Not All Shocks Are Shared Equally: Sectoral Projections and International Risk Sharing*

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Abstract

Using world commodity prices as an instrument, this paper applies a novel method for decomposing channels of international risk sharing for commodity-exporting countries. The method identifies the commodity "sector" as the projection of gross national product growth on commodity-price growth, and the non-commodity "sector" as its orthogonal complement. Commodity-price-induced risk is shared significantly more than other risks, in particular via pro-cyclical government savings, but also via counter-cyclical net international factor income.

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1 Introduction

We propose a new method for estimating how components of GDP risk are shared ("insured" or "smoothed") internationally, focusing on commodity-exporting countries ("commodity exporters"). We decompose GDP growth of commodity exporters into two components: one explained by the projection on commodity-price growth, which captures the commodity-dependent portion of the economy, and an orthogonal residual component that reflects growth shocks from other (non-commodity) sources. We estimate how risk emanating from each of these components is shared. Our methodological innovation is that we estimate risk sharing and its channels for two types of GDP shocks: those caused by variation in commodity-prices and those orthogonal to commodity-prices. We use a Bartik-style shift-share setup (see Goldsmith-Pinkham, Sorkin and Swift (2020)) to decompose GDP growth into the projection on the instrument and the projection on the orthogonal space. We interpret the projection components as representing distinct sectors of the economy, which we label the commodity sector and the non-commodity sector, although these projections are not strictly sectors from the standard national accounts classification. In the case of commodity sector shocks, the risk sharing estimates can be interpreted as the extent to which exogenous shocks are shared.

In this context, the standard interpretation of instrumental variables (IV) estimation in macroeconomics is misleading when the endogenous variable—in this case GDP—is heterogeneous across sub-components or "sectors," which have different responses to the instrument. This problem is the macroeconomic analogue of the local average treatment effect insight of Imbens and Angrist (1994): just as IV in micro identifies treatment effects only for compliers rather than the full population, IV in macro may identify treatment effects only for the sectors of GDP driven by the instrument rather than the aggregate economy. When those sectors have structurally different properties—as the commodity sector does relative to the rest of the economy—the IV estimate cannot be interpreted as capturing aggregate relationships, regardless of instrument validity.

Our decomposition approach may have other application in empirical macroeconomics. For example, a regression of, say, GDP growth on a change in tariffs may be better interpreted as capturing the implications of tariffs on certain components of the economy than as capturing the effect on the total economy, and the orthogonal complement may be interpreted as the fluctuations in the economy not affected by tariffs. Our application illustrates the importance of considering beforehand the channels through which an instrument can affect the instrumented variable before claiming the estimation of an average treatment effect.

Commodity-price shocks lead to large and persistent fluctuations in the value of GDP for countries whose exports are dominated by commodities—particularly energy and metals exporters—see Figure 1, and the induced volatility of GDP makes international risk sharing especially important for such economies. Our methodology allows us to investigate whether the volatility that is caused by commodity-price shocks is insured better than other shocks and, if so, through which channels. We measure the amount of unshared risk as the correlation of consumption growth with GDP growth after controlling for aggregate effects at short (1-year) and long (5-year) horizons.[1]

Countries can hedge against risk in various ways. First, they can insure their consumption from GDP fluctuations by trading ownership rights for their commodities and investing the proceeds in a diversified international portfolio (through trading equities, via foreign direct investment, etc.). This generates pro-cyclical net factor income, a "channel of risk sharing" typically highlighted in stylized perfect-market models. Second, pro-cyclical outflows of transfers can provide macroeconomic insurance. Third, countries can self-insure via pro-cyclical savings. To analyze the channels of risk sharing from the commodity sector and the non-commodity sector shocks, we generalize the accounting methodology developed by Asdrubali, Sørensen and Yosha (1996) (henceforth "ASY") to country-level "sectoral" shocks. The ASY accounting framework measures risk sharing, regardless of whether GDP shocks are exogenous or not, but we isolate commodity-price shocks as exogenous shocks emanating from abroad. The overall ASY-style country-level channels of risk sharing are weighted averages of our sectoral measures of risk sharing. We estimate risk sharing from the following three "channels:" net factor income, international transfers, and savings. We find that the savings channel of risk sharing is quantitatively the most important one.

Our main finding is that GDP risk attributed to the commodity sector is shared significantly more than other types of risk. We first establish that exporters of energy and metals share risk similarly and significantly more than commodity importers and agricultural commodity exporters. We then apply our methodology to energy and metal exporting countries, which we refer to as commodity exporters throughout the paper. We find substantial risk sharing for commodity-sector shocks, even at longer frequencies: full risk sharing cannot be rejected over the 1-year horizon, and only about one-seventh of commodity-price-driven GDP shocks are reflected in consumption at the 5-year horizon. In contrast, for non-commodity shocks, roughly half of short-term fluctuations are

[1] Measuring the amount of unshared risk as the correlation of consumption growth with GDP growth has been common since first suggested by Cochrane (1991) and Mace (1991) using individual-level data, and by Obstfeld (1993), using country-level data.

absorbed, but full risk sharing is rejected. Over 5-year horizons, nearly two-thirds of non-commodity-driven shocks are reflected in consumption.

These sectoral differences in risk sharing are driven by country-level savings that are positively correlated with the commodity-price cycle. We find that this pattern is particularly strong for government savings, especially at shorter time horizons, which possibly reflects the inability of credit-constrained governments to increase savings (borrow) over longer horizons following negative shocks. International factor income plays a smaller but still important role, while international transfers play a negligible role. In terms of uses of savings, commodity-sector shocks are smoothed significantly via pro-cyclical current account flows rather than through physical domestic investment, especially at the annual frequency. These results suggest the importance of sound fiscal management of commodity windfalls as a key mechanism of international risk sharing for commodity exporters.

Related literature. To our knowledge, this is the first paper to estimate sectoral channels of risk sharing for commodity-exporting (or any other) countries. Recent related literature such as Arroyo Marioli and Vegh (2023) illustrates the challenges for government saving and spending due to volatility in commodity-exporting countries. They show that government spending is twice as pro-cyclical for commodity exporters than for commodity importers (although they show that this pattern has become less pronounced in the last 15 years). Early estimates of the degree of international risk sharing consistently found that risk sharing is low relative to theoretical predictions, even for highly financially integrated economies (Lewis (1996); Obstfeld (1993)). This holds true even more for emerging markets, in part because these countries have low holdings of international financial assets (Kose, Prasad and Terrones (2009)).

Estimating channels of risk sharing was first suggested by ASY for U.S. states and applied to countries by Sørensen and Yosha (1998). The ASY regressions have a simple intuitive interpretation in terms of diversification of ownership and savings, although the findings are not matched to any specific structural model. However, Hoffmann et al. (2019) estimate channels of risk sharing using a computational quantitative equilibrium model where income smoothing and risk sharing are functions of cross-ownership of firms and of international banking integration. Simulating the model, they find that it explains well the channels of risk sharing in the European Union. They show that intuitive interpretations of ASY channels of risk sharing line up closely with an explicit model-based interpretation. In a theoretical contribution, Maggiori (2017) shows that optimal risk sharing between financially advanced countries, such as the United States, and developing countries can be asymmetric, with the more developed countries absorb-

ing a greater share of global shocks in downturns.

GDP from assets such as ore or oil deposits are likely easier to monitor across borders than, say, GDP from small service-oriented firms and it is therefore likely that the commodity-dependent sector will be able to obtain more risk sharing via international ownership diversification. Heathcote and Perri (2004) model risk sharing as a function of endogenous global financial integration, while Luttini et al. (2026) find that commodity-exporting countries share more risk than commodity importers, and that this holds for both advanced and developing economies. They find that countries with larger initial foreign asset holdings and sovereign wealth funds display more risk sharing. Indeed, risk sharing via government savings may be higher for commodity-price shocks than for other shocks because of explicit government policies intended to smooth the large shocks associated with commodities, such as the use of dedicated sovereign wealth funds.

The rest of the paper is organized as follows. Section 2 proposes a conceptual framework and derives a decomposition of the channels of risk sharing by sector. Section 3 describes the data used in the analysis. Section 4 reports our results, including robustness checks detailed in the appendix. Section 5 concludes.

2 Decomposition of channels of risk sharing by sector

2.1 Conceptual framework

Before developing the econometric decomposition, consider a simple conceptual framework. Assume that per-capita GDP growth of country i, deflated by consumer prices, is composed of two sectors j, $j \epsilon [ncom, com]$, to be constructed later, so that

$$\Delta \log \text{GDP}_i = \Delta \log \text{GDP}_i^{com} + \Delta \log \text{GDP}_i^{ncom}, \tag{1}$$

where $\Delta \log \text{GDP}_i^{com}$ is growth in value added of the commodity-producing sector and $\Delta \log \text{GDP}_i^{ncom}$ is growth in value added of the non-commodity-producing sector of a country in a given period. The two components of GDP growth are orthogonal by construction.

The proceeds from GDP growth of each sector are allocated to the representative consumer of the country and to foreign stockholders. The foreign share in sector j is f^j. In this stylized model, assuming that country i's revenue from selling shares is invested in a globally diversified portfolio, and the dividends to foreign owners from investing in each sector are proportional to growth in that sector, we can define net factor income NFI as $\text{NFI} = \lambda \Delta \log \text{GDP}^W - f^{com} \Delta \log \text{GDP}^{com} - f^{ncom} \Delta \log \text{GDP}^{ncom}$ (we omit country subscripts in this

section henceforth). Then gross national income (GNI) growth of the country will be

$$\Delta \log \text{GNI} = (1 - f^{com})\Delta \log \text{GDP}^{com} + (1 - f^{ncom})\Delta \log \text{GDP}^{ncom} + \lambda \Delta \log \text{GDP}^{W}, \tag{2}$$

where GDP^{W} is world GDP and λ is the country's share of the proceeds from world GDP.[2] Because the components (sectors j) of GDP are orthogonal, a regression of GDP growth minus GNI growth with controls for world-wide effects on $\Delta \log \text{GDP}^{com}$ ($\Delta \log \text{GDP}^{ncom}$), will return a coefficient of f^{com} (f^{ncom}), which we interpret as the extent of risk sharing obtained from diversifying commodity (non-commodity) income internationally. For the remainder of this exposition, we will abstract from the term $\Delta \log \text{GDP}^{W}$.

Along the same lines, net international transfers will smooth disposable income relative to GNI and the share of GNI transferred may be a function of which sector GNI originates from (or gets transferred to), so transfers' share of risk sharing for sector j-generated national income is t^{j}, where $j \epsilon [ncom, com]$. We ignore depreciation here and observe that net national disposable income (NNDI) growth is

$$\Delta \log \text{NNDI} = (1 - t^{com})(1 - f^{com})\Delta \log \text{GDP}^{com} + (1 - t^{ncom})(1 - f^{ncom})\Delta \log \text{GDP}^{ncom}. \tag{3}$$

Using Equation (2) and taking the difference between GNI and NNDI growth we get:

$$\Delta \log \text{GNI} - \Delta \log \text{NNDI} = t^{com}(1 - f^{com})\Delta \log \text{GDP}^{com} + t^{ncom}(1 - f^{ncom})\Delta \log \text{GDP}^{ncom}. \tag{4}$$

Running the above as a regression on $\Delta \log \text{GDP}^{com}$, returns a coefficient of $t^{com}(1 - f^{com})$, the fraction of commodity-sector GDP shocks smoothed by international transfers. t^{com} would thus capture the smoothing of the part of GNI growth which is proportional to commodity-sector GDP growth; that is, $(1 - f^{com})\Delta \log \text{GDP}^{com}$. Likewise for $\Delta \log \text{GDP}^{ncom}$.

