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Commodity-Price-Linked Bonds ENHANCING DEBT RESILIENCE IN COMMODITY-DEPENDENT ECONOMIES

BY YING QIAN¹

ABSTRACT

Commodity-dependent developing countries face increasing challenges to sovereign debt sustainability due to exposure to external shocks, some are coming from volatile commodity prices. This paper examines commodity-price-linked bonds (CPLBs) as a mechanism to better align debt service with repayment capacity and underlying resource cycles. By linking payments to internationally traded commodity prices, CPLBs provide a natural hedge for economies whose fiscal revenues are closely tied to export prices; empirical evidence shows strong correlations between commodity prices and fiscal outcomes, while portfolio simulations suggest that combining CPLBs with diversified currency borrowing can reduce debt service volatility by 10-50 percent. Scaling up the use of CPLBs will require greater standardization in product design, calibrated hedging approaches and issuance during favorable market conditions, alongside catalytic support from multilateral and bilateral lenders through credit enhancement and market intermediation. When embedded within broader multicurrency debt strategies and combined with complementary instruments, CPLBs can serve as a practical, countercyclical and scalable pillar of a more resilient and climate-aligned sovereign debt architecture. China, as a major commodity importer and financial actor, can support this development by facilitating market growth and aligning financing with long-term resource partnerships, including, where appropriate, RMB-denominated instruments.

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INTRODUCTION

Rising debt distress across developing market and emerging economies has renewed concerns over the sustainability of traditional sovereign borrowing models. Many of these countries—particularly those dependent on primary commodities for export earnings and fiscal revenues—remain highly vulnerable to global price volatility, interest rate shocks and sudden reversals of capital flows. Conventional fixed-payment debt instruments often exacerbate these risks by imposing procyclical repayment burdens that intensify precisely when export income and economic growth weaken. The combination of concentrated commodity dependence, volatile external conditions and limited fiscal buffers has repeatedly generated boom-and-bust cycles, deepening macroeconomic instability and constraining long-term development prospects. Existing debt relief mechanisms, including the G20 Common Framework, have struggled to deliver timely or comprehensive solutions, underscoring the need for more adaptive and market-based approaches to sovereign debt sustainability.

Debt distress in low- and middle-income countries is a recurrent outcome of global economic cycles, monetary tightening, commodity price volatility and major external shocks. Past episodes—from the 1980s Latin American debt crisis and the 1990s emerging market crises in Mexico, East Asia and Russia, to the early 2000s debt overhang primarily in Africa addressed through the Heavily Indebted Poor Countries (HIPC) Initiative and the Multilateral Debt Relief Initiative (MDRI), and to renewed stress after the 2008 global financial crisis—demonstrate how rigid debt structures, currency mismatches and dependence on volatile commodity revenues amplify downturns. The post-COVID-19 period reflects the same pattern. As of 2023, over 60 percent of low-income countries were at high risk of debt distress (World Bank 2023b), with defaults and restructurings underway in Sri Lanka, Zambia and Ghana. Progress under the G20 Common Framework has been slow: Zambia concluded a \$6.3 billion deal only in late 2023, while Sri Lanka's \$2.9 billion International Monetary Fund (IMF) program required difficult reforms and complex creditor coordination, particularly with China and India (IMF 2023b). Although China supports multilateral processes, it generally favors maturity extensions and interest rate reductions over outright forgiveness (Brookings Institution 2023). New instruments such as debt-for-climate swaps, natural-disaster pause clauses and the IMF's Resilience and Sustainability Trust have gained traction (IMF n.d.), yet private creditor resistance and tighter global financial conditions continue to complicate restructurings (IMF 2023a).

By early 2025, debt servicing pressures had intensified further, reflecting the cumulative impact of successive shocks. Interest payments exceed 10 percent of government revenues in 56 developing countries—double the level a decade earlier—and surpass 20 percent in 17 countries (Reuters 2025a). Without substantial relief, the United Nations Development Programme (UNDP) warns of a potential “lost decade” for development (UNDP 2025). Calls for a unified global debt relief initiative have intensified, including those by former African leaders and South African President Cyril Ramaphosa during his G20 presidency (Reuters 2025a). However, the persistent limitations of ex post restructuring—slow processes, weak creditor coordination and repeated reliance on ad hoc solutions—underscore the need for ex ante, countercyclical debt instruments. This recurring historical experience provides a strong rationale for exploring commodity-price-linked bonds (CPLBs) and other state-contingent debt instruments (SCDIs) that align debt service with underlying economic and commodity cycles, reducing the frequency and severity of crisis-driven restructurings (Reuters 2025a).

Against this backdrop, this paper examines the potential of SCDIs—particularly CPLBs—as innovative tools for mitigating sovereign risk and enhancing debt resilience in commodity-dependent economies. The analysis combines quantitative and qualitative approaches, integrating historical data on gross domestic product (GDP), fiscal revenues and commodity price volatility (1971–2023) with correlation and volatility analysis to identify structural linkages between export prices and debt sustainability indicators. Debt portfolio optimization techniques are applied to simulate the effects



of incorporating CPLBs into sovereign debt structures for selected case countries. Complementing the empirical analysis, the paper also examines policy and institutional dimensions through a comparative literature review and an assessment of the evolving roles of key actors, including China, in global commodity markets and sovereign debt management frameworks.

BOOM-AND-BUST CYCLES

Economic growth in many developing countries is marked by recurring boom-and-bust cycles, often triggered by external shocks such as the global financial crisis and the COVID-19 pandemic. During periods of expansion, fiscal discipline is frequently relaxed, leading to excessive external borrowing. When economic conditions reverse—typically due to falling global demand for key exports—growth slows, government revenues contract and pressures on sovereign debt servicing mount. This increases the risk of default, which in turn can damage a country’s credit rating, accelerate repayment obligations and trigger broader economic instability that negatively affects public finances and livelihoods.

Historical GDP data from 1971 to 2023 (Table 1) highlights these dynamics, showing sharp fluctuations in growth across many developing countries. Ghana and Malawi, for instance, experienced dramatic booms in the mid-2000s and early 2000s, respectively, while countries such as Haiti, Lao People’s Democratic Republic (LPDR) and Mongolia endured deep contractions linked to local or global crises. Other countries, including Zambia and the Republic of the Congo, show repeated cycles of rapid growth followed by steep downturns. These boom-and-bust episodes are often short-lived, with sustained growth rarely lasting beyond two to three years. The high volatility underscores the structural instability and external vulnerability facing many of these economies.

Table 1: Annual Percentage Change of Nominal GDP (\$) in Selected Developing Countries, 1971-2023

Country Name	Min.	Max.	Mean	Standard Deviation	Volatility
Burundi	-20.9%	28.2%	5.2%	11.0%	211.8%
Cameroon	-45.0%	38.8%	8.3%	14.0%	167.8%
Central African Republic	-33.4%	35.6%	6.0%	13.6%	228.4%
Comoros (1981-2023)	-29.5%	41.9%	5.1%	12.2%	239.3%
Congo, Rep.	-34.1%	42.8%	9.5%	18.4%	193.9%
Ethiopia	-22.1%	37.3%	8.5%	11.9%	140.1%
Ghana	-35.4%	94.4%	8.3%	18.7%	224.8%
Guinea-Bissau	-32.5%	39.8%	5.2%	12.5%	241.1%
Haiti	-35.0%	64.0%	9.1%	15.4%	169.5%
Lao PDR (1985-2023)	-44.9%	34.7%	7.5%	17.5%	233.5%
Malawi (1981-2023)	-42.9%	103.7%	6.7%	22.4%	334.0%
Mongolia (1981-2023)	-44.6%	56.9%	7.7%	21.7%	280.8%
Papua New Guinea	-23.2%	71.7%	8.6%	15.6%	181.7%
Tajikistan (1991-2023)	-24.8%	43.3%	6.3%	18.3%	292.3%
Vanuatu	-8.7%	23.1%	5.5%	8.0%	144.5%
Zambia	-26.1%	64.6%	7.0%	19.3%	277.8%

Source: Data 360, World Bank Group, 2026.

Note: The table covers years from 1971-2023 unless indicated otherwise. Volatility is calculated as the ratio of standard deviation over mean.



