of this function matters more than its slope: with a premium that is linear in debt and has the same slope, debt retirement gains 0.747 percent at the lending-rate χ , as much as the fund, and 0.519 percent at the trade-balance χ , less than the fund. With K&T’s function the fund and debt retirement are equally good when new debt of 10 percent of GDP adds only 0.16 pp to the sovereign spread (0.04 pp at the trade-balance χ). We do not estimate this elasticity: public debt and the sovereign spread both rose in the bust of 2012–2016, and our data cannot separate the two effects. The low return of the fund is therefore best read as the premium of an insurance against costly borrowing in a bust, as in the literature on reserves and rollover risk ([Bianchi et al. 2018](#)). The premium is worth

paying if that risk is material; if the government can count on borrowing in a bust at spreads that reflect commodity prices alone, retiring debt is the better use of a windfall.

These results hold across eight variants of the extended model: the cost of varying public investment halved or raised by half, risk aversion of 1.5 or 3, a return gap of 3.5 pp (2018–2026) or 4.7 pp (2013–2026), no public debt, and only half of the net financial income reaching households. The best share saved in the fund lies between 61 and 87 percent at the lending-rate χ and between 69 and 94 percent at the trade-balance χ , and debt retirement gains more than the fund in every variant except risk aversion of 3 at the trade-balance χ . If half of the net financial income reaches households, the best share is 66 and 76 percent, between the benchmark and the extended model.

5.7 Robustness

Table 11 varies one parameter at a time around the Mongolian benchmark and reports the gain of the SWF over SAYG and the welfare-maximising saving share. The gain rises with χ in every case except a debt-elastic premium ten times larger, which discourages private borrowing so much that the spread link has little room to work. The level of the gain is sensitive to the parameters that govern the cost of volatile public investment and the curvature of utility. With ϕ^G halved SAYG is preferred at low χ (-0.521 at the lending-rate χ); with ϕ^G 50 percent higher the gain is 0.657. With $\gamma = 1.5$ SAYG is preferred at low χ (-0.130), but the SWF wins at $\chi \geq 0.1$. A higher output elasticity of public capital, a higher private investment adjustment cost and the higher commodity share of 2024 all raise the gain, and so does the price process of the fixed-weight index (0.149). In all cases except the strong-premium one, the gain at $\chi = 0.3$ lies between about 0.4 and 2.0 percent of consumption.

The division of the windfall is more robust than the ranking of the poles. In every case the best saving share lies strictly between the poles. At the lending-rate χ it is between 42 and 66 percent in all cases but one, and at the trade-balance χ between 46 and 84 percent; the exception is the case in which varying public investment costs half as much, where the best shares are 14 and 38 percent. The best share rises with the cost of varying public investment, with risk aversion and with the size of the commodity sector, and in every case except the strong premium it is higher at the trade-balance χ than at the lending-rate χ . With the price process of the fixed-weight index it is 52 and 65 percent. How much to save thus depends on parameters that are not well known, above all the cost of varying public investment; that a windfall should be divided does not.

Table 11 Sensitivity analysis: welfare gain of the SWF over SAYG and welfare-maximising saving share

Case	Gain at $\chi =$				Best share at $\chi =$	
	0	0.0097	0.1	0.3	0.0097	0.144
Benchmark (Mongolia)	0.056	0.078	0.308	0.963	50	64
Output elasticity of public capital 0.10	0.021	0.035	0.177	0.589	50	64
Output elasticity of public capital 0.17	0.078	0.104	0.372	1.134	50	64
Investment adjustment cost $\phi = 5$	-0.016	0.000	0.178	0.751	47	57
Investment adjustment cost $\phi = 13$	0.109	0.135	0.401	1.139	52	69
Risk aversion $\gamma = 1.5$	-0.145	-0.130	0.030	0.475	42	51
Risk aversion $\gamma = 3$	0.451	0.486	0.839	1.820	65	84
Debt-elastic premium $\psi = 0.01$	-0.009	-0.009	-0.023	-0.187	47	46
Public-investment adjustment cost $\times 0.5$	-0.545	-0.521	-0.275	0.404	14	38
Public-investment adjustment cost $\times 1.5$	0.636	0.657	0.870	1.503	65	74
External debt as in K&T ($D/Y = 0.1$)	0.139	0.142	0.195	0.497	51	53
Commodity share 2024 ($TB^c/Y = 0.52$)	0.347	0.371	0.608	1.260	66	84
Price process: linear detrending	-0.237	-0.192	0.297	1.964	42	58
Price process: fixed export weights	0.126	0.149	0.385	1.048	52	65

Notes: Gain: welfare gain of the SWF over SAYG, percent of steady-state consumption. Best share: the share of the windfall saved that maximises welfare when the rest is invested, in percent, at the lending-rate and the trade-balance estimate of χ . One parameter is changed at a time from the Mongolian benchmark; ϕ^G is kept at its benchmark value except in the two rows that change it.