The share of disposable income that is not consumed is saved. Let $s = s^{j}$ be a country's saving as a share of the part of NNDI that is driven by sector j GDP. Then consumption (CONS) growth is equal to

$$\Delta \log \text{CONS} = (1-s^{com})(1-t^{com})(1-f^{com})\Delta \log \text{GDP}^{com} + (1-s^{ncom})(1-t^{ncom})(1-f^{ncom})\Delta \log \text{GDP}^{ncom}. \tag{5}$$

Similarly to the role of transfers, regressing the difference between commodity sector NNDI growth and consumption growth on commodity-sector GDP growth, returns a coefficient of $s^{com}(1 - t^{com})(1 - f^{com})$; that is, the fraction of commodity-sector GDP shocks

[2] In a more realistic model, only capital's share of GDP is traded, but if that share is proportional to GDP growth, similar expressions will be obtained.

smoothed by saving.

In this stylized setup, we do not model the constraints and choices that determine the magnitude of the coefficients; however, the model outline provides an interpretation of the estimates of the regressions we develop.

2.2 Econometric accounting framework

Consider a decomposition of GDP projected on a variable Z, which in our case is the weighted price growth of commodities. Let P_Z be the projection matrix $Z(Z'Z)^{-1}Z'$, and let the "residual maker" $M_Z = (I - P_Z)$. The projection matrix and the residual maker are orthogonal as $M_Z P_Z = 0$. The standard textbook interpretation of IV-regressions is one where the independent variable is a linear function of an exogenous instrument plus an endogenous "noise term." If treatment effects are heterogeneous, IV identifies a local average treatment effect on the outcome variables (Imbens and Angrist, 1994). Our setting is more general: we interpret the projection of GDP on commodity prices as capturing heterogeneity in the composition of GDP, and we allow different components of output to have different effects on consumption.

As explained earlier, a commodity-exporting country consists of two sectors ($j = 2$) in our stylized model: (i) a commodity-dependent "sector," and (ii) its orthogonal non-commodity-dependent "sector." These sectors do not correspond to any formal sector classification in the national accounts but are constructed from projections. The commodity sector identified in this fashion will include extraction sectors and their suppliers, parts of the public sector that are impacted by commodity prices through taxes and transfers, retail sectors affected by the demand of workers employed in the extraction sector, and other activities subject to fluctuations caused by commodity-price shocks.

We quantify country-level risk sharing by running the regression (where we omit the error terms for brevity)

$$\Delta \log \text{CONS}_{it} = \gamma^U \Delta \log \text{GDP}_{it} \tag{6}$$

after controlling for world-wide growth. Under perfect risk sharing in a one-good model, $\gamma^U = 0$. Our main goal is to measure the extent of risk sharing $1 - \gamma^U$. We do not attempt to model the potential barriers, such as the non-tradability of goods, which could thwart perfect international risk sharing.

Similarly, we measure how much commodity-sector GDP risk is shared by running the regression

$$\Delta \log \text{CONS}_{it} = \gamma^U_{com} \Delta \log \text{GDP}^{com}_{it}, \tag{7}$$

after controlling for world-wide growth. $\Delta \log \text{GDP}^{com}_{it}$ denotes $P_Z \Delta \log \text{GDP}_{it}$ and the coef-

ficient γ^U_{com} is 0 if shocks to commodity-sector GDP (orthogonal to world GDP shocks) do not impact consumption; i.e., these shocks are "perfectly shared." γ^U_{com} measures the pass-through of commodity-GDP shocks to consumption and $(1 - \gamma^U_{com})$ is a measure of how much commodity-GDP risk is shared. Note that the regression provides no information about the intra-country risk sharing between owners/workers in the commodity sector and owners/workers in the non-commodity sector. We only observe per-capita consumption.

And we measure how much non-commodity-sector GDP risk is shared by running the regression

$$\Delta \log \text{CONS}_{it} = \gamma^U_{ncom} \Delta \log \text{GDP}^{ncom}_{it}, \tag{8}$$

controlling for worldwide growth. $\Delta \log \text{GDP}^{ncom}_{it}$ denotes $M_Z \Delta \log \text{GDP}_{it}$ and the coefficient γ^U_{ncom} is 0 if shocks to non-commodity-sector GDP do not impact consumption. We show in Appendix A.2 that the country-level risk sharing coefficients are weighted averages of the sectoral coefficients γ^U_{com} and γ^U_{ncom} where the weights are the relative variance of the sectoral shocks:[3]

$$\gamma^U = \gamma^U_{com} \frac{Var(P_Z \Delta \log \text{GDP})}{Var(\Delta \log \text{GDP})} + \gamma^U_{ncom} \frac{Var(M_Z \Delta \log \text{GDP})}{Var(\Delta \log \text{GDP})}.$$

This weighted average relationship reveals what a standard IV estimation would identify in our setting and why its interpretation as aggregate risk sharing is incorrect. A researcher applying IV—using commodity prices as an instrument for GDP growth in the aggregate risk sharing regression—would obtain an estimate that can be written as:

$$\gamma^{U,IV} = \frac{E(\Delta \log \text{CONS}_{it} Z)}{E(\Delta \log \text{GDP}_{it} Z)} = \gamma^U_{com},$$

that is, the IV estimator identifies the pass-through of commodity-sector shocks to consumption, γ^U_{com}, not the aggregate pass-through, γ^U. A researcher interpreting $\gamma^{U,IV}$ as measuring aggregate risk sharing implicitly assumes $\gamma^U_{com} = \gamma^U_{ncom}$—that the commodity and non-commodity sectors share risk equally. However, in a wide range of macroeconomic models, the assumption of homogeneity in risk sharing across different sectors would be violated. For example, the model of Backus and Smith (1993) explicitly model the economy as having a sector producing tradeable goods and a sector producing non-tradeable goods. For a country that mainly exports commodities, one might take the commodity sector, that is identified by the projection onto commodity prices, as an ap-

[3] By construction, $\Delta \log \text{GDP}^{com}_{it} + \Delta \log \text{GDP}^{ncom}_{it} = \Delta \log \text{GDP}_{it}$ because we decompose the growth-rate, rather than the level, of GDP.

proximation to the tradeable sector (and the orthogonal as an approximation to the non-tradeable sector).

2.2.1 Sectoral channels of risk sharing

We adapt the ASY decomposition of GDP growth to sectoral GDP growth for a given country and time period as follows:

$$P_Z \Delta \log \text{GDP} = (P_Z \Delta \log \text{GDP} - \Delta \log \text{GNI}) + (\Delta \log \text{GNI} - \Delta \log \text{NNDI}) + (\Delta \log \text{NNDI} - \Delta \log \text{CONS}) + (\Delta \log \text{CONS}) \,.$$

This equation demonstrates how, if there is a gap between the growth rates of consumption and commodity-sector GDP, it occurs because GNI growth does not follow commodity-sector GDP growth one-to-one, and/or because disposable national income growth does not follow GNI growth one-to-one, and/or because consumption growth does not follow disposable national income growth. Multiplying all terms by $P_Z \Delta \log \text{GDP}$ above, subtracting the mean, and taking expectations yields:

$$\begin{aligned} Var(P_Z \Delta \log \text{GDP}) \quad &= \quad Covar(P_Z \Delta \log \text{GDP}, \Delta \log \text{GDP} - \Delta \log \text{GNI}) \\ &+ \quad Covar(P_Z \Delta \log \text{GDP}, \Delta \log \text{GNI} - \Delta \log \text{NNDI}) \\ &+ \quad Covar(P_Z \Delta \log \text{GDP}, \Delta \log \text{NNDI} - \Delta \log \text{CONS}) \\ &+ \quad Covar(P_Z \Delta \log \text{GDP}, \Delta \log \text{CONS}) \,. \end{aligned} \tag{9}$$

The novelty here is that we consider only a subset of GDP growth, namely the projection onto commodity-price growth. While the difference between, say, net national disposable income NNDI and consumption CONS reflects income smoothing via savings *in the whole economy*, the covariance with commodity-sector GDP can naturally be interpreted as a measure of how savings smooth shocks to commodity-sector GDP.

Dividing Equation (9) by the left-hand side and noticing that the covariances divided by the variance are OLS coefficients, we get the coefficients labeled in the order of the covariances in Equation (9): $\gamma^F_{com}, \gamma^T_{com}, \gamma^S_{com}$, and γ^U_{com}, respectively. Since these coefficients are derived from an identity, they satisfy:

$$\gamma^F_{com} + \gamma^T_{com} + \gamma^S_{com} + \gamma^U_{com} = 1 \,, \tag{10}$$

where, for example, γ^U_{com} is $\frac{Covar(P_Z \Delta \log \text{GDP}, \Delta \log \text{CONS})}{Var(P_Z \Delta \log \text{GDP})}$, which is the coefficient from a regression of consumption on the projection of GDP on commodity-price shocks. If Z is

exogenous, the coefficients are IV-estimates.[4]

The coefficient γ^F_{com} measures how sensitive gross national income is to commodity-price-induced GDP shocks. The closer to 1, the more sensitive. Because gross national income is the sum of GDP and international net factor income, γ^F_{com} thus measures how much *commodity risk* is shared by net factor income. In the stylized Arrow-Debreu model, where risk sharing occurs through contingent payments, this is how risk is shared. Similarly, γ^T_{com} measures how international transfers smooth the part of national income driven by commodity-price shocks, because the regression on the commodity-price projection captures only movements correlated with commodity-price growth. Net national income is net of depreciation, so risk sharing from depreciation will also be captured by this term. We choose this simplification, as the role of transfers is not the main focus of this paper. It is included mainly to complete the decomposition.

Our interpretation of γ^S_{com} is that it measures how savings smooth the part of national income driven by commodity-price growth. In the stylized framework notation presented above, the γ^F_{com}, γ^T_{com}, and γ^S_{com} coefficients capture f^{com}, $t^{com}(1-f^{com})$, and $s^{com}(1-t^{com})(1-f^{com})$, respectively.

We obtain coefficients $\gamma^F_{ncom}, \gamma^T_{ncom}, \gamma^S_{ncom}, \gamma^U_{ncom}$ in the same fashion for the non-commodity sector, using the component of GDP growth orthogonal to commodity-price shocks (which measures how risk to the non-commodity sector is absorbed). However, we do not have an exogenous instrument for the non-commodity sector; the coefficients still measure risk sharing but may not be unbiased estimates of the response to some exogenous shock to that particular sector.

We modify the ASY decomposition slightly to capture the international risk sharing of commodity producers *with the world*. Because world GDP growth cannot be diversified away, we quantify risk sharing by defining the regressand as country-level GDP growth minus world GDP growth. That means we are now measuring risk sharing with the world (rather than with the other countries in the sample, as in ASY). It also implies that the estimates do not strictly reflect a variance decomposition. As a result, the estimated coefficients in Equation (10) may not strictly sum to 1, but typically to a number less than one (refer to Appendix A.3 for a derivation).

We implement our empirical strategy by estimating the regressions (shown here for

[4] ASY show that the coefficients from a panel-data regression with time-fixed effects are weighted averages of the year-by-year cross-sectional coefficients, implying that the panel-estimated coefficients still sum to unity.

total country-level risk sharing):

$$\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GNI}_{it} = const^h + \gamma^{F,h} \Delta_h \left(\log \text{GDP}_{it} - \log \text{GDP}_t^{world} \right) + u_{it,h} \tag{11}$$

$$\Delta_h \log \text{GNI}_{it} - \Delta_h \log \text{NNDI} = const^h + \gamma^{T,h} \left(\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GDP}_t^{world} \right) + u_{it,h} \tag{12}$$

$$\Delta_h \log \text{NNDI}_{it} - \Delta_h \log \text{CONS}_{it} = const^h + \gamma^{S,h} \left(\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GDP}_t^{world} \right) + u_{it,h} \tag{13}$$

$$\Delta_h \log \text{CONS}_{it} - \Delta_h \log \text{CONS}_t^{world} = const^h + \gamma^{U,h} \left(\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GDP}_t^{world} \right) + u_{it,h}, \tag{14}$$

for overall risk sharing, while for estimation of risk sharing from commodity- and non-commodity sector GDP shocks, GDP is replaced by GDP^{com} and GDP^{ncom}, respectively. $const^h$ is a constant that can vary with h. For the sectoral regressions, we still subtract world GDP growth, rather than its projection on commodity prices, implying that we technically do not run IV regressions. Finally, using intervals of varying lengths $h = 1, 2, 3, 4$ and 5 years allows us to estimate risk sharing, and its channels, at different horizons in a parsimonious, easy-to-interpret fashion.