One key factor behind this volatility is the procyclical nature of capital flows and fiscal policy in developing countries. Rather than smoothing economic fluctuations, financial inflows and government spending often reinforce them, expanding during booms and contracting in busts. Government revenues typically surge during commodity booms, creating strong incentives to increase spending on infrastructure and wages, often based on overly optimistic assumptions about future revenues. This pattern is partly due to credit constraints and reliance on commodity exports as collateral for external borrowing, as discussed in Frankel (2018). Addressing this issue requires not just better policy choices but also stronger institutions that can enforce more countercyclical or at least less procyclical fiscal behavior. Notably, some commodity exporters succeeded in using the 2002–2008 boom to strengthen their fiscal positions, which enabled more effective responses to the 2009 global downturn, highlighting the role of institutional quality in managing macroeconomic volatility.

STATE-CONTINGENT DEBT INSTRUMENTS AND DEBT SUSTAINABILITY

SCDIs are designed to enhance debt sustainability and fiscal flexibility by linking debt service obligations to observable economic variables such as GDP growth, commodity prices or natural disasters. By allowing payments to adjust automatically to a country's capacity to pay, SCDIs aim to smooth fiscal pressures over the economic cycle and reduce the likelihood of disruptive debt restructurings (Cohen 2020). In principle, SCDIs can be issued as stand-alone instruments during normal market access, forming part of a forward-looking debt management strategy. Common structures include linkers, which index both principal and interest to a state variable; floaters, which keep principal fixed but vary coupon payments based on indicators such as real GDP growth; and extendibles, which preserve contractual terms while allowing maturity extensions under predefined stress conditions (Abbas et al. 2017). When designed symmetrically and embedded in diversified debt portfolios, such stand-alone SCDIs are intended to provide ex ante risk-sharing between sovereigns and investors, reducing procyclicality and strengthening debt resilience.

In practice, however, many observed applications of SCDIs have taken the form of Value Recovery Instruments (VRIs) attached to sovereign debt restructurings. Introduced ex post in crisis situations, VRIs have primarily served as negotiation tools to bridge differences between debtors and creditors over growth or revenue prospects. Their empirical record has been mixed. Evidence suggests that these instruments often carry high and persistent risk premia, reflecting concerns over complexity, illiquidity, data reliability and the credibility of contingent triggers (Igan 2022). As a result, VRIs have tended to trade at significant discounts and display greater volatility than comparable plain-vanilla sovereign bonds. More fundamentally, experience shows that many VRIs are asymmetric, offering creditors upside participation in favorable states without providing commensurate downside protection in adverse conditions, thereby weakening their stabilizing role (Panizza 2024). In several cases, VRIs have failed to deliver materially deeper debt relief at the time of restructuring while exposing sovereigns to sizable and politically sensitive ex post payment obligations when recoveries exceeded expectations. These limitations help explain why governments under acute stress often prefer immediate and predictable relief through conventional instruments rather than complex contingent claims with uncertain long-term fiscal implications (IMF 2017).

This distinction between stand-alone SCDIs issued ex ante and VRIs deployed ex post in restructurings is therefore critical. While restructuring-linked VRIs have shaped historical experience and investor skepticism, they should not be conflated with the broader potential of well-designed SCDIs as preventive, countercyclical instruments. Although they can be used effectively in an ex post manner, CPLBs are conceived in this ex ante spirit: issued during normal market access, linked to transparent and market-based commodity price indices and designed to provide



symmetric and automatic adjustment of debt service over commodity cycles. In doing so, CPLBs seek to preserve the core benefits of state contingency while avoiding the pitfalls associated with restructuring-driven VRIs, positioning them as preventive risk-sharing instruments rather than crisis-driven sweeteners (IMF 2017).

COMMODITY-PRICE-LINKED BONDS

Commodity Dependence

Many developing countries rely heavily on the production and export of primary commodities, making them particularly vulnerable to fluctuations in global commodity prices. For instance, in Zambia, copper exports account for more than 60 percent of total export revenues in 2023, meaning that any significant drop in copper prices can lead to severe fiscal and economic instability. Similarly, agricultural commodities such as coffee, cocoa and bananas dominate the export portfolios of several countries in Africa, Latin America and Southeast Asia. As shown in Appendix Table 1, among the 69 countries eligible for support by the IMF's Poverty Reduction and Growth Trust (PRGT) as of October 31, 2024, about 40 countries derive more than 50 percent of total export revenue from their top three exports, and 20 derive 80 percent of export revenue from their top three exports (Appendix Table 2). In fact, for 21 PRGT-eligible countries, a single export commodity already accounts for more than 50 percent of their total export revenues, with 10 of these countries relying on just one commodity for 70 percent of their export earnings.

Beyond PRGT-eligible countries, more developing countries show heavy dependence on primary commodities. According to the United Nations Conference on Trade and Development (UNCTAD), a country is dependent on a commodity when it derives at least 60 percent of its merchandise export revenues from the commodity sector. In 2018–2019, about two-thirds (64 percent) of developing countries were commodity dependent compared to 13 percent for developed countries (UNCTAD 2021a, 2021b).

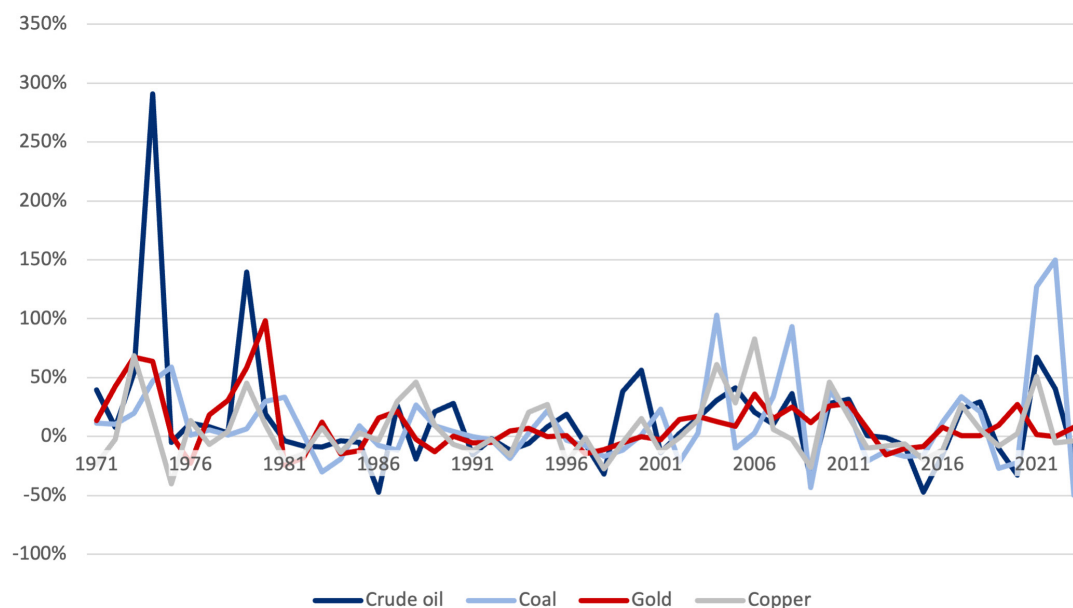
Volatile Primary Commodity Markets

Primary commodity prices are highly volatile due to a combination of supply, demand and stock change factors, market speculation and external shocks. Supply-side disruptions, such as extreme weather events, geopolitical conflicts and production and trade constraints, can lead to sudden shortages, driving prices up. On the demand side, fluctuations in global economic growth, technological changes and shifts in consumer preferences influence price movements. Exchange rate fluctuations and government policies, such as export restrictions or subsidies, also contribute to price instability, making commodity-dependent economies particularly vulnerable to economic shocks.

Figure 1 shows annual percentage changes in the prices of crude oil, coal, gold and copper in the past 50 years. Volatile changes can be observed annually, and there were also clusters of years during which volatility was evidently higher. For the whole period, the volatilities (calculated as the standard deviation of changes in prices) of crude oil, coal, gold and copper were 50 percent, 38 percent, 24 percent and 25 percent, respectively.