6 Conclusion

This paper has asked how a commodity exporter whose borrowing costs move with commodity prices should divide a windfall between saving abroad and investing at home, and has answered the question for Mongolia, a commodity exporter that recently reached upper-middle income and whose debate on its fund is conducted between two poles. The answer depends on how strongly spreads respond to commodity prices, which we measure in three ways. Dollar lending spreads fall when a commodity price index with time-varying export weights rises, and so do the spreads on the government's dollar bonds once 2022, when world coal prices overstated Mongolia's export prices, is set aside. These direct measures put the spread sensitivity at 0.0097 and 0.0141 in model units, whereas the fall of the trade balance after a commodity price shock in a VAR points to a much stronger link, less precisely. Calibrated to Mongolia, the model implies that neither pole is optimal. The best rule saves about half of each

windfall at the direct estimates and almost two-thirds, close to the 65 percent in the 2024 Law, at the trade-balance estimate, and invests the rest in public capital; welfare is flat around the optimum, so that avoiding the poles matters more than the exact share. Between the poles, saving every windfall is better than investing every windfall by 0.078–0.089 percent of consumption at the direct estimates and by 0.434 percent at the trade-balance estimate, at least five times the gains in K&T’s five-country calibration at the same χ . The difference comes from Mongolia’s large commodity sector, its reliance on mineral revenue for public investment and, when spreads respond strongly, its high private external debt. The sovereign spread responds more to busts than to booms; with this asymmetry the gain at the direct estimates rises to 0.161 percent and the best saving share to 53 percent. Rebating windfalls to households, as the Human Development Fund did, is the worst option at all our estimates.

The first pole of the debate points to the low return of the fund, and the cost is real: earning SOFR, the fund has returned 1.9 pp a year less than the government’s dollar bonds have yielded since 2024, about USD 29 million a year at its present size. It is not, however, a reason to spend the money at home. When the return on what is saved reaches households, even a fund with this low return should receive 80–84 percent of a windfall, more than in the benchmark. What the low return changes is the best use of the money that is saved. If the government can borrow in a bust at spreads that depend on commodity prices alone, a windfall is worth more retiring public debt than building the fund. If borrowing becomes more expensive as debt builds up, the fund is the better buffer, and its low return is the premium of an insurance against costly borrowing in a bust.

The model is deliberately close to K&T’s so that the results can be compared with theirs. It has one final good and no exchange rate, monetary policy, liquidity-constrained households or Dutch disease, and public investment is fully efficient. In the extension public debt has one period to maturity and is all priced at the sovereign rate, the response of that rate to the amount of debt is not estimated, and there is no default or loss of market access, the risks against which a fund insures; windfalls are measured from steady-state revenue, so that the saving rules accumulate on average. Our measure of private external debt excludes intercompany lending to mining, so the debt exposed to the spread may be understated. The sovereign spread starts only in 2013, its link to commodity prices is not significant with 2022 included or with a control for the US corporate spread, and the asymmetry is a quadratic approximation estimated on 50 quarters. The response of the trade balance in the VAR, on which the higher estimate of the spread sensitivity rests, is sensitive to the specification. Three extensions would strengthen the conclusions: estimating the spread link jointly with the model, using an export price index built from Mongolia’s own export prices; adding long-term public debt with default risk, the exchange rate, monetary policy and liquidity-constrained households, as in the estimated models of [Doojav and Batmunkh \(2018\)](#) and [Doojav and Gantumur \(2023\)](#); and linking the model’s fund to the accumulation path of the FHF under the law. The main lesson is unlikely to change. For an upper-middle-income commodity exporter whose borrowing costs rise when commodity prices fall, neither spending every windfall at home nor locking all of it away is the best rule. At least half of each windfall should be kept out of the domestic

economy, and more if spreads respond strongly or if households receive what the saved money earns; the rest should be invested steadily at home; and whether the saved part should repay public debt or build the fund depends on how costly borrowing becomes in a bust.

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- **Data availability:** The data from the National Statistics Office of Mongolia (www.1212.mn; [National Statistics Office of Mongolia 2026](#)), the World Bank commodity price database ([World Bank 2026](#)) and the Federal Reserve Economic Data database ([Federal Reserve Bank of St. Louis 2026](#)) are publicly available. Yields on Mongolian government bonds are from a commercial data provider and are subject to its licence terms.
- **Code availability:** All estimation and model solution were carried out in R. The scripts that reproduce every number, table and figure are available from the corresponding author on reasonable request.
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- **Author contributions:** T.L.: conceptualisation, data curation, methodology, software, formal analysis, writing (original draft). B.N.: conceptualisation, supervision, writing (review and editing). Both authors read and approved the final manuscript.

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