As mentioned earlier, the coefficients estimated for the channels, using regression Equations (11), (12), (13), and (14), will typically sum to less than unity. Also, the country-level risk sharing coefficients in this case will not exactly add up to a weighted average of the sectoral risk sharing coefficients as in a regression with time-fixed effects. Nonetheless, the variance decomposition of ASY provides the approximate magnitude of the coefficients, which we still interpret as fractions of risk shared.

The projection ("instrumental") variable is constructed as follows. Let $\Delta_h p_{it}^{shock}$ be the weighted average of real price changes over period h for the basket of commodity exports of country i, where the weights are determined by the nominal shares of each commodity in GDP:

$$\Delta_h p_{it}^{shock} = \sum_{g \in Commodity} \frac{P_{gt-h}^{USD} X_{git-h}}{GDP_{it-h}^{USD}} \Delta_h \log \frac{P_{gt}^{USD}}{CPI_{it}^{US}}. \tag{15}$$

P_{gt}^{USD} is the price of commodity g in U.S. dollars at time t and X_{git-h} is the export volume of commodity g in country i at time $t-h$. The weights given to commodity g are the revenue from country i exports of that commodity h periods lagged, divided by GDP_{it-h} in U.S. dollars; that is, the country-specific importance of exports of commodity g relative to GDP. The weights use variables lagged h periods in order to be pre-determined and not functions of the price change from $t-h$ to t. The commodity-specific price in the second term is divided by the CPI_t^{US}—the U.S. consumer price index at time t.

3 Data

Annual data for GDP, GNI, consumption, international transfers, gross savings, gross capital formation, consumer prices, and commodity exports are from the UN National Accounts statistics and World Development Indicators (WDI). Savings data are from the United Nations National Accounts Statistics, *Main Aggregates and Detailed Tables*, including data for the general government sector. Private savings is the difference between Gross Savings and Government Gross Savings. Appendix Table A.1 summarizes the data sources.

Commodity prices are from the World Bank Commodities ("Pinksheet") database, which covers more than 70 commodity prices and indexes. There are several commodities g in the Pinksheet database classified into groups: either energy, metals, or agricultural commodities.[5] Export data are from the World Bank's World Integrated Trade Solutions (WITS) database.

Our baseline sample covers 96 countries for the period 2000 to 2022, although the majority of our regressions focus on 23 energy and metal exporting countries, according to the World Bank's definition. Countries are included in the sample only if sufficient data are available to compute 5-year differences for the variables in Equations (9) and (15), and we restrict the sample to observations for which 1- to 5-year differences can be calculated. Appendix Table A.2 lists the country sample and classification of countries. In the table they are classified as energy, metal, or non-commodity exporters (which in our case, includes agricultural exporters and commodity importers). We follow the Pinksheet database definition where an economy is defined as a commodity exporter when, on average for 2017–2019, either (i) total commodities exports accounted for 30 percent or more of total exports or (ii) exports of any single commodity accounted for 20 percent or more of total exports. In our sample, commodity exports (energy and metals) on average account for about 19 percent of GDP (last column of Table 1).

4 Results

4.1 How much do commodity-exporting countries share risk?

Figure 1 shows that GDP growth is about twice as volatile in energy and metal commodity-exporting countries as in non-commodity-exporting countries. High volatility of GDP

[5]The commodities included in the study for metals are aluminum, copper, ammonium phosphate, gold, iron ore, lead, nickel, platinum, silver, tin, and zinc. The energy commodities are coal, natural gas, and crude oil.

and export earnings will, in the absence of mitigation mechanisms, translate into high volatility of consumption, providing incentives for risk sharing. Indeed, consumption is more volatile for the group of commodity-exporting countries than for non-commodity exporters (Column (1) of Table 1). However, descriptive statistics also suggest that commodity exporters have achieved some risk sharing: the variance of consumption relative to GDP and the correlation between consumption and GDP are notably lower for commodity exporters than for non-commodity exporters; see Columns (2) and (3) of Table 1.

Before proceeding with the sectoral decomposition, we establish whether the amount of risk sharing differs depending on the main commodity group exported, or on whether the country is a commodity importer. We quantify country-level risk sharing for commodity-exporting countries *exp* (either energy or metals), or other countries *nexp* (agricultural exporters or commodity importers) at different frequencies, using the regression model:

$$\begin{aligned}\Delta_h \log \text{CONS}_{it} - \Delta_h \log \text{CONS}_t^{world} = const^h + \beta_{nexp}^{U,h} \left(\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GDP}_t^{world}\right) \times I_i^{nexp} \\ + \beta_{exp}^{U,h} \left(\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GDP}_t^{world}\right) \times I_i^{exp} + u_{it,h},\end{aligned} \tag{16}$$

where I_i^{nexp} is an indicator function that takes a value of 1 for commodity non-exporters (in our definition, importers and agricultural exporters), and 0 otherwise. Likewise, I_i^{exp} takes a value of 1 for energy and metals exporters and 0 otherwise.

The coefficient $\beta_{exp}^{U,h}$ is interpreted as the average deviation from full consumption risk sharing for commodity exporters, and $\beta_{nexp}^{U,h}$ is interpreted similarly for non-commodity exporters. For commodity exporters, for instance, if shocks to GDP are fully passed on to consumption, $\beta_{exp}^{U,h} = 1$, while full risk sharing corresponds to $\beta_{exp}^{U,h} = 0$. Because we discuss the extent of risk sharing rather than lack of it, we focus on $1-\beta^{U,h}$. The difference $\beta_{nexp}^{U,h} - \beta_{exp}^{U,h}$ measures the gap in risk sharing between commodity-exporting and non-commodity-exporting countries.

Table 2 presents the estimates for Equation (16), with each row displaying results for a different frequency h, while the columns display the results for non-commodity exporters, commodity exporters, and the difference in Columns (1)–(3), respectively. For commodity non-exporters, we find 21 percent consumption risk sharing at the annual frequency, with a slight decline at longer frequencies. For commodity-exporting countries, there is substantial risk sharing at the annual frequency at 70 percent (49 percentage points higher than for commodity non-exporters), although risk sharing for commodity-exporting countries declines monotonically with length of the smoothing horizon, with 44 percent risk sharing at the 5-year frequency (still with a statistically significant differ-

ence of 27 percentage points to commodity non-exporters at the same frequency).[6]

The results are consistent with a growing body of literature that treats the macroeconomic risks faced by commodity-exporting countries——such as those associated with the "resource curse"—as fundamentally different from the macroeconomic risks faced by other economies (see, for example Venables (2016) and Arezki et al. (2018)).

4.2 The relevance of commodity prices for GDP: The commodity sector and the non-commodity sector

For the remainder of the analysis, we focus exclusively on commodity-exporting countries (i.e., energy and metals exporters) and measure the degree of risk sharing for the commodity and non-commodity *sectors*.

We first construct an instrument using the commodity-price shock defined in Equation (15). We stress that we are not presenting IV-regressions, but rather identifying an exogenous component of GDP growth. Commodity-price shocks translate into real (CPI-deflated) GDP shocks because they directly change the value of commodities produced and because they stimulate or dampen production activities tied to the commodity sector. Although our risk sharing measures are not conditional on exogeneity, we interpret global commodity prices as exogenous to commodity exporters' aggregate variables, as individual economies are unlikely to impact global commodity prices.[7] For exogenous shocks, we measure what fraction of shocks coming from commodity-price shocks are shared. In the case of non-exogenous shocks, the regression of consumption on GDP shocks (adjusted to world-wide effects) still measures risk sharing, but the magnitude of these fluctuations may be affected by other sector-specific effects such as Keynesian demand feedback effects.

To decompose the exogenous shock effects, we define the $NT \times 2$ matrix Z^h, such that the row corresponding to country i at time t is $[1, \Delta_h p_{it}^{shock}]$ for frequency h, and define P_Z^h as the projection matrix onto the space spanned by Z^h as defined in Section 2. Define $\Delta_h \log \text{GDP}$ (without sub-scripts) as the GDP growth-rates stacked correspondingly. Then $\Delta_h \log \text{GDP}^{com}$ and $\Delta_h \log \text{GDP}^{ncom}$ are the growth rates at frequency h of the commodity and non-commodity sectors defined as:

[6] Separating commodity exporters into agriculture-, energy-, and metal-exporters, does not change the story. We find that agricultural exporters have the same level of risk sharing as commodity importers, while energy and metal exporters share more risk than agricultural and commodity importers, and the difference in risk sharing between energy and metal exporters is not statistically significant. See Table B.1 for details.

[7] An exception in the case of oil is Saudi Arabia, which has the largest spare capacity and substantial influence on OPEC policies. Excluding Saudi Arabia from the estimation does not materially change the results.

$$\Delta_h \log \text{GDP}^{com} = P_Z^h \, \Delta_h \log \text{GDP}, \tag{17}$$

$$\Delta_h \log \text{GDP}^{ncom} = (I - P_Z^h) \, \Delta_h \log \text{GDP}, \tag{18}$$

where the projections can be found using least squares regressions.

Table 3 displays the coefficients from estimating Equation (17), the "first stage" regressions of GDP on the instrument, with the projection on the commodity prices being the fitted values labeled $\Delta_h \log \text{GDP}_{it}^{com}$. The table shows that commodity-price shocks are highly statistically significant for the growth of cross-sectionally demeaned GDP across all horizons considered, with a coefficient close to 1, consistent with a strong causal impact of commodity prices on CPI-deflated GDP. The residuals from the regressions are projections on the space orthogonal to that spanned by commodity prices.

4.3 Risk sharing in commodity-exporting countries: A tale of two sectors

Table 4 presents estimates of risk sharing for GDP, commodity-, and non-commodity-sector growth at frequencies h varying from one year to five years. The coefficients in Column (1) are calculated as $(1-\gamma^{U,h})$, which is interpreted as the fraction of risk shared, where $\gamma^{U,h}$ is the coefficient from estimating Equation (14). Columns (2) and (3) show the results from the same regression specification but using sector-level GDP growth. Column (1) of Table 4 shows that commodity exporters smooth consumption growth relative to income growth by 70 percent at the annual frequency, declining to 44 percent at the 5-year frequency.

Our main result is that the high level of risk sharing found for these countries is largely due to shocks to the commodity sector being well-insured; see Column (2) of Table 4. At the annual frequency, the point estimate is larger than 1, but not significantly different from the full risk sharing benchmark of unity. The point estimate declines a bit at longer frequencies, but at none of the frequencies can full risk sharing be rejected.

Estimates for the non-commodity sector in Column (3) of Table 4 display much less risk sharing, with 49 percent of non-commodity-sector GDP shocks smoothed at the annual frequency, declining to 37 percent at the 5-year frequency. The estimates for country-level risk sharing in Column (1) are weighted averages of the estimates in Columns (2) and (3), so it is not surprising that commodity exporters display high risk sharing because shocks to the commodity sector are substantially smoothed. Figure 2, Panel (a) shows

graphically how GDP on average moves with commodity prices, suggesting that most risk sharing comes from the insurance of commodity-sector shocks. Note that even the amount of risk sharing for the non-commodity sectors of the commodity-exporting countries is high relative to country-level estimates for non-commodity-exporting countries shown in Table 2.