Figure 1: Annual Percentage Changes of Primary Commodity Prices, 1971-2023

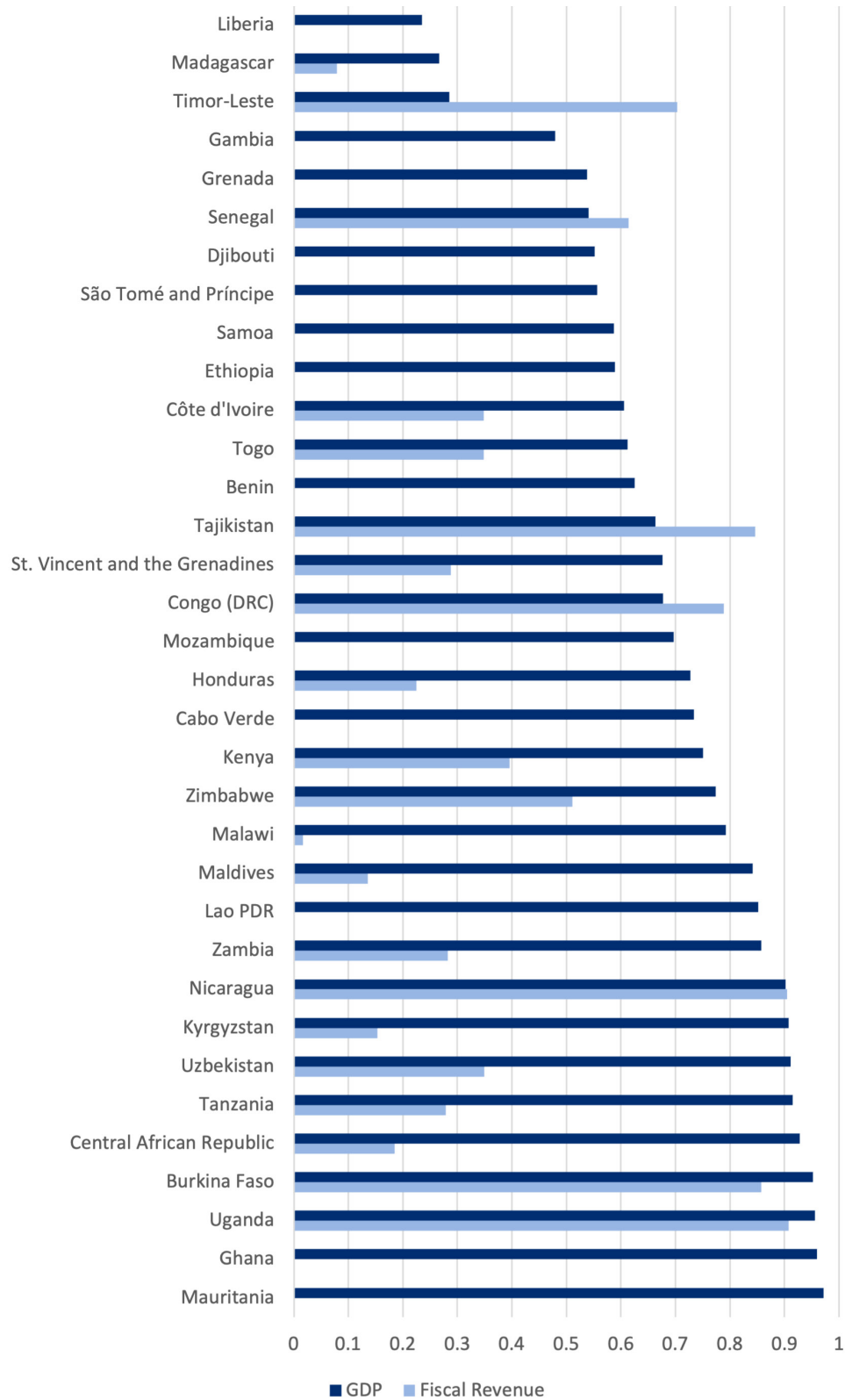


Source: Calculation based on World Bank Commodity Price Data (Pink Sheet).

Figure 2 illustrates a strong positive correlation between countries' GDP, fiscal revenue and the prices of their top export commodities. Tajikistan and the Central African Republic exhibit the highest GDP correlation, driven by commodities like aluminum and oil, respectively. Congo, Zambia, Burundi and Malawi also show strong GDP and fiscal revenue correlations, influenced by copper and cobalt. Ethiopia, Cameroon, Mongolia and Guinea-Bissau have moderate ties to commodities like coffee and oil, with fiscal revenue significantly affected by export price volatility.



Figure 2: Correlation of Countries' GDP and Fiscal Revenue Against the Price of Their Top 1 Export Commodity, 2001–2023



Source: Calculation based on World Bank Commodity Price Data (Pink Sheet), Observatory of Economic Complexity, IMF World Economic Outlook database.



The volatile movements of primary commodity prices naturally result in fluctuations in GDP and fiscal revenue for commodity-dependent countries. Table 2 and Appendix Figure 1 illustrate the statistical relationships and trends between Mongolia's GDP, fiscal revenue and its top three export commodities: coal, copper and gold. Mongolia's economy is highly dependent on primary commodities, with these three accounting for 83.3 percent of total exports. From 2000 to 2023, the price volatility of coal, copper and gold stood at 53.4 percent, 27.7 percent and 13.1 percent, while GDP and fiscal revenue had volatilities of 17.5 percent and 24.1 percent over the same period. This strong linkage is also reflected in the high correlation between commodity prices and both GDP and fiscal revenue, ranging from 65 to 95 percent, with a 99 percent significance level.

Table 2: Volatilities, Shares and Correlations of Top Three Export Commodities with GDP and Fiscal Revenue of Mongolia, 2000–2023

			Correlation		
	Share in Total Export	Volatility	Coal	Copper	Gold
GDP		17.5%	65.5%	76.4%	95.1%
Fiscal revenue		24.1%	69.8%	77.6%	93.7%
Coal	59.0%	53.4%			
Copper	18.5%	27.7%			
Gold	5.8%	13.1%			

Source: Data 360, World Bank Group and World Bank Commodity Price Data (Pink Sheet), annual prices, 1960 to present, nominal US dollars.

Over the past three decades, Mongolia's economic performance has been closely tied to the global prices of coal, copper and gold—its main export commodities. After transitioning to a market economy in the early 1990s, the country faced sharp contraction due to the end of Soviet aid and weak commodity markets. A period of growth followed in the 2000s, driven by rising demand from China and the development of the Oyu Tolgoi mine in 2009. The 2011 commodity boom pushed GDP growth to a record 17.3 percent, but the downturn in global prices by 2014–2016 led to economic slowdown and fiscal strain. Recovery began after 2017 with rising coal exports, though the COVID-19 pandemic again disrupted trade. A rebound in copper and gold prices in 2022 helped restore stability. Mongolia's growth remains vulnerable to commodity cycles, highlighting the importance of diversification and countercyclical planning.



Mitigating Commodity Price Risk

Among the 40 PRGT-eligible developing countries that are heavily reliant on commodity exports, half are currently experiencing or are at high risk of debt distress as of October 31, 2024, according to the Debt Sustainability Analysis report (IMF 2024). This widespread vulnerability stems from their dependence on volatile commodity revenues, which exposes them to significant fiscal and macroeconomic instability. When global commodity prices fall, these economies often face sharp declines in foreign exchange earnings, making it difficult to service external debt and increasing the likelihood of default or costly restructuring. The strong correlation between commodity dependence and debt distress underscores the need for more effective risk management instruments, such as CPLBs, which can serve as a natural hedge against price fluctuations and help enhance debt sustainability in resource-dependent countries.

In the short term, commodity-dependent countries can use futures and options contracts to hedge against declines in export prices. These instruments offer the potential to smooth revenue volatility while retaining upside price exposure. However, their practical application is limited—many commodities lack liquid and long-term derivative markets, making these tools inaccessible or inadequate for managing extended downturns or structural shifts in prices. As highlighted by Frankel (2017), these constraints suggest the need for alternative instruments like CPLBs, which are better suited to address long-term price risks and provide more sustainable protection against commodity-related fiscal shocks.

CPLBs are structured debt instruments that link repayment terms to commodity price movements, allowing debt obligations to adjust in line with the borrower's fiscal capacity. Like other SCDIs, CPLBs can be designed with features such as linkers, floaters or maturity extensions. For instance, a CPLB linked to West Texas Intermediate crude oil may include a supplemental redemption amount based on oil prices during the bond's term, subject to predefined ceilings and floors. These instruments are especially attractive because commodity prices are determined by global markets rather than domestic policy, making them transparent, widely recognized and less prone to manipulation or data uncertainty. This exogeneity helps mitigate the risks often associated with SCDIs, such as measurement lags or moral hazard.

Moreover, the existence of well-established futures and options markets for many primary commodities—such as oil, metals and agricultural products—facilitates pricing transparency and market confidence in CPLBs. These markets provide standardized contracts and long historical data series, enabling robust valuation techniques. Various models, including the Black-Scholes option pricing formula and simulation-based methods like Monte Carlo and bootstrap approaches, have been widely applied to commodity-price-linked instruments (Claessens and Qian 1995). These well-tested methodologies improve price discovery and investor confidence, potentially enhancing liquidity in both primary and secondary markets for CPLBs. With the right design and institutional backing, CPLBs could become a valuable addition to the toolkit for managing sovereign risk in commodity-exporting developing countries.

Use of Commodity-Price-Linked Bonds

CPLBs can, in principle, be used both ex post, as part of crisis resolution, and ex ante, as a preventive instrument against future shocks. In postcrisis settings—when sovereigns are near default or already restructuring—CPLBs may offer a more structured alternative to debt-equity swaps, which replace fixed-income claims with equity-like exposure to a country's recovery but often prove illiquid, volatile and politically contentious. Compared with direct equity stakes or claims on physical assets such as commodity stockpiles or mining infrastructure, CPLBs rely on transparent price indices, historical



data and standardized pricing frameworks, reducing transaction, governance and political risks. However, when introduced ex post, investor confidence is typically weak, and elevated sovereign risk, policy uncertainty and limited liquidity mean that CPLBs often require high risk premia, credit enhancement or official sector support, limiting their effectiveness as crisis resolution tools.

The strongest case for CPLBs therefore lies on the ex ante side. When issued during normal market access, CPLBs' countercyclical design aligns debt service with a commodity producer's capacity to pay, reducing sovereign credit risk before crises emerge. This feature is particularly appealing to investors with natural exposure to commodity price movements—such as airlines for oil, utilities for energy inputs, steelmakers for iron ore and food companies for agricultural products (Frankel 2017)—and complements broader debt management strategies that combine currency and commodity baskets to smooth fiscal volatility (Frankel 2018). Yet ex ante adoption has proven difficult in practice. During commodity booms, governments often expect favorable conditions to persist and exhibit a procyclical bias toward conventional borrowing, limiting incentives to insure against downside risks. As a result, CPLBs are least likely to be issued when they are most affordable and effective.

From the demand side, CPLBs can still attract investors even when issued by commodity-dependent sovereigns with relatively low credit ratings. One source of demand comes from natural hedgers, particularly commodity-consuming firms or countries for which the underlying commodity represents a major cost input. For these investors, CPLBs provide a built-in hedge: higher commodity prices raise input costs but also increase CPLB payments, partially offsetting losses, while lower prices reduce both costs and payments. A second, broader source of demand comes from portfolio investors, including asset managers, pension funds and insurance companies. Because CPLB repayments are driven by commodity price dynamics that are imperfectly correlated with traditional macroeconomic risks, they offer diversification benefits. Moreover, the state-contingent design can improve the effective credit quality of the instrument itself by automatically reducing debt service during commodity downturns, when default risk is highest. When combined with conservative indexation, payment caps, standardized contracts and—where appropriate—modest credit enhancement, this feature can support higher instrument-level credit ratings than the sovereign's plain-vanilla debt, expanding eligibility for institutional investors and allowing commodity-dependent countries to borrow further up the credit curve.

CPLBs also offer a promising financing channel for the global climate transition and the scaling up of critical mineral supply. Demand for minerals such as copper, lithium, cobalt, nickel and rare earths—essential inputs for renewable energy, electric vehicles and energy storage—is expected to rise sharply, increasing both price volatility and investment needs in resource-rich developing economies. CPLBs linked to these transition-critical commodities can align sovereign debt service with long-term demand trends while sharing price risks between producers and consumers. For major importing economies and firms seeking secure and sustainable access to transition minerals, CPLBs provide a financial hedge that complements physical supply agreements and equity investments. When combined with sustainability standards, transition-linked use-of-proceeds frameworks and support from multilateral and development finance institutions (DFIs), CPLBs could help mobilize long-term capital for green infrastructure and mineral development while embedding climate and supply-chain resilience directly into sovereign debt structures.



Product Standardization and Hedging Ratio

Standardizing the design of CPLBs and applying appropriate hedging ratios can significantly enhance their market viability. Uniform features—such as coupon structures, maturities and redemption terms—help reduce uncertainty and improve transparency, making it easier for market participants to assess value and risk. Referencing widely recognized commodity prices and indices further strengthens credibility and guards against manipulation. Aligning CPLB structures with international financial standards and using established pricing models based on futures or spot markets increases predictability, strengthens investor confidence and facilitates broader institutional participation. This in turn promotes greater liquidity in both primary and secondary markets. However, standardization must be carefully balanced with flexibility to account for diverse issuer needs, commodity-specific risks and differing regulatory environments.

Implementing a partial hedging strategy—using a hedging ratio below 100 percent—can also be effective in managing commodity price risk while preserving flexibility. For commodity producers and related businesses, hedging only a portion of their exposure helps control transaction costs and retain the ability to benefit from favorable price movements. This approach enables risk mitigation without fully sacrificing potential upside, allowing firms to adapt their strategies to evolving market conditions and financial objectives. Partial hedging also simplifies compliance with regulatory and accounting requirements, making it a more accessible option for many market participants. Ultimately, determining the optimal hedging ratio requires careful consideration of the issuer's risk tolerance, financial goals and the volatility of the underlying commodity market.

Role of Financial Intermediary

A promising strategy is for development institutions and financial intermediaries—such as the World Bank or major multinational banks—to take the lead in structuring commodity-linked financing (Frankel 2017). Rather than issuing loans denominated in US dollars, the World Bank could provide financing to commodity-exporting countries with repayment terms indexed to the prices of their main export commodities. To manage its own exposure, the World Bank could also issue bonds linked to a standardized commodity price index, transferring commodity price risk to investors—such as manufacturers or traders—who seek such exposure. This creates a well-aligned ecosystem: borrowers' debt obligations reflect their actual income streams, intermediaries redistribute risk efficiently and investors gain access to tailored hedging or speculative tools. Institutions like the World Bank could further support such structures by offering partial risk guarantees or credit enhancements to mitigate political or repayment risk, thus improving the credit profile of the instruments. Similarly, bilateral lenders like Chinese DFIs could apply this model to fund infrastructure in resource-dependent countries, aligning debt repayment with commodity cycles while deepening the CPLB market and enhancing financial resilience (Frankel 2017).



COMMODITY PRICES AND EXCHANGE RATES

Commodity prices have historically shown a negative correlation with the US dollar. During commodity booms, the US dollar tends to weaken, while in downturns, it typically strengthens. This pattern holds for many commodities, particularly nonferrous metals like copper and tin, which are commonly priced in dollars. Because the US is a net importer of many key commodities—such as crude oil—this inverse relationship offers some protection for commodity-importing countries. However, for commodity-exporting countries, this dynamic can magnify economic volatility. When prices are high and the dollar is weak, these countries often borrow in US dollars, only to be hit hard by rising debt burdens when prices fall and the dollar strengthens (Rees 2023).

In contrast, commodity prices often show a positive correlation with the Chinese renminbi (RMB). A strong Chinese economy typically drives up demand for primary commodities, boosting their prices alongside a strengthening RMB. As shown in Table 3, the RMB exhibits strong positive correlations across all major commodity groups—nonferrous metals, energy, agriculture, gold and wood—while the US dollar shows negative correlations with most. This suggests that for commodity-exporting countries with trade ties to China, exposure to the RMB could offer a more aligned hedge against income volatility.