The large amount of risk sharing at the longer frequencies (h=5) is important, because energy and metal price shocks are typically persistent, and the welfare effects of long-lasting shocks are significantly larger than the effects of transitory shocks.

4.3.1 Channels of risk sharing for commodity and non-commodity sector shocks

Digging into the channels provides evidence of whether risk sharing is obtained mostly through, for example, the government or through markets. We present the coefficients γ^F_{com} (γ^F_{ncom}), γ^T_{com} (γ^T_{ncom}), and γ^S_{com} (γ^S_{ncom}) as calculated from panel regressions, similar to Equations (11)–(13), except we now regress on sectoral GDP growth minus world GDP growth, rather than country-level GDP growth minus world GDP growth.[8] For example, to estimate the factor income channel smoothing of commodity-sector shocks through the factor income channel labeled F, we run the regression

$$\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GNI}_{it} = const^h + \gamma^{F,h}_{com} \left(\Delta_h \log \text{GDP}^{com}_{it} - \Delta_h \log \text{GDP}^{world}_{t} \right) + u_{it,h},$$

which is identical to Equation (11), except the GDP shock on the right-hand side of the equality sign now is the shock to commodity-sector GDP growth.[9] World GDP growth is assumed to be exogenous with respect to consumption, GNI, and NNDI. This allows us to interpret the coefficients from the approximate variance decomposition for the commodity sector ($\gamma^{F,h}_{com}$) as measuring risk sharing from shocks to commodity-sector GDP (adjusted for non-diversifiable world GDP).

Table 5 presents estimates of the channels of risk sharing in each sector. From Panel (a), Columns (2) and (3), net factor income smooths 6 (roughly 0) percent of GDP shocks in the commodity (non-commodity) sector, respectively. Country-level risk sharing from net factor income is estimated at 5 percent in Column (1), which is a weighted average of the sector estimates.

One possible explanation for the high risk sharing observed for the commodity sector

[8] Regressing sectoral GDP growth minus world growth, rather than minus world sectoral growth, implies that the projection is not that of a pure instrument. Relaxing this assumption does not change the results, as shown in Table A.3.

[9] The regressions correspond to the variance decomposition and we maintain the "γ-notation" for the estimates.

is the stabilizing role of multinational corporations, which often hold significant shares in mining operations. These corporations may mitigate the effects of commodity-price shocks through pro-cyclical movements in net factor income. For instance, during periods of high commodity prices, international corporations may remit dividends abroad, while during downturns, they may fund investments using foreign earnings.[10] International borrowing, or financial integration more generally, may also be higher for the commodity sector due to the comparative ease of monitoring profits, which are closely tied to observable commodity-price movements. For brevity, Table 5 reports the results only for the 1- and 5-year frequencies, but risk sharing from net factor income remains stable as the observation frequency gets longer. Risk sharing from net factor income is around 0 and stable across different frequencies for the non-commodity sector.

Panel (b) of Table 5 shows risk sharing from net international transfers. The amount is not significantly larger than 0 for the aggregate GDP and the commodity sector, although transfers smooth 3 percent of GDP shocks in the non-commodity sector at both frequencies. This could be related to remittances which help smooth out consumption in this sector, as many countries in our sample are large remittance recipients. However, this is a topic for future research.

Pro-cyclical savings are the main source of risk sharing, smoothing 65 percent of shocks at the aggregate country level a the one-year frequency—see Column (1) of Panel (c), Table 5—although it declines to 38 percent at the five-year frequency. Columns (2) and (3) show that 71 percent of shocks are smoothed via savings in the commodity sector versus 20 percent in the non-commodity sector. At the five-year frequency, the difference in the risk smoothing becomes smaller: 41 percent in the commodity sector versus a significant 23 percent in the non-commodity sector.

Figure 2, Panel (b) shows that consumption growth fluctuates much less than the relatively large commodity sector shocks, while Panel (c) shows that savings growth has a strong positive correlation with commodity-sector growth. Taken together, they illustrate how risk sharing comes from the insurance of commodity-sector shocks, and that it takes place via pro-cyclical savings.

Pro-cyclical savings play a larger role at shorter frequencies, where transitory shocks dominate. Risk sharing from savings at longer frequencies may be lower because savings become depleted following negative and persistent shocks or because consumption reacts slowly. This could be due to some forms of habit formation, which does not neces-

[10] In many countries, national resource companies also play an important role in production and benefit from the resource revenue through joint ventures. They also typically direct payments to the state. To the extent that these proceeds are invested abroad, for example, through investments of sovereign wealth funds, such international capital movements could also contribute to changes in net factor income.

sarily imply welfare losses, or due to credit constraints, which do. The pattern for savings contrasts with the stable persistent smoothing from net factor income, highlighting the importance of taking advantage of financial integration, specifically ownership diversification, to insure persistent GDP fluctuations.

4.3.2 Sources and uses of savings

We now turn to examining the risk sharing role of savings, broken down into private and public (government) savings (the "sources" of savings). Also, as savings are used either for investment in domestic real assets, or to accumulate or draw down net foreign assets via current account surpluses or deficits, we examine the role of each of these "uses." Under Ricardian equivalence, it does not matter if savings are private or public, but if governments provide the lion's share of risk sharing, it indicates that governments are better integrated in international financial markets and, for example, may be able to borrow at lower rates via bond markets.

Regarding uses of savings, if most risk sharing is associated with pro-cyclical domestic investment, risk is not really shared with other countries. This may be optimal for commodity producers if positive commodity-price shocks are persistent at the same time as it is optimal to invest in mining and extraction. It may also be that some commodity-exporting countries are following the policy advice that resource-rich developing countries, in particular, should invest more windfall profits from exports into the domestic economy and less in foreign assets as discussed in van der Ploeg and Venables (2011). Moreover, if the correlation of savings and domestic investment is low, it could imply that greater global financial integration enabled these countries to invest their savings abroad, breaking down the puzzle of high savings/investment correlation first highlighted by Feldstein and Horioka (1980). We do not attempt to answer these questions here but provide the stylized facts.

We decompose the contributions of savings to risk sharing following Kalemli-Ozcan, Luttini and Sørensen (2014) from the perspective of either sources or uses. For *sources of savings*, we run the regressions which measure which component of savings best absorbs GDP fluctuations:

$$\Delta_h \frac{\text{Savings}_{it}^{k}}{\text{CONS}_{it}} = const^h + \gamma_k^{S,h}\left(\Delta_h \log \text{GDP}_{it}^{com} - \Delta_h \log \text{GDP}_{t}^{world}\right) + u_{it,h},$$

where savings are sourced from the private or government sector, k, ($k \in \{\text{priv};\text{gov}\}$, respectively). The share of savings from each source is regressed on sectoral GDP growth over h periods, in this case $\Delta_h \log \text{GDP}_{it}^{com}$ and we normalize the estimated coefficients such

that they sum up to the savings channel of risk sharing estimated earlier. The coefficients $\gamma^{S,h}_{\text{priv}}$ and $\gamma^{S,h}_{\text{gov}}$ are interpreted as the percentage of consumption-smoothing obtained through private and public savings, respectively.

From Table 6, Panel (a), Column (2), it is clear that government savings are the main source of risk sharing, accounting for 52 percentage points of the 71 percent risk sharing from the savings channel in the commodity-dependent sector at the annual frequency (almost three-quarters of the total). In contrast, the contribution of private savings at the annual frequency is 19 percent as shown in Panel (a), Column (1). This is an important result, as it indicates that the government is primarily responsible for consumption smoothing through pro-cyclical savings, despite government savings comprising only 5 percent of GDP and 25 percent of total savings on average in commodity-exporting countries (Figure 3a). Over a 5-year horizon, neither government nor private savings from the commodity sector are statistically significant at the 10 percent level, although government savings provide 31 percent risk sharing (compared to 10 percent by the private sector). The results are consistent with the interpretation that fiscal constraints may begin to kick in earlier for the public sector, or that government budgets adjust to commodity-price windfalls with a lag.

For non-commodity-sector GDP shocks, private savings account for about 34 percent of risk sharing at the annual frequency, whereas the contribution from government savings is statistically insignificant and negative (see Table 6, Panel (a), Columns (3) and (4)).[11] At the 5-year frequency, the relative impact of fluctuations in non-commodity-sector GDP is much more precisely estimated, with significant point estimates of 9 percent and 15 percent of risk sharing attributed to private and public savings, respectively. In other words, private savings only provide economically significant risk sharing over shorter horizons.

For *uses of savings* either at home (in domestic investment, INV) or investing abroad through the current account (CA), the contribution of savings to risk sharing can be decomposed into the sum of coefficients $\gamma^{h}_{INV,j}$, the fraction allocated to domestic real investment; and $\gamma^{h}_{CA,j}$, the fraction allocated to the current account. The coefficients are estimated from the following regressions (shown here for the commodity sector $j = com$):

$$\Delta_h \frac{CA_{it}}{\text{CONS}_{it}} = const^h + \gamma^{h}_{CA,com}\left(\Delta_h \log \text{GDP}^{com}_{it} - \Delta_h \log \text{GDP}^{world}_{t}\right) + u_{it,h} \tag{19}$$

[11] The coefficient of –14 percent implies negative risk sharing but is imprecisely estimated. Our tentative explanation for this negative coefficient could be reverse causality, so that a reduction in government savings to stimulate the economy leads to higher non-commodity-sector GDP and thus a negative correlation between savings and GDP growth in that sector.

$$\Delta_h \frac{INV_{it}}{\text{CONS}_{it}} = const^h + \gamma^h_{INV,com}\left(\Delta_h \log \text{GDP}^{com}_{it} - \Delta_h \log \text{GDP}^{world}_{t}\right) + u_{it,h}, \tag{20}$$

where h indicates the horizon.

It is clear that current accounts play a large role in international risk sharing: the ratio of the current account to consumption changes by 62 times the fractional change in commodity-sector GDP at the annual frequency (Table 6, Panel (b), Column (1)). The effect is lower at the 5-year frequency where the coefficient is 34.

Domestic investment, in Column (2), plays a smaller role with an insignificant coefficient of 9 at the annual frequency and 7 at the 5-year frequency. For the non-commodity-exporting sector, in Table 6, Panel (b), Columns (3) and (4), the role of the current account balance is much smaller and insignificant. Domestic real investment has even smaller point estimates, in particular at the annual frequency, but the coefficient of 10 at the 5-year frequency is significant at the five percent level. The higher level of significance of domestic investment at the longer frequency may reflect the longer time it takes to implement physical investments.

4.4 Projections versus instrumental variables regression

We interpret the regression of the projection of GDP on commodity prices as isolating the part of the economy ("sector") that directly or indirectly is dependent on commodity prices. The results reported in Column (2) of Table 5 are quite similar to the results from a standard instrumental variables regression, in Table A.3, Column (1), where the latter projects GDP minus world GDP (growth) on the instrument (the price shock $\Delta_h p^{shock}_{it}$). The results are similar in our case because most of the variation comes from country-level GDP and not from world GDP.

The important difference is in the interpretation. A "standard" IV regression is interpreted as the risk sharing obtained for the full economy, with the instrument correction for endogeneity bias. That is, the difference between, say, the Row (1), Column (1), of Table 2 and the Row (1), Column (1), OLS-results of Table A.3 is interpreted as endogeneity bias.[12] The difference is, however, too large to plausibly be a result of endogeneity and we interpret the difference (or more precisely the similar results in Table 2) as the result of intra-country heterogeneity. And, in our case, where the risk sharing measure is not conditional on exogeneity, we obtain an estimate for the orthogonal sector and interpret the OLS estimate as a weighted average of the amount of risk sharing obtained by the two

[12] The sample in the former table is larger, but we do not re-run this table in order to make this technical point.

sectors.