Table 3: Correlation Between Commodity Prices and Exchange Rates (USD and RMB), 2000–2023

	Nonferrous Metal	Energy	Agricultural Products	Gold	Wood
US Dollar	-0.00896	-0.393***	-0.136*	0.0601	0.0614
RMB	0.605***	0.254***	0.704***	0.732***	0.143*

Source: Federal Reserve Bank of St. Louis. Producer Price Index by Commodity.

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. Both US Dollar and RMB are reflected in Real Broad Effective Exchange Rates.

Although the US dollar still dominates global commodity pricing, many commodities are increasingly traded in other regional or local currencies. For example, oil can be traded in British pounds, euros or RMB; gold and silver in euros and RMB; natural gas in Japanese yen, Indian rupees or RMB; and wheat, iron ore, coffee and cocoa in currencies like euros, Brazilian real and pounds. This diversification of commodity income streams across currencies introduces currency mismatch risk for many exporting nations. Even for commodities priced in US dollars, the exchange rate dynamics can expose borrowers to volatility. Therefore, constructing a well-diversified debt portfolio across multiple currencies is essential to mitigate mismatch risk and stabilize debt servicing obligations.



OPTIMAL PORTFOLIO OF EXTERNAL DEBT

CPLBs have been brought up in Africa's debt management discussions in the past. Theoretically, a risk-minimizing debt portfolio for sub-Saharan Africa should have comprised about 30 percent general obligation debt and about 70 percent debt indexed to the prices of sub-Saharan Africa's most important exports: cocoa, coffee, cotton, copper and oil (Claessens and Qian 1991). This portfolio would have reduces by about 90 percent the uncertainty in sub-Saharan Africa's resources available for imports, and the risk reduction benefits were stable over the period for which they were estimated. Another example is Papua New Guinea, which had poorly balanced assets and liabilities for debt servicing. An optimal debt portfolio including the use of CPLBs and conventional debt denominated in different currencies could play an important role in the country's risk management strategy (Coleman and Qian 1991; Duncan and Qian 1994).

Table 4 shows results using recent data and illustrates that integrating commodity-price-linked and non-US dollar instruments into sovereign debt portfolios can markedly reduce macroeconomic and fiscal volatility for resource-dependent economies. For Mongolia, allocating about 45 percent of its optimal debt portfolio to copper-linked bonds helps align debt service obligations with export revenues, providing a natural hedge against fluctuations in global copper prices. Although Mongolia still maintains a significant share of US dollar debt, the introduction of commodity-price-linked instruments contributes to a nearly 10 percent reduction in overall debt volatility. In contrast, Ghana achieves a far greater volatility reduction—almost 50 percent—by combining petroleum-linked bonds with a diversified currency mix including the euro, RMB and Japanese yen. This diversified composition lowers exposure to both commodity price shocks and US dollar exchange rate movements, reflecting a more balanced and resilient debt structure.

Table 4: Estimation of the Debt Optimal Portfolio, 2024

	R=1%	R=3%	R=5%	Volatility Reduction
Ghana				
Crude oil	4.00%	4.00%	4.00%	
Euro	5.60%	5.60%	5.60%	49.00%
RMB	61.90%	61.90%	61.90%	
Japanese yen	28.50%	28.50%	28.50%	
Malawi				
Dried legumes	8.50%	8.30%	8.10%	33.90%
British pound	11.50%	11.30%	11.10%	
US dollar	80.00%	80.40%	80.80%	
Mongolia				
Copper	46.30%	45.40%	44.50%	9.90%
US dollar	53.70%	54.60%	55.50%	

Source: Author's calculation.



Similarly, Malawi's inclusion of dried-legume-linked bonds and partial use of British pound-denominated debt yields a 34 percent volatility reduction, highlighting the benefits of tailoring debt to the structure of agricultural exports and trade partners. Non-US dollar borrowing mitigates the impact of dollar appreciation on debt servicing costs, while commodity-linked instruments stabilize repayment burdens when export revenues decline. Overall, the results suggest that an optimal debt composition—one that mirrors the country's export earnings and currency exposure—can significantly enhance fiscal stability. By diversifying across commodities and currencies, countries can hedge external risks more effectively and reduce the volatility of debt sustainability indicators over time.

Commodity price dynamics and exchange rate movements are closely intertwined, with important implications for debt sustainability in commodity-dependent economies. Because commodity price cycles are systematically associated with currency movements—most notably the inverse relationship with the US dollar and the closer alignment with currencies of major commodity consumers—borrowing decisions that ignore these linkages can amplify fiscal and balance sheet volatility. Debt portfolios concentrated in a single currency, particularly the US dollar, tend to perform poorly when commodity prices decline and exchange rates move adversely, increasing debt servicing burdens precisely when export revenues weaken. In contrast, aligning debt obligations with both the currency composition of trade and the underlying commodity base improves the coherence between income flows and repayment capacity.

The portfolio results in Table 4 show that the largest risk reduction gains arise from the joint interaction of commodity price indexation and currency diversification rather than from either instrument in isolation. Commodity-linked bonds stabilize debt service by tracking export revenues, while multicurrency borrowing mitigates valuation and refinancing risks driven by global financial cycles. Omitting commodity price linkages would leave countries exposed to revenue shocks even with diversified currencies, while relying solely on commodity-linked debt without currency diversification would fail to address exchange-rate-induced volatility. Optimal debt portfolios therefore require a combined strategy in which commodities and currencies function as complementary hedging instruments; excluding either dimension would materially weaken portfolio performance and increase volatility in debt service and fiscal balances over time.

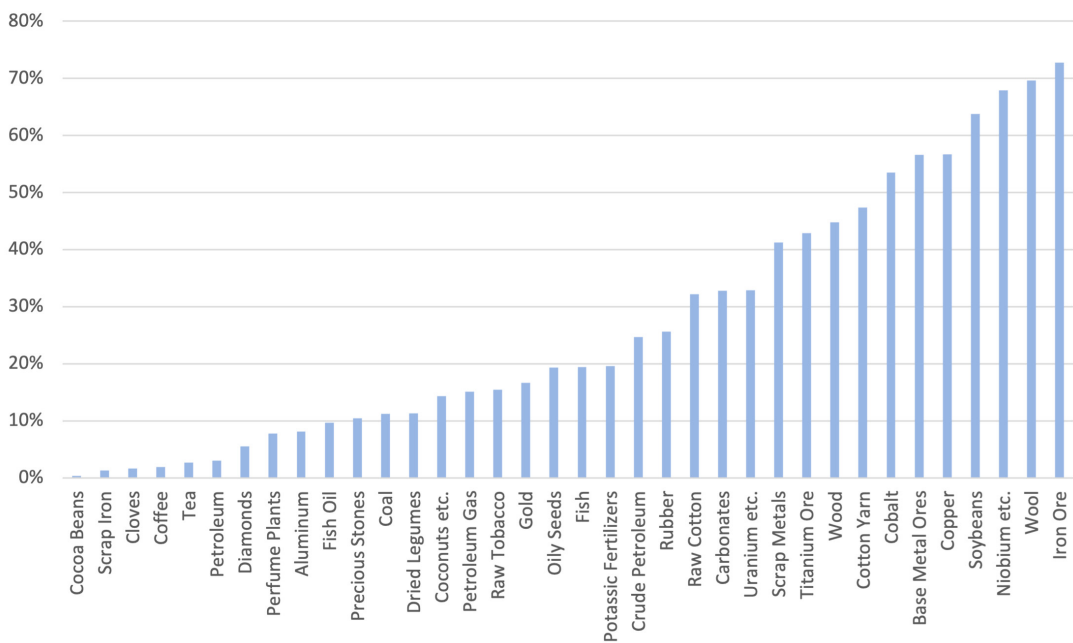


CHINA AND PRIMARY COMMODITY MARKETS

Trade Patterns

China plays a central role in global commodity markets, not only as the world’s most populous country and second-largest economy but also as a dominant force in manufacturing and intermediate goods trade. Its vast industrial base drives significant demand for primary commodities such as energy, metals and agricultural products, placing it at the heart of global value chains. In 2023, China imported \$2.19 trillion worth of goods, making it the second-largest importer globally. Figure 3 illustrates the composition of these imports by commodity type, with crude petroleum (\$319 billion), integrated circuits (\$200 billion), iron ore (\$112 billion), gold (\$87.8 billion) and petroleum gas (\$83.7 billion) among the largest categories. These import patterns reflect China’s dual role as both a global manufacturing hub and a major consumer of resource-intensive goods. Its key import partners—South Korea, the US, Japan, Australia and Russia—demonstrate the geographical breadth of its trade networks.