4.5 Different benchmarks for full risk sharing

Our main equation estimates risk sharing with the "world" (the full sample of countries). We also estimated risk sharing using a time-fixed effect estimator, which measures how the group of countries smooth risk among themselves. The main thrust of the results, reported in Appendix Tables A.4–A.7, is that the bulk of the risk sharing happens via smoothing of shocks to the commodity-producing sector, mostly via savings. For example, Table A.6, Panel (c), Column (2) shows that the commodity sector shares practically all the risk through the savings channel.

We examine how the results change if we measure risk sharing with other country-groups than "the world." First, we use the aggregate GDP of advanced economies: risk sharing from net factor income flows may be higher with these more financially developed economies, which might offer more robust and diversified markets for commodity exporters to buy and sell assets. Our results did not change significantly, likely because our "world" sample captures GDP and consumption volatility of the group of advanced economies as well. Second, we use the group of commodity importers instead of "the world." Possibly, risk sharing is more efficient with commodity exporters that face risks that are partly orthogonal to those faced by commodity-importing countries. The results were very similar to those obtained for other risk sharing "targets."

4.6 Robustness

The results above have been checked using a battery of robustness tests, and we find that they hold up well. These tests are discussed in more detail in the online appendix, but we refer to the three main results here.

First, we consider an unbalanced number of observations across regressions with different time spans. As we move back in time, data for some countries are not available, so loss of observations is inevitable, but the results do not qualitatively change (Tables B.2 and B.3).

Second, our benchmark world GDP, consumption, and other aggregates were constructed by defining world GDP growth as the cross-country average growth rate. In other words, we are giving the same weight to each country in this aggregate. But some may argue that larger countries could have a larger "pull" effect, so we also considered aggregate world variables weighted by GDP. The results hold up whether we consider the growth rate of world GDP, or equal weights of the country growth rates.

Third, our results remain virtually unchanged if we normalize the country-specific commodity-price instrument using as weights the share of the country's commodity exports to total commodity exports, rather than to its GDP as defined in Equation (15). Define:

$$\Delta_h p_{it}^{shock2} = \sum_{g \in Commodity} \frac{P_{gt-h}^{USD} X_{git-h}}{\sum_{g \in Commodity} P_{gt-h}^{USD} X_{it-h}^{USD}} \Delta_h \log \frac{P_{gt}^{USD}}{CPI_{it}^{US}}. \tag{21}$$

The alternative specification of Equation (21) makes the shock relatively smaller for countries with high commodity exports relative to GDP, compared to the weighting scheme of Equation (15), but may be more robust to potential endogeneity of GDP, which is no longer used in the weight. Online Appendix Tables B.4 to B.7 show that the results obtained using this alternative instrument are substantively similar to the results of our main specification. Savings is still the main channel of risk sharing for commodity sector shocks, smoothing GDP growth fluctuations by 82 percent, slightly more than the 70 percent found using our main specification reported in Table 5, Panel (c), Column (2).

5 Conclusions

We focus on energy and metals exporting countries (commodity exporters) and develop a projection-based method for decomposing risk sharing at the country-level into risk shared for the part of the GDP that is driven by (exogenous) commodity-prices, and risk shared for the part of the economy that features shocks orthogonal to these. Our method may be relevant for other empirical work in macroeconomics where an instrumented variable is heterogeneous across sectors and those sectors have structurally different relationships with the outcome of interest.

We find that shocks induced by commodity prices are smoothed substantially more than other shocks. Indeed, energy and metal exporting countries in the aggregate use counter-cyclical government savings actively to reduce GDP fluctuations (as shown in Panel (b) of Figure 3), whereas other countries barely use government savings, as shown in Panel (c). The amount of risk sharing from the savings channel is particularly large at the 1-year time horizon. Although it is still the most important channel at the 5-year horizon, the amount is smaller.

For commodity-exporting countries, most risk sharing happens through the smoothing of shocks to the commodity-dependent *sector*. The main channels of risk sharing for shocks to this sector are factor income flows and savings, with pro-cyclical government

savings playing the largest role, especially at shorter time horizons. The net factor income channel of risk sharing plays a minor significant role in risk sharing, but it is relatively more important at longer horizons. As commodity shocks are persistent and generate persistent profits over longer frequencies, this channel is potentially important for international risk sharing and substantial welfare gains could be obtained from greater ownership diversification.

Government savings provide significantly more risk sharing for commodity-price-induced shocks, and significantly more at shorter than at longer horizons. A possible explanation for its importance is the role of sovereign wealth funds and stabilization mechanisms to accumulate savings abroad and mitigate the pro-cyclical nature of government spending. These funds require governments to accumulate assets in response to high commodity prices, ensuring that financial buffers are built during boom periods. This can help prevent excessive spending during good times and preserve the capacity to weather economic downturns.

Risk sharing through pro-cyclical government savings may be a substitute for diversification, but a decline in savings in the face of negative shocks may entail borrowing, which might dry up when shocks are large and persistent. Dedicated sovereign wealth funds, to the extent that they build up a buffer of savings abroad over time and can limit the need to borrow in downturns, may be an attractive alternative to ownership diversification. An evaluation of benefits from alternative forms of income diversification will require a model calibrated to a host of institutional details.

We also find that pro-cyclical savings are mostly reflected in pro-cyclical current account balances, while the amount allocated to pro-cyclical domestic investment is negligible and not necessarily commodity-induced. Risk sharing via domestic investment, however, persists somewhat over longer horizons. Energy and metal exporters may have become more internationally integrated, saving more via international markets, but the factor income channel of risk sharing is still small, indicating barriers to financial diversification. Our results highlight how commodity exporters obtain substantial risk sharing mostly by smoothing shocks induced by commodity-price shocks. Obtaining an understanding of the structural features that underly our results is an important topic for future research.

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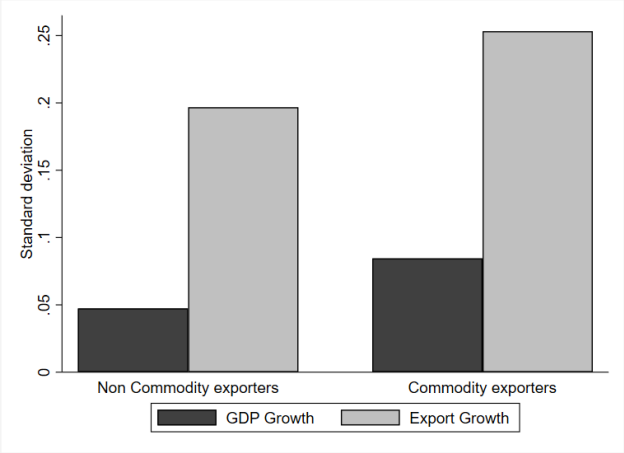
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Figures

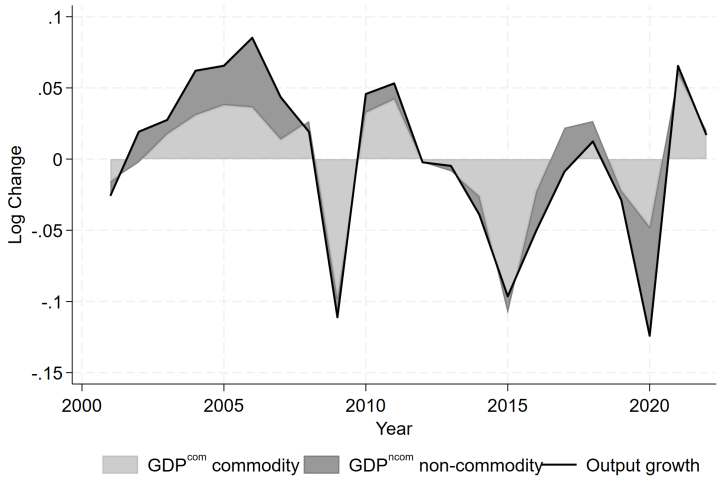
Figure 1: Volatility of GDP and export growth



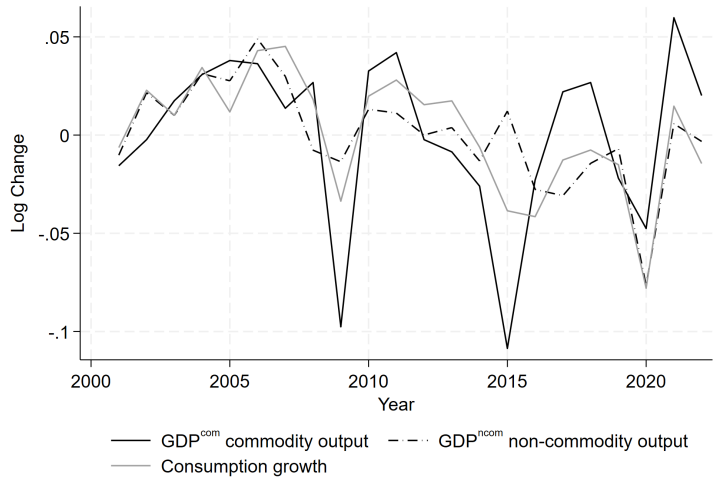
Volatility in GDP growth is measured by the standard deviation of annual growth in per capita GDP, deflated using the U.S. Consumer Price Index. Country classifications into commodity exporters and non-exporters—as well as by commodity type—follow the World Bank's definitions, as described in the Data Section. Non-commodity exporters include agricultural commodity exporters. Commodity exporters include only energy and metal commodity exporters. Volatility of export growth is measured by the standard deviation of the annual growth of export revenues, including both commodity and non-commodity exports.

Figure 2: Sources of GDP fluctuations, consumption, and savings growth

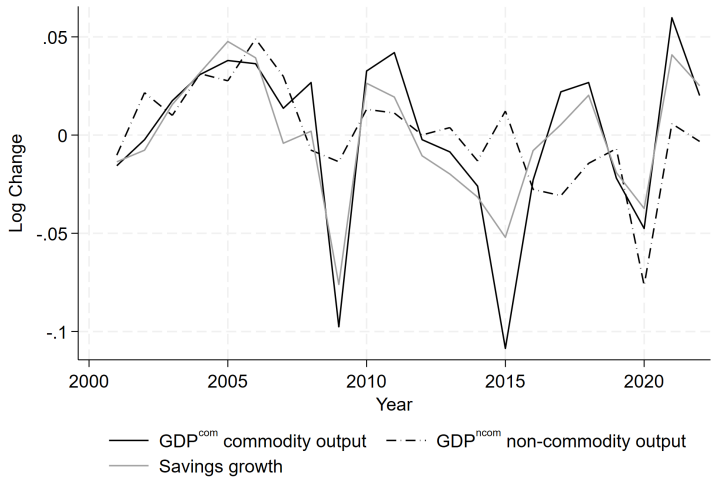
(a) GDP growth and its components: commodity- and non-commodity-sector GDP growth



(b) Growth of commodity- and non-commodity-sector GDP against consumption growth



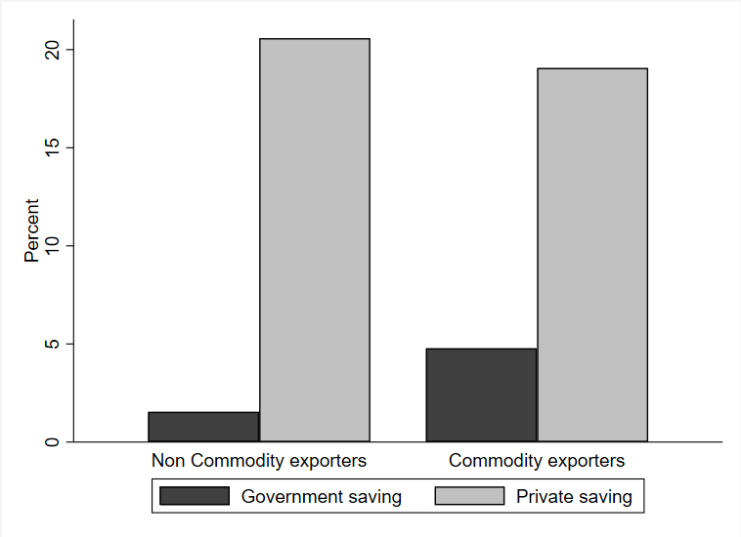
(c) Growth of commodity- and non-commodity-sector GDP against savings growth