Figure 3: Shares of China's Imports in Total World's Import by Commodities, 2023



Source: Observatory of Economic Complexity.

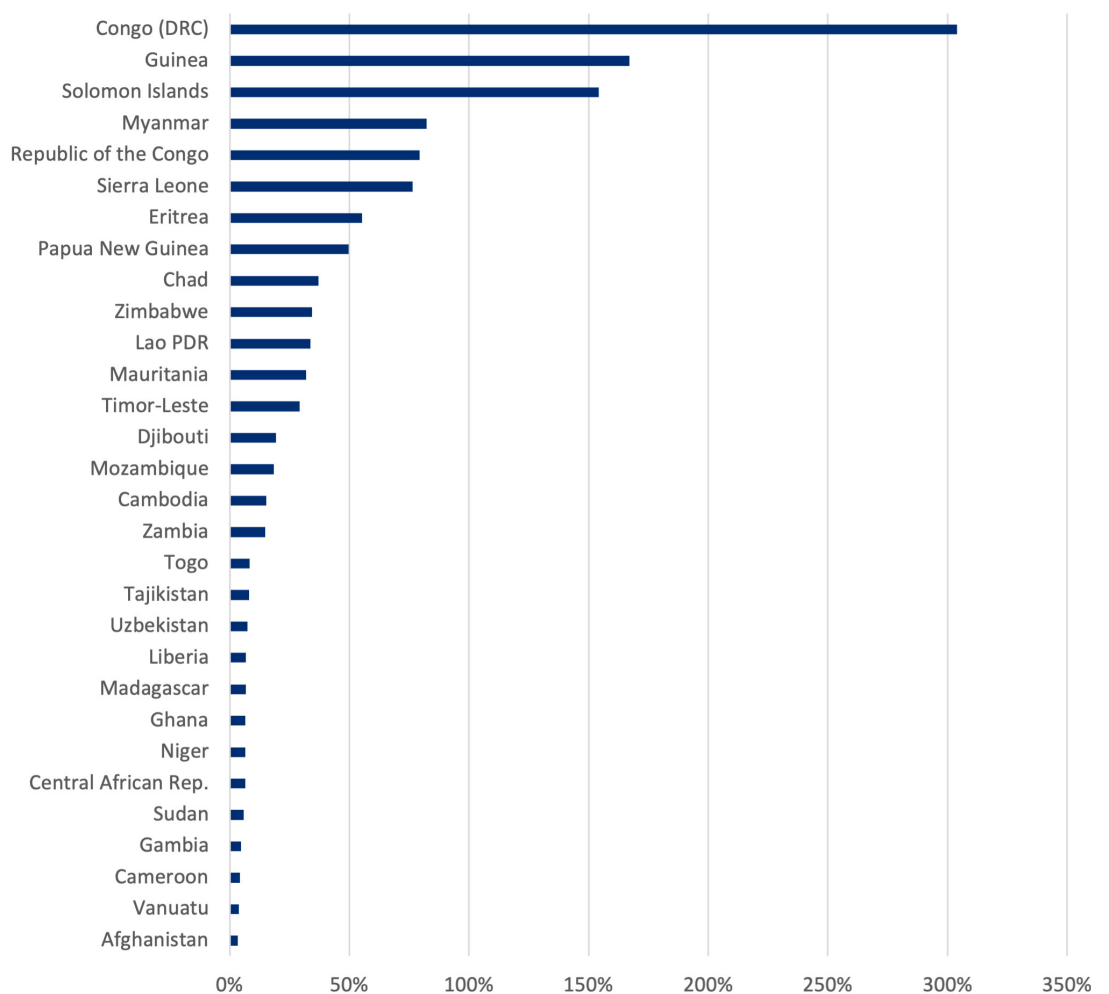
A large portion of China’s imports consist of primary commodities critical for manufacturing and infrastructure development. From the mid-1990s to 2014, China’s global demand share rose dramatically: from around three percent in 1990s to 40 percent in 2014 for key industrial metals like iron ore and copper, from one percent to 60 percent for soybeans and from one percent to 11 percent for crude oil (Kolerus 2016). The nation is the largest global importer of crude oil and liquefied natural gas, shaping global energy prices and trade routes, and despite green transition efforts, it remains the largest coal consumer in the world. China’s dominance in global metal markets—especially steel, aluminum and copper—gives it considerable influence over pricing and supply chains. In agriculture, its massive imports of soybeans and role as a major wheat and corn producer allow it to affect both demand and supply-side dynamics. Furthermore, through the Belt and Road Initiative (BRI) and



strategic commodity reserves, China secures long-term access to resources and stabilizes domestic supply during global market fluctuations.

Importantly, China is a critical trading partner for many low-income, commodity-dependent countries. Figure 4 shows the ratio of China's imports to the external debt levels of selected PRGT-eligible countries, many of which are in or at risk of debt distress. The data reveal that in countries such as the Democratic Republic of the Congo, Guinea, Mongolia and the Solomon Islands, China's import demand relative to these countries' external debt is exceptionally high—exceeding or nearing 100 percent, with the Democratic Republic of the Congo surpassing 300 percent. This underscores strong trade dependencies, particularly in resource exports. Other countries like Vanuatu and Cameroon exhibit much lower ratios, indicating weaker integration with China's trade flows. These differences highlight China's uneven but often pivotal economic relationship with commodity-exporting economies, especially where strategic resource flows and infrastructure ties are prominent.

Figure 4: Ratio of China's Imports over External Debt of Selected Countries, 2024



Source: Observatory of Economic Complexity, World Bank International Debt Statistics.



China's Commodity Risk Profile

As China's economy matures and shifts toward cleaner energy, its influence on global commodity markets is becoming more complex and strategic. The country's evolving policy priorities—especially its decarbonization targets—are expected to reduce demand for traditional fossil fuels like coal, while boosting demand for transition minerals such as lithium, cobalt and rare earths used in renewable energy and electric vehicle manufacturing. At the same time, China's trade and foreign policy choices continue to shape the flow of global commodities, reinforcing its central role in market dynamics. Whether through domestic reforms, environmental regulations or geopolitical realignments, China's decisions increasingly ripple through supply chains, investment patterns and global pricing structures.

Given its position as one of the world's largest importers of primary commodities, China remains highly exposed to commodity price volatility. These imports are vital for the country's infrastructure, energy and manufacturing sectors, making economic stability tightly linked to global commodity cycles. Fluctuations in oil prices can drive changes in transport and industrial costs, while swings in metals prices affect construction and electronics production. For example, from 2003 to 2008, international iron ore prices rose by 8.9 percent, 18.62 percent, 71.5 percent, 19 percent, 9.5 percent and 65 percent each in successive years, resulting in a cumulative increase total surge of 337.5 percent in over five years (Reuters 2025b). To manage such risks, China uses multiple strategies such as building strategic reserves, diversifying supply sources, securing long-term contracts and investing in overseas resource extraction. Its resource diplomacy—particularly in Africa, Latin America and Central Asia—not only helps insulate China from market shocks but also extends its influence in shaping the rules and resilience of the global commodities system.

Roles of China in Broadening Commodity-Price-Linked Bond Applications

China's credit market has a powerful influence on commodity prices, particularly through its effects on collateral demand. Historically, information asymmetries in the nation's banking sector have led banks to favor lending to state-owned enterprises, leaving private sector borrowers, especially small- and medium-sized enterprises, with restricted credit access. Because of this, collateral requirements are high: about 80 percent of loans demand collateral, much higher than in Organisation for Economic Co-operation and Development (OECD) economies. After the 2007 Property Rights Law allowed movable assets, including commodities, to be pledged as collateral, Chinese firms began to leverage base metals like aluminum and copper to secure loans, driving structural changes in inventories. Moreover, many firms engage in offshore commodity financing deals, using dollar-denominated letters of credit to import commodities, which they then deploy as collateral to obtain cheaper or more flexible domestic financing. This complex interplay between domestic credit constraints and global financing channels adds a significant dimension to commodity market dynamics.

Empirical research underscores the importance of these linkages. Tang and Zhu (2015) find that increased collateral demand in China contributed to a 12–15 percent rise in major base metal prices between 2007 and 2014. Similarly, growth shocks in industrial production typically influence commodity prices, with a one percentage point increase in Chinese industrial output driving oil, aluminum, and copper prices 6.5–9 percent higher. However, these relationships have evolved since 2007 due to legal and structural shifts in how collateral is treated. This underscores how China's financial architecture is deeply intertwined with its industrial policy and commodity price trends, amplifying its role as both a price-setter and a price-taker in global markets.



China could play an important role in advancing CPLBs in several ways. Chinese producers dependent on imported commodities could adopt CPLBs from resource-rich countries as a natural hedge against price swings, protecting their cost structures. Chinese financial institutions could also use CPLBs as collateral, reducing their reliance on physical commodity storage while sustaining lending activity. Furthermore, China's DFIs could issue CPLBs in RMB or other currencies, offering flexible financing tools that align with the income streams of commodity-dependent nations and enhancing global market resilience. This would not only deepen China's influence in global commodity-linked finance but also support broader risk management objectives for developing countries.

China's expanding demand for transition minerals—such as lithium, cobalt, nickel and rare earths—underpins its leadership in clean energy and advanced manufacturing. To secure reliable access to these strategic inputs, China is exploring financial instruments that complement traditional investment and trade channels. Among these, commodity-linked bonds—where returns are tied to the price or production of specific resources—offer a mechanism for aligning financial and resource interests. By investing in or structuring such bonds, Chinese DFIs, sovereign funds and state-owned enterprises can hedge against commodity price volatility, diversify foreign assets and strengthen long-term supply relationships with resource-rich countries in Africa, Latin America and Asia. These instruments could deepen its influence in resource-finance markets, promote yuan-denominated transactions and support global green transition projects under the BRI and related initiatives. Transparent pricing, fair risk-sharing and alignment with sustainability standards will help such instruments gain international acceptance and contribute to more resilient and equitable critical-mineral supply chains.



CONCLUSION

This paper shows that CPLBs represent a practical and scalable form of SCDIs for commodity-dependent developing economies. Compared with other SCDIs—such as GDP-linked bonds or restructuring-driven VRIs—CPLBs benefit from a clearer economic rationale, stronger data availability and greater transparency. Commodity prices are determined in deep global markets with long historical series and liquid derivatives, facilitating pricing, verification and investor confidence. These characteristics help address common concerns around data manipulation, trigger credibility and valuation complexity, making CPLBs better suited for stand-alone issuance during normal market access rather than primarily as crisis resolution tools.

Demand for CPLBs is broader than it might initially appear and can arise even when they are issued by sovereigns with relatively low credit ratings. One source of demand comes from natural hedgers—commodity-consuming firms, utilities and governments—for whom CPLBs provide a direct hedge against input price volatility. A second source comes from portfolio investors. By reducing debt service automatically during commodity downturns—when fiscal stress and default risk peak—CPLBs improve the risk profile of the instrument relative to conventional fixed-payment bonds. This feature can support higher instrument-level credit ratings, expand eligibility for institutional investors subject to rating or capital constraints and allow issuers to borrow further up the credit curve when combined with conservative indexation, standardized contracts and targeted credit enhancement.

The benefits also depend on how CPLBs are embedded within a sovereign's broader debt portfolio. The largest stability gains arise from the interaction between commodity indexation and currency diversification rather than from either element alone. Commodity price cycles are systematically linked to exchange rate movements, most notably the inverse relationship with the US dollar and the closer alignment with currencies of major commodity consumers such as the RMB. Debt strategies that ignore these linkages tend to amplify fiscal and balance sheet volatility. Portfolio simulations show that optimal debt structures combine commodity-linked instruments with diversified currency borrowing, reducing exposure to both export revenue shocks and exchange-rate-driven valuation effects.

These findings point to a clear agenda for policymakers, DFIs and investors to move CPLBs from concept to scale. Policymakers in developing countries should integrate CPLBs into sovereign debt strategies during periods of market access, supported by standardized and transparent indexation frameworks. DFIs can catalyze the market through common issuance templates, credit enhancement and anchor investments. Investors, including institutional funds and commodity-consuming firms, should engage more actively, recognizing the diversification and natural hedging benefits. China can play an important role—both as an investor and through its position in global commodity supply chains—by facilitating market development and aligning financing with long-term resource partnerships, including, where appropriate, RMB-denominated instruments. Coordinated action across these stakeholders can enable CPLBs to scale and establish them as a core pillar of a more resilient, countercyclical and climate-aligned sovereign debt architecture.



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APPENDIX

Appendix Table 1: Selected Examples of Debt Instruments with State-Contingent Features

Instrument	Country (Period)	Adjustment: Discrete/Continuous	Currency	Tenor (Years)	State/Trigger Variable	Payout/Deferral Type	Tradable/Nontradable
Guaranteed equity bond	UK (2002–2009)	Continuous (with principal cap/floor)	LCY	5	Equity index	Payout at redemption linked to FTSE 100 level	Nontradable (retail)
Gold bond	India (2015–)	Continuous	LCY	8 (redeemable at 5)	Price of gold	Principal linked to price of gold	Nontradable (retail)
Nominal-wage-linked bond	Uruguay (2014–)	Continuous (with coupon floor)	LCY	30	Nominal wage index	Principal linked to level of nominal wage index	Tradable
GDP-linked treasury certificates	Portugal (2013–)	Continuous (with coupon floor)	LCY	5	Real GDP growth	Coupon linked to GDP growth (in the final 2 years only)	Nontradable (retail)
Revenue-indexed bond	Turkey (2009–2012)	Continuous (with coupon floor)	USD/LCY	3	Gov't SOE revenues	Coupon linked to income from SOEs	Tradable
Oil-linked bond	Mexico (1977–1980)	Continuous (with coupon floor)	LCY	3	Export price of oil in \$	Principal linked to the local currency price of oil	Tradable
Petrocaribe loans from Venezuela	Petrocaribe members ¹ (2005–)	Hybrid	USD/LCY	25	Price of oil in USD	Down payment share, interest rate, and grace period linked to price of oil and exchange rate	Nontradable (Official)
AFD Countercyclical loans	5 countries (2007–)	Discrete	EUR	25 (with 5-year grace)	Export earnings	Maturity and grace period extended by up to 5 years	Nontradable (Official)
Extendible municipal paper	USA muni. (2000–)	Discrete	LCY	180–270 days	Issuer's discretion	90-day maturity extension if triggered (from 180 to 270 days)	Tradable

Source: Agence Française de Développement (2007), Zoheir and Tavakoli (2016).

Note: AFD = Agence Française de Développement; EUR = euro; FTSE = Financial Times Stock Exchange; GDP = gross domestic product; LCY = local currency; SOE = state-owned enterprise; UK = United Kingdom; USD = United States dollar.



Appendix Table 2: Top Three Export Commodities in Total Exports of Products, 2023