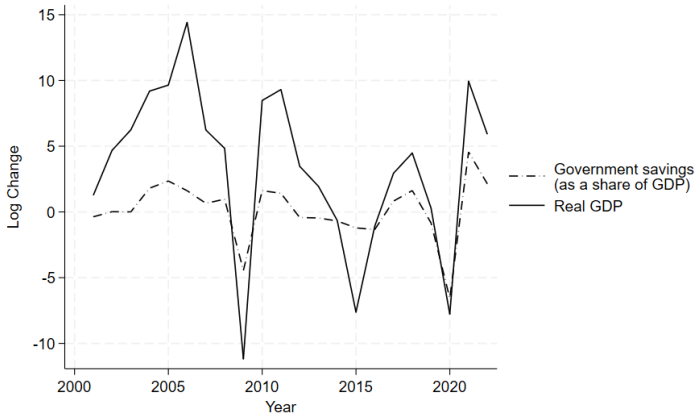
Panel (a): GDP growth and commodity- and non-commodity-sector GDP. Commodity-sector GDP growth ($\Delta \log \text{GDP}^{com}$) is the fitted value from regressing annual real (CPI deflated) per-capita GDP growth on a country-specific weighted index of global commodity-price changes, with weights given by each commodity's share in nominal GDP. Non-commodity-sector GDP growth ($\Delta \log \text{GDP}^{ncom}$) is the residual from this projection. Data spans 2000–2022. Country classifications into commodity exporters and non-exporters—as well as by commodity type—follow the World Bank's definitions, as described in the Data Section. Non-commodity exporters include agricultural commodity exporters. Commodity exporters include only energy and metal commodity exporters.
Panel (b): Commodity- and non-commodity-sector GDP and consumption growth. Consumption growth is measured as the annual log change in real per-capita household consumption, plotted alongside $\Delta \log \text{GDP}^{com}$ and $\Delta \log \text{GDP}^{ncom}$.
Panel (c): Commodity- and non-commodity-sector GDP and savings growth. Savings growth is defined as $\Delta \log \text{NNDI} - \Delta \log \text{CONS}$ where NNDI is Net National Disposable Income and CONS is the sum of private and government consumption (all variables are CPI deflated), plotted alongside GDP^{com} and GDP^{ncom}.

Figure 3: Savings as a share of GDP

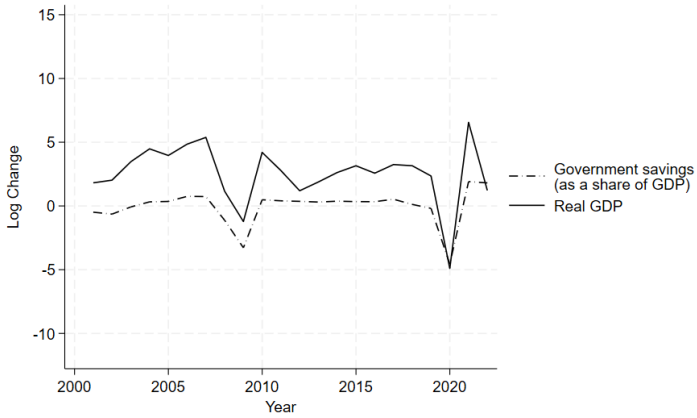
(a) Government and private savings as a share of GDP



(b) Growth of real GDP and the share of government savings in GDP for commodity exporters



(c) Growth of real GDP and the share of government savings in GDP for non-commodity exporters



Commodity exporters denotes metal and energy commodity exporters. Non-commodity exporters include agricultural commodity exporters. Panel (a): Data for general government savings and total savings from the UN System of National Accounts. Private savings were derived as the residual: (1 - share of government savings)*total savings. Two countries with extreme values for the share of private and government savings (Russia and Belarus) were excluded from the analysis. Average values were computed for each country 2000–2022, and then averaged across the commodity and non-commodity-exporting subgroups of countries. Panels (b) and (c): For each panel, we compute the cross-country average for each year (2000–2022) across commodity-exporting groups. Panel (b) reports commodity exporters; Panel (c) reports non-commodity exporters.

Tables

Table 1: Descriptive statistics across the full sample of countries 2000–2022

	(1)	(2)	(3)	(4)
	$\sigma(\Delta \log \text{CONS})$	$\sigma(\Delta \log \text{CONS})/\sigma(\Delta \log \text{GDP})$	$\rho(\Delta \log \text{CONS}, \Delta \log \text{GDP})$	Commodity exporters Export Share
Panel a. Commodity exporters				
	0.05	0.68	0.57	19.05
	(0)	(0.07)	(0.05)	(2.28)
Countries			23	
Panel b. Non-commodity exporters				
	0.03	0.87	0.71	
	(0)	(0.04)	(0.03)	
Countries			73	

The table reports descriptive statistics. $\sigma(\Delta \log \text{CONS})$ and $\sigma(\Delta \log \text{GDP})$ are the within-country standard deviations of annual real per-capita consumption and per-capita GDP growth. Column (1) reports the statistic for consumption and Column (2) reports the average across countries of the ratio $\sigma(\Delta \log \text{CONS})/\sigma(\Delta \log \text{GDP})$. $\rho(\Delta \log \text{CONS}, \Delta \log \text{GDP})$ is the within-country correlation between consumption and GDP growth. Column (4) reports the commodity export share, defined as the average share (percent) of annual commodity exports in total merchandise exports over the sample period. For each panel, we compute each statistic at the country level and then report the cross-country mean. Standard errors of the cross-country mean is reported in parentheses. Panel (a) reports commodity exporters *exp* (energy and metal exporters only), and Panel (b) reports non-commodity exporters (defined as agricultural exporters and commodity importers). The classification is reported in Appendix Table A.2. The estimation period is 2000–2022.

Table 2: Consumption risk sharing in commodity- and non-commodity-exporting countries

Consumption risk	(1) Commodity exporters	(2) Non-commodity exporters	(3) Difference (1)–(2)
$\Delta_1 \log \text{GDP}_{it} - \Delta_1 \log \text{GDP}_t^{world}$	$0.70^{\#\#\#}$	$0.21^{\#\#\#}$	0.49^{***}
	(0.08)	(0.05)	(0.09)
$\Delta_2 \log \text{GDP}_{it} - \Delta_2 \log \text{GDP}_t^{world}$	$0.61^{\#\#\#}$	$0.19^{\#\#\#}$	0.43^{***}
	(0.08)	(0.03)	(0.09)
$\Delta_3 \log \text{GDP}_{it} - \Delta_3 \log \text{GDP}_t^{world}$	$0.53^{\#\#\#}$	$0.17^{\#\#\#}$	0.35^{***}
	(0.08)	(0.03)	(0.09)
$\Delta_4 \log \text{GDP}_{it} - \Delta_4 \log \text{GDP}_t^{world}$	$0.47^{\#\#\#}$	$0.17^{\#\#\#}$	0.30^{***}
	(0.07)	(0.03)	(0.08)
$\Delta_5 \log \text{GDP}_{it} - \Delta_5 \log \text{GDP}_t^{world}$	$0.44^{\#\#\#}$	$0.16^{\#\#\#}$	0.27^{***}
	(0.07)	(0.03)	(0.08)
Observations		1801	

Risk sharing for commodity non-exporters (including agricultural exporters) in Column (1), commodity exporters (energy and metals exporters) in Column (2), and the difference between commodity and non-commodity exporters' risk sharing in Column (3). Risk sharing is calculated as $(1 - \beta_{exp}^{U,h})$ and $(1 - \beta_{nexp}^{U,h})$, where the $\beta_{exp}^{U,h}$ and $\beta_{nexp}^{U,h}$ coefficients are estimated from the regression model $\Delta_h \log \text{CONS}_{it} - \Delta_h \log \text{CONS}_t^{world} = const^h + \beta_{exp}^{U,h} \left(\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GDP}_t^{world}\right) \times I_i^{exp} + \beta_{nexp}^{U,h} \left(\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GDP}_t^{world}\right) \times I_i^{nexp} + u_{it,h}$, with Δ_h defined as $\Delta_h x_t = x_t - x_{t-h}$ and $h \in \{1, \ldots, 5\}$. The difference in risk sharing between commodity and non-commodity exporters is $\beta_{nexp}^{U,h} - \beta_{exp}^{U,h}$. CONS_{it} (GDP_{it}) is aggregate consumption (GDP) in country i in year t. $\Delta_h \log \text{CONS}_t^{world}$ ($\Delta_h \log \text{GDP}_t^{world}$) is the cross-sectional average of consumption (GDP) growth of all the countries in the sample. I_i^{exp} (I_i^{nexp}) are indicator functions for commodity-exporting (non-commodity-exporting) countries. Estimation period 2000–2022. Standard errors, clustered at the country level, in parentheses. $^{\#\#\#}$ denote significance at the 1% level for the null hypothesis of full risk sharing ($1 - \beta_m^{U,h} = 1$) where $m = [exp, nexp]$ indicates commodity export status of the country. In Column (3), *** denote significance at the 1% for the null hypothesis that risk sharing is equal for commodity and non-commodity exporters ($1 - \beta_{nexp}^{U,h} = 1 - \beta_{exp}^{U,h}$).

Table 3: OLS projection of commodity-price shocks on GDP growth

	(1)	(2)	(3)	(4)	(5)
	$\Delta_1 \log \text{GDP}_{it}$	$\Delta_2 \log \text{GDP}_{it}$	$\Delta_3 \log \text{GDP}_{it}$	$\Delta_4 \log \text{GDP}_{it}$	$\Delta_5 \log \text{GDP}_{it}$
Commodity-price shock	0.90***	0.83***	0.82***	0.88***	1.05***
	(0.11)	(0.16)	(0.16)	(0.17)	(0.18)
R-squared	0.46	0.37	0.30	0.27	0.28
Observations			406		

Estimates for the β_h coefficients from estimating the regression $\Delta_h \log \text{GDP}_{it} = const^h + \beta_h \Delta_h p_{it}^{shock} + \epsilon_{it}$, with Δ_h defined as $\Delta_h x_t = x_t - x_{t-h}$ and $h \in \{1, \ldots, 5\}$. The commodity-price shock, p_{it}^{shock}, is defined as $\sum_{g \in Commodity} \frac{P_{gt-h}^{USD} X_{git-h}}{GDP_{it-h}^{USD}} \Delta_h \log \frac{P_{gt}^{USD}}{CPI_{it}^{US}}$, where P_{gt}^{USD} is the price of commodity g in U.S. dollars at time t, and X_{git-h} is the export volume of commodity g in country i at time $t-h$. The numerator, export revenue from commodity g of country i, divided by GDP_{it-h}, the value added in U.S. dollars, CPI_t^{US} is the U.S. consumer price index. The estimation period is 2000–2022. Standard errors clustered at the country level in parentheses. ***denote significance at the 1% level.

Table 4: Consumption risk sharing of aggregate, commodity-, and non-commodity-sector GDP

	(1)	(2)	(3)
	Aggregate Consumption risk sharing	Sector-level risk sharing with the world	
Sectors:		Commodity	Non-commodity
$\Delta_1 \log \text{GDP}_{it} - \Delta_1 \log \text{GDP}_t^{world}$	$0.70^{\#\#\#}$	1.07^{a}	$0.49^{\#\#\#}$
	(0.08)	(0.09)	(0.05)
$\Delta_2 \log \text{GDP}_{it} - \Delta_2 \log \text{GDP}_t^{world}$	$0.62^{\#\#\#}$	0.90^{a}	$0.51^{\#\#\#}$
	(0.08)	(0.08)	(0.07)
$\Delta_3 \log \text{GDP}_{it} - \Delta_3 \log \text{GDP}_t^{world}$	$0.53^{\#\#\#}$	0.88^{a}	$0.44^{\#\#\#}$
	(0.08)	(0.07)	(0.07)
$\Delta_4 \log \text{GDP}_{it} - \Delta_4 \log \text{GDP}_t^{world}$	$0.48^{\#\#\#}$	0.90^{a}	$0.39^{\#\#\#}$
	(0.08)	(0.08)	(0.06)
$\Delta_5 \log \text{GDP}_{it} - \Delta_5 \log \text{GDP}_t^{world}$	$0.44^{\#\#\#}$	0.86^{a}	$0.37^{\#\#\#}$
	(0.07)	(0.10)	(0.06)
Observations		406	

Aggregate risk sharing is calculated as $1-\gamma^{U,h}$, where the $\gamma^{U,h}$ coefficients are estimated from the regression model $\Delta_h \log \text{CONS}_{it} - \Delta_h \log \text{CONS}_t^{world} = const^h + \gamma^{U,h}\left(\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GDP}_t^{world}\right) + u_{it,h}$, with Δ_h defined as $\Delta_h x_t = x_t - x_{t-h}$ and $h \in \{1,\ldots,5\}$; CONS_{it} (GDP_{it}) is aggregate consumption (GDP) in country i in year t. $\Delta_h \log \text{CONS}_t^{world}$ ($\Delta_h \log \text{GDP}_t^{world}$) is the cross-sectional average of consumption (GDP) growth of all the commodity-exporting countries in the sample of Table 2. Risk sharing for the commodity and non-commodity sectors is estimated likewise, where GDP in the equation above is substituted by GDP^{com} and GDP^{ncom}, respectively. Column (1) reports aggregate consumption risk sharing with the world; Columns (2)-–(3) report sectoral risk sharing with the world for commodity- and non-commodity-sector GDP, respectively. Commodity-sector GDP is defined as $\Delta_h \log \text{GDP}^{com} = const^h + \beta_h \Delta_h p_{it}^{shock}$ and non-commodity-sector GDP is $\Delta \log \text{GDP}^{ncom} = \Delta \log \text{GDP} - \Delta \log \text{GDP}^{com}$. $\Delta_h p_{it}^{shock}$ is defined as $\sum_{g \in Commodity} \frac{P_{gt-h}^{USD} X_{git-h}}{GDP_{it-h}^{USD}} \Delta_h \log \frac{P_{gt}^{USD}}{CPI_{it}^{US}}$ where P_{gt}^{USD} represents the price of commodity g in U.S. dollars at time t, and X_{git-h} is the export volume of commodity g in country i at time $t-h$. The numerator, export revenue from commodity g of country i, divided by GDP_{it-h}, the value added in U.S. dollars, CPI_t^{US} is the U.S. consumer price index. Standard errors, clustered at the country level, in parentheses. Subscript $^{\#\#\#}$ denotes that the coefficient is significant at the 1 percent level for a test of the null hypothesis of full risk sharing ($1-\gamma^{U,h}=1$). Superscript a denotes that full risk sharing is not rejected at the 10% level.

Table 5: Channels of risk sharing at the aggregate and sector level

	(1)	(2)	(3)
	Aggregate channels of risk sharing	Channels of risk sharing with world, overall	
Sectors:		Commodity	Non-commodity
Panel a. Net factor income channel			
$\Delta_1 \log \text{GDP}_{it} - \Delta_1 \log \text{GDP}_t^{world}$	0.05**	0.06**	–0.01
	(0.02)	(0.03)	(0.02)
$\Delta_5 \log \text{GDP}_{it} - \Delta_5 \log \text{GDP}_t^{world}$	0.04***	0.04**	0.03
	(0.01)	(0.01)	(0.02)
Panel b. International net transfers channel			
$\Delta_1 \log \text{GDP}_{it} - \Delta_1 \log \text{GDP}_t^{world}$	–0.01	–0.03	0.03*
	(0.02)	(0.02)	(0.01)
$\Delta_5 \log \text{GDP}_{it} - \Delta_5 \log \text{GDP}_t^{world}$	0.02	0.00	0.03*
	(0.01)	(0.01)	(0.01)
Panel c. Savings channel			
$\Delta_1 \log \text{GDP}_{it} - \Delta_1 \log \text{GDP}_t^{world}$	0.65***	0.71***	0.20*
	(0.09)	(0.13)	(0.11)
$\Delta_5 \log \text{GDP}_{it} - \Delta_5 \log \text{GDP}_t^{world}$	0.38***	0.41***	0.23***
	(0.07)	(0.10)	(0.08)
Observations		406	

Column (1) shows channels of country-level consumption risk sharing and Columns (2)–(3) show channels of sectoral risk sharing for commodity- and non-commodity-sectors, respectively. Each panel reports the slope derived, for instance for the aggregate, from the univariate regressions $\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GNI}_{it} = const^h + \gamma^{F,h} \Delta_h \left(\log \text{GDP}_{it} - \log \text{GDP}_t^{world} \right) + u_{it,h}$. Panel (a) shows risk sharing from net factor income) : $\Delta_h \log \text{GNI}_{it} - \Delta_h \log \text{NNDI} = const^h + \gamma^{T,h} \left(\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GDP}_t^{world} \right) + u_{it,h}$. Panel (b) shows risk sharing from international net transfers: $\Delta_h \log \text{NNDI}_{it} - \Delta_h \log \text{CONS}_{it} = const^h + \gamma^{S,h} \left(\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GDP}_t^{world} \right) + u_{it,h}$. Panel (c) shows risk sharing from savings. Δ_h is defined as $\Delta_h x_t = x_t - x_{t-h}$ and $h \in \{1, \ldots, 5\}$. $\Delta_h \text{GDP}_t^{world}$ is the cross-sectional average of log differenced GDP of all countries included in the sample of Table 2. Risk sharing for commodity- and non-commodity-sector sectors is estimated likewise, where GDP is substituted with GDP^{com} and GDP^{ncom}, respectively. Commodity-sector GPP, $\Delta \log \text{GDP}^{com}$ is the fitted value from a regression of $\Delta \log \text{GDP}$ on $\Delta_h p_{it}^{shock}$ and non-commodity-sector GDP is $\Delta \log \text{GDP}^{ncom} = \Delta \log \text{GDP} - \Delta \log \text{GDP}^{com}$. $\Delta_h p_{it}^{shock}$ is defined as $\sum_{g \in Commodity} \frac{P_{gt-h}^{USD} X_{git-h}}{GDP_{it-h}^{USD}} \Delta_h \log \frac{P_{gt}^{USD}}{CPI_{it}^{US}}$ where P_{gt}^{USD} is the price of commodity g in U.S. dollars at time t, and X_{git-h} is the export volume of commodity g in country i at time $t-h$. The numerator, export revenue from commodity g of country i, divided by GDP_{it-h}, the value added in U.S. dollars, CPI_t^{US} is the U.S. consumer price index. The estimation period is 2000–2022. Standard errors, clustered at the country level, in parentheses. ***, **, and * denote significance at 1%, 5%, and 10%; respectively, for the null of no risk sharing from the relevant channel.

Table 6: Contribution of sources and uses of savings to risk sharing for commodity- and non-commodity-sectors

	(1)	(2)	(3)	(4)	(5)
Consumption risk	Commodity sector		Non-commodity sector		
Panel a. Savings' sources	Private	Government	Private	Government	Obs
$\Delta_1 \log \text{GDP}_{it} - \Delta_1 \log \text{GDP}_t^{world}$	0.19**	0.52**	0.34*	–0.14	264
	(0.08)	(0.23)	(0.17)	(0.26)	
$\Delta_5 \log \text{GDP}_{it} - \Delta_5 \log \text{GDP}_t^{world}$	0.10	0.31	0.09*	0.15**	248
	(0.20)	(0.19)	(0.04)	(0.06)	
Panel b. Savings' uses	Current account	Investment	Current account	Investment	Obs
$\Delta_1 \log \text{GDP}_{it} - \Delta_1 \log \text{GDP}_t^{world}$	0.62***	0.09	0.18	0.02	382
	(0.10)	(0.07)	(0.14)	(0.08)	
$\Delta_5 \log \text{GDP}_{it} - \Delta_5 \log \text{GDP}_t^{world}$	0.34***	0.07	0.13	0.10**	374
	(0.11)	(0.04)	(0.10)	(0.04)	

The table reports decompositions of sectoral risk sharing from savings: commodity-sector GDP in Columns (1)–(2), and non-commodity-sector GDP in Columns (3)–(4). Panel (a) estimates the decomposition by private/government sources. For the commodity sector, each column reports the slope from the regression $\Delta_h \frac{\text{Savings}_{it}^k}{\text{CONS}_{it}} = const^h + \gamma_k^h \Delta_h \left(\log \text{GDP}_{it}^{com} - \Delta_h \log \text{GDP}_t^{world} \right) + u_{it,h}$, where $k \in \{\text{priv}, \text{gov}\}$, and Δ_h defined as $\Delta_h x_t = x_t - x_{t-h}$, and $h \in \{1, \ldots, 5\}$ for generic x. $\gamma_{priv}^h + \gamma_{gov}^h$ approximates the coefficients $\gamma^{S,h}$. $\gamma^{S,h}$ is estimated from $\Delta_h \log \text{NNDI}_{it} - \Delta_h \log \text{CONS}_{it} = const^h + \gamma^{S,h} \left(\Delta_h \log \text{GDP}_{it}^{com} - \Delta_h \log \text{GDP}_t^{world} \right) + u_{it,h}$, where the $\Delta_h \frac{S_{it}^{\text{gov}}}{\text{CONS}_{it}} + \Delta_h \frac{S_{it}^{\text{priv}}}{\text{CONS}_{it}}$ is a linear approximation to $\Delta_h \log \text{NNDI}_{it} - \Delta_h \log \text{CONS}_{it}$). Panel (b) reports risk sharing by uses of savings, either invested abroad through the current account (CA) or invested domestically (INV). It reports the slope from the regressions $\Delta_h \frac{\text{CA}_{it}}{\text{CONS}_{it}} = const^h + \gamma_{\text{CA}}^h \Delta_h \left(\log \text{GDP}_{it}^{com} - \log \text{GDP}_t^{world} \right) + u_{it,h}$ and $\Delta_h \frac{\text{INV}_{it}}{\text{CONS}_{it}} = const^h + \gamma_{\text{INV}}^h \left(\Delta_h \log \text{GDP}_{it}^{com} - \Delta_h \log \text{GDP}_t^{world} \right) + u_{it,h}$. $\gamma_{\text{CA}}^h + \gamma_{\text{INV}}^h$ approximate the coefficients $\gamma^{S,h}$. ($\Delta_h \frac{\text{CA}_{it}}{\text{CONS}_{it}} + \Delta_h \frac{INV_{it}}{\text{CONS}_{it}}$) is a linear approximation to $\Delta_h \log \text{NNDI}_{it} - \Delta_h \log \text{CONS}_{it}$.) For the non-commodity sector, GDP^{com} is substituted by GDP^{ncom}. Commodity-sector GDP is the fitted value from a regression of $\Delta^h \log \text{GDP}$ on $\Delta_h p_{it}^{shock}$ and non-commodity-sector GDP is $\Delta \log \text{GDP}^{ncom} = \Delta \log \text{GDP} - \Delta \log \text{GDP}^{com}$. $\Delta_h p_{it}^{shock}$ is defined as $\sum_{g \in Commodity} \frac{P_{gt-h}^{USD} X_{git-h}}{GDP_{it-h}^{USD}} \Delta_h \log \frac{P_{gt}^{USD}}{CPI_{it}^{US}}$, where P_{gt}^{USD} is the price of commodity g in U.S. dollars at time t, and X_{git-h} is the export volume of commodity g in country i at time $t-h$. The numerator, export revenue from commodity g of country i, is divided by GDP_{it-h} in U.S. dollars and CPI_t^{US} is the U.S. consumer price index. Estimation period is 2000–2022. Standard errors in parentheses are clustered by country. The γ-coefficients (and standard errors) are rescaled such that their sum equates the coefficients $\gamma^{S,h}$ from Table 5. ***, **, and * denote significance at 1%, 5%, and 10%; respectively, for the null of no contribution from the relevant source or use.

A Appendix

A.1 Appendix tables

The appendix provides additional details in the tables that follow. Table A.1 shows the definitions and sources of the main variables while Table A.2 shows the list of countries used in the analysis. The group of countries comprising metals and energy exporters is called commodity-exporting countries, and they are the main subject of analysis. Their GDP growth is decomposed into two "sectors:" the commodity sector and the non-commodity sector. Non-commodity-exporting countries include agricultural exporting countries and commodity-importing countries. Table A.2's footnote describes the classification criteria. We use annual data for the 2000–2022 period based on availability.

Table A.3 presents the results of a standard IV regression estimating aggregate risk sharing and its channels. As discussed in Section 4.4, the estimates are quantitatively similar to those obtained for the commodity sector.

Tables A.4 to A.7 are similar to our main results presented in Tables 3–6, but instead of looking at risk sharing with the world, we use time-fixed effects. The interpretation is that we are measuring risk sharing among the countries in the regression sample, so deviations from our main results in that sense do not reflect lack of robustness but rather the different interpretation. At the first stage, the commodity-price shock is not as correlated to $\Delta_h \log \text{GDP}_{it}$ (0.57 instead of 0.9 for $h = 1$). However, the consumption risk sharing results in Table A.5 show that the commodity sector shares risk with other commodity exporters quite a bit, especially compared to Table 4. Column (2), Row 1, of Table A.5 shows a coefficient of 1.22 compared to 1.07 in the baseline Table 4.

Over a 5-year period, there is a bit less risk sharing in this case compared to our baseline specification of Table 4. Table A.6 shows that the net factor income channel is less important compared to the main results of Table 5, otherwise the results are very similar. Table A.7 shows that government savings are even more important for commodity sector shocks, absorbing practically all fluctuations. With this alternative construction of the estimates, the use of savings abroad is more important than in our baseline specification.

Table A.1: Variables: description and sources

Variables	**Definition**	**Source**
Transfers	The difference between Net Disposable National Income and Gross National Income	WDI (database), authors' calculations
Net factor income	The difference between Gross National Income and GDP	WDI (database), authors' calculations
Savings	Gross national savings, the difference between Consumption and Net	WDI (database), authors' calculations
Domestic investment	Gross capital formation (public and private)	WDI (database), authors' calculations
Government savings	General government tax revenue, non-tax revenue, and short-term grants minus expenditures	National account statistics
Private savings	Gross national savings minus government savings	National account statistics

Table A.2: Sample description

Energy or Metal Exporters			Non-energy/non-metal Exporters		
Economy	First year	Last year	Economy	First year	Last year
Angola (E)	2014	2021	Albania	2001	2022
United Arab Emirates (E)	2012	2020	Austria	2000	2021
Azerbaijan E)	2001	2022	Belgium	2004	2021
Bolivia (E)	2000	2021	Benin (A)	2003	2004
Canada (E)	2000	2022	Bangladesh	2008	2013
Colombia (E)	2000	2022	Bulgaria	2001	2022
Algeria (E)	2001	2017	Bosnia and Herzegovina	2010	2012
Ghana (E)	2001	2017	Belarus	2003	2021
Indonesia (E)	2015	2022	Brazil (A)	2000	2022
Iran, Islamic Rep. (E)	2002	2018	Switzerland	2017	2021
Kazakhstan (E)	2000	2021	China	2000	2021
Kuwait (E)	2000	2019	Côte d'Ivoire	2020	2020
Norway (E)	2000	2021	Costa Rica (A)	2000	2022
Oman (E)	2005	2021	Czechia	2000	2021
Russian Federation (E)	2001	2021	Germany	2000	2022
Saudi Arabia (E)	2010	2021	Denmark	2000	2022
Armenia (M)	2004	2022	Dominican Republic	2006	2022
Australia (M)	2000	2022	Egypt, Arab Rep.	2000	2022
Chile (M)	2000	2022	Spain	2000	2021
Kyrgyz Republic (M)	2003	2021	Finland (M)	2000	2022
Mongolia (M)	2001	2022	France	2000	2021
Mauritania (M)	2005	2022	United Kingdom	2000	2021
Peru (M)	2000	2021	Georgia	2001	2022
South Africa (M)	2000	2022	Greece	2011	2021
			Guatemala (A)	2000	2022
			Hong Kong SAR, China	2002	2022
			Honduras (A)	2000	2021
			Croatia	2000	2022
			Hungary	2000	2021
			India	2000	2022
			Ireland	2000	2021
			Israel	2000	2021
			Italy	2000	2022
			Jordan	2002	2019
			Japan	2000	2021
			Kenya (A)	2000	2022
			Cambodia	2010	2021
			Korea, Rep.	2000	2022
			Lao PDR (A)	2015	2016
			Sri Lanka	2004	2009
			Lithuania	2000	2021
			Latvia	2000	2021
			Morocco	2000	2022
			Moldova	2001	2022
			Madagascar (A)	2006	2022
			Mexico	2000	2022
			North Macedonia	2000	2022
			Malaysia	2000	2022
			Nicaragua (A)	2004	2022
			Netherlands	2000	2021
			Nepal	2014	2022
			New Zealand (A)	2000	2021
			Pakistan	2000	2022
			Panama	2000	2017
			Philippines	2003	2022
			Poland	2000	2022
			Portugal	2000	2021
			Paraguay (A)	2005	2022
			Rwanda (A)	2006	2022
			Senegal (A)	2001	2022
			Singapore	2000	2022
			El Salvador	2000	2022
			Slovak Republic	2000	2021
			Slovenia	2000	2021
			Sweden	2000	2021
			Togo (A)	2005	2018
			Thailand	2000	2022
			Tunisia	2000	2022
			Türkiye	2000	2022
			Tanzania (A)	2003	2022
			Uganda (A)	2000	2021
			Uruguay (A)	2000	2015
			United States	2000	2021
			Uzbekistan (A)	2022	2022
			Viet Nam	2002	2021

List of countries by type of exports and years of observation, classified according to the definitions used in the World Bank *Global Economic Prospects June 2024*. A country is considered an exporter of a commodity group if at least 30 percent of its export value in the 2022–2024 period is in commodities, or at least 20 percent of its export value during that period is in a type of commodity group (energy, metals, or agriculture). Energy exporters are denoted with "(E)" Metal exporters are denoted "(M)," and Agricultural exports "(A)." The remaining countries are commodity importers (as they do not fit the above World Bank definition). In our analysis, countries listed in the left column are defined as "commodity-exporting countries."

Table A.3: Consumption risk sharing and its channels following a pure instrumental variable estimation for the commodity sector

	(1)	(2)	(3)	(4)
	Aggregate Consumption risk sharing, commodity sector	Channels of risk sharing		
		Factor income	Transfers	Savings
$\Delta_1 \log \text{GDP}_{it} - \Delta_1 \log \text{GDP}_t^{world}$	1.14^a	0.12**	–0.05*	1.08***
	(0.10)	(0.04)	(0.03)	(0.08)
$\Delta_2 \log \text{GDP}_{it} - \Delta_2 \log \text{GDP}_t^{world}$	0.93^a	0.09***	–0.04	0.88***
	(0.13)	(0.03)	(0.02)	(0.13)
$\Delta_3 \log \text{GDP}_{it} - \Delta_3 \log \text{GDP}_t^{world}$	0.85^a	0.09***	–0.03	0.79***
	(0.11)	(0.02)	(0.02)	(0.12)
$\Delta_4 \log \text{GDP}_{it} - \Delta_4 \log \text{GDP}_t^{world}$	0.83^a	0.08***	–0.02	0.77***
	(0.10)	(0.02)	(0.02)	(0.10)
$\Delta_5 \log \text{GDP}_{it} - \Delta_5 \log \text{GDP}_t^{world}$	$0.77^{\#}$	0.07***	–0.01	0.71***
	(0.12)	(0.02)	(0.02)	(0.11)
Observations		406		

The table reports instrumental variable estimation of consumption risk sharing and its channels, using commodity-prices as an instrument for GDP growth. Aggregate consumption risk sharing is calculated as $1-\gamma^{U,h}$, where the $\gamma^{U,h}$ coefficients are estimated from the regression model $\Delta_h \log \text{CONS}_{it} - \Delta_h \log \text{CONS}_t^{world} = const^h + \gamma^{U,h}\left(\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GDP}_t^{world}\right) + u_{it,h}$, with $\Delta_h x_t = x_t - x_{t-h}$ and $h \in \{1,\ldots,5\}$. CONS_{it} (GDP_{it}) is aggregate consumption (GDP) in country i in year t, and $\Delta_h \log \text{CONS}_t^{world}$ ($\Delta_h \log \text{GDP}_t^{world}$) is the cross-sectional average of consumption (GDP) growth of all the commodity-exporting countries in the sample of Table 2. Channels of risk sharing are obtained from the following univariate regressions. For Factor income: $\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GNI}_{it} = const^h + \gamma^{F,h}\Delta_h\left(\log \text{GDP}_{it} - \log \text{GDP}_t^{world}\right) + u_{it,h}$, for Transfers: $\Delta_h \log \text{GNI}_{it} - \Delta_h \log \text{NNDI}_{it} = const^h + \gamma^{T,h}\left(\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GDP}_t^{world}\right) + u_{it,h}$, and for Savings: $\Delta_h \log \text{NNDI}_{it} - \Delta_h \log \text{CONS}_{it} = const^h + \gamma^{S,h}\left(\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GDP}_t^{world}\right) + u_{it,h}$. The term $\Delta_h\left(\log \text{GDP}_{it} - \log \text{GDP}_t^{world}\right)$ is instrumented by $\Delta_h p_{it}^{shock}$, defined as $\Delta_h p_{it}^{shock} = \sum_{g \in Commodity} \frac{P_{g,t-h}^{USD} X_{g,i,t-h}}{GDP_{i,t-h}^{USD}} \Delta_h \log\left(\frac{P_{g,t}^{USD}}{CPI_t^{US}}\right)$, where $P_{g,t}^{USD}$ is the price of commodity g in U.S. dollars at time t, $X_{g,i,t-h}$ is the export volume of commodity g in country i at time $t-h$, $GDP_{i,t-h}^{USD}$ is nominal GDP in U.S. dollars, and CPI_t^{US} is the U.S. consumer price index. Standard errors, clustered at the country level, in parentheses; ***, **, and * denote significance at the 1%, 5%, and 10% levels. Superscript $^{\#}$ denotes that the coefficient is significant at the 10% level for a test of the null hypothesis of full risk sharing ($1-\gamma^{U,h}=1$). Superscript ^{a} denotes that full risk sharing is not rejected at the 10% level.

Table A.4: OLS projection of commodity-price shocks on GDP growth: regression model including time-fixed effects

	(1)	(2)	(3)	(4)	(5)
	$\Delta_1 \log \text{GDP}_{it}$	$\Delta_2 \log \text{GDP}_{it}$	$\Delta_3 \log \text{GDP}_{it}$	$\Delta_4 \log \text{GDP}_{it}$	$\Delta_5 \log \text{GDP}_{it}$
commodity-price shock	0.57***	0.54***	0.55***	0.61***	0.73***
	(0.11)	(0.13)	(0.12)	(0.12)	(0.13)
R-squared	0.60	0.57	0.53	0.50	0.49
Observations			406		

The β_h coefficients are estimated from the regression $\Delta_h \log \text{GDP}_{it} = \tau_{ht} + \beta_h \Delta_