	#1		#2		#3		Total
Chad	Crude petroleum	69.4%	Gold	25.4%	Oily seeds	3.9%	98.7%
Guinea	Gold	53.8%	Aluminum	42.4%			96.2%
Mali	Gold	94.5%	Oily seeds	0.6%	Insect resins	0.4%	95.5%
Guinea-Bissau	Coconuts etc.	70.4%	Fish oil	12.4%	Fish	12.2%	95.0%
Timor-Leste	Crude petroleum	69.4%	Petroleum gas	13.8%	Coffee	11.7%	94.9%
Burundi	Gold	66.5%	Coffee	22.2%	Tea	5.9%	94.6%
Angola	Crude petroleum	74.2%	Diamonds	11.7%	Petroleum gas	7.0%	92.9%
Congo, Rep.	Crude petroleum	56.6%	Copper	31.0%	Gold	5.3%	92.9%
Burkina Faso	Gold	85.9%	Raw cotton	3.1%	Oily seeds	2.2%	91.2%
Congo, Dem. Rep.	Copper	74.8%	Cobalt	11.6%	Crude petroleum	3.8%	90.3%
Central African Republic	Gold	49.2%	Wood	31.3%	Diamonds	9.5%	90.0%
Guyana	Crude petroleum	77.0%	Rail containers	7.2%	Gold	5.0%	89.3%
Nigeria	Crude petroleum	71.3%	Petroleum gas	13.7%	Gold	2.5%	87.5%
Comoros	Cloves	64.9%	Scrap metals	17.4%	Essential oils	5.0%	87.3%
Haiti	Clothing	80.0%	Essential oils	3.8%	Scrap iron	1.6%	85.4%
Rwanda	Gold	65.6%	Niobium etc.	11.2%	Coffee	6.6%	83.4%
Mongolia	Coal	59.0%	Copper	18.5%	Gold	5.8%	83.3%
Vanuatu	Fish	60.9%	Perfume plants	11.2%	Ships	9.6%	81.7%
Ghana	Gold	57.6%	Crude petroleum	18.9%	Cocoa beans	4.0%	80.5%
Sierra Leone	Iron ore	59.0%	Titanium ore	12.4%	Diamonds	9.0%	80.4%
Somalia	Sheep and goats	43.9%	Gold	30.6%	Bovine	4.2%	78.6%
Sao Tome and Principe	Crude petroleum	54.0%	Cocoa beans	15.3%	Vehicle parts	8.2%	77.5%
Zambia	Copper	61.3%	Gold	11.6%	Precious stones	3.2%	76.1%
Mauritania	Gold	34.8%	Iron ore	33.7%	Fish	7.4%	75.9%
Solomon Islands	Wood	50.2%	Fish	14.3%	Gold	10.8%	75.3%
Benin	Gold	39.7%	Cotton	25.4%	Coconuts etc.	7.3%	72.4%
Togo	Gold	40.2%	Petroleum	21.9%	Soybeans	6.0%	68.1%



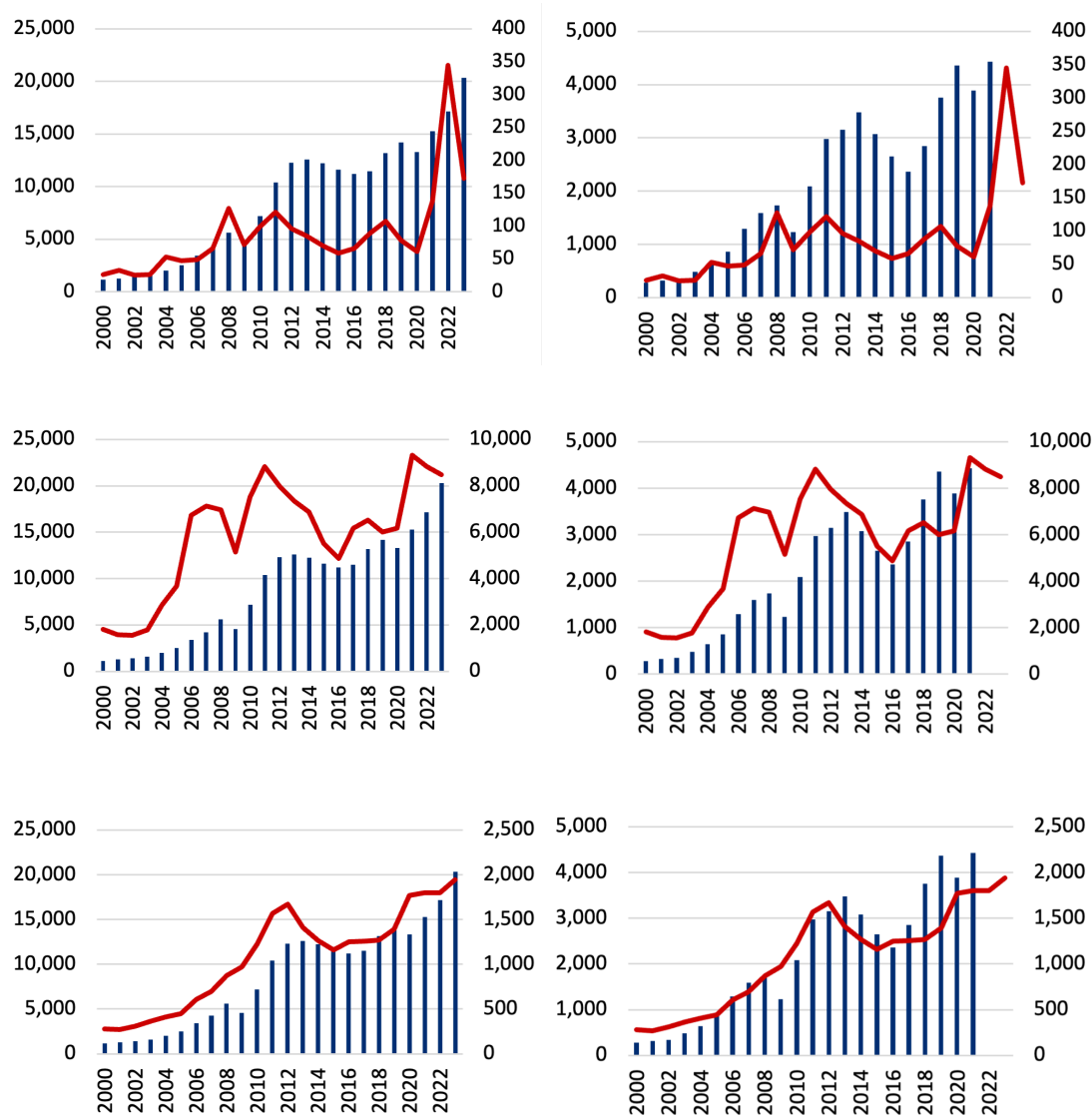
	#1		#2		#3		Total
Cameroon	Crude petroleum	36.0%	Petroleum gas	16.6%	Gold	14.1%	66.7%
Papua New Guinea	Petroleum gas	44.6%	Gold	14.8%	Copper	7.2%	66.6%
Tajikistan	Gold	43.2%	Base metal ores	15.4%	Aluminum	6.9%	65.5%
Liberia	Gold	36.9%	Iron ore	16.7%	Ships	11.7%	65.3%
Niger	Gold	31.7%	Oily seeds	20.2%	Uranium etc.	11.9%	63.8%
Malawi	Raw tobacco	47.1%	Tea	8.3%	Dried legumes	8.2%	63.5%
Uganda	Gold	44.4%	Coffee	13.9%	Petroleum	1.9%	60.2%
Lesotho	Diamonds	47.3%	Men's suits	6.2%	Wool	5.5%	59.0%
Kyrgyz Republic	Gold	46.0%	Coal	5.9%	Petroleum	3.4%	55.3%
Uzbekistan	Gold	45.9%	Cotton yarn	5.7%	Copper	3.5%	55.1%
Mozambique	Coal	23.1%	Petroleum gas	17.0%	Aluminum	12.0%	52.1%
Tanzania	Gold	44.5%	Petroleum	3.5%	Coal	3.0%	51.0%
Ethiopia	Coffee	32.9%	Dried legumes	8.3%	Cut flowers	6.5%	47.7%
Côte d'Ivoire	Gold	19.2%	Cocoa beans	16.5%	Rubber	10.9%	46.6%
Senegal	Gold	18.7%	Petroleum	14.7%	Phosphoric acid	8.7%	42.1%
Lao PDR	Electricity	24.7%	Potassic fertilizers	9.7%	Gold	7.5%	41.9%
Colombia	Petroleum	30.0%	Coal	20.0%	Gold	5.9%	55.9%
Chile	Copper	45.0%	Carbonates	6.2%	Fish	4.4%	55.6%
Peru	Copper	29.9%	Gold	13.4%	Petroleum	3.1%	46.4%

Source: Observatory of Economic Complexity.

Note: "Petroleum" refers to refined petroleum; all metals include ores, concentrates and refined forms; coal, cotton and wood include all forms. The first block of countries consists of those eligible for the G20 Debt Service Suspension Initiative.



Appendix Figure 1: GDP and Fiscal Revenue Against Prices of Top Three Export Commodities of Mongolia, 2000-2023



Source: Data 360, World Bank Group and World Bank Commodity Price Data (Pink Sheet), annual prices, 1960 to present, nominal US dollars.





GLOBAL CHINA INITIATIVE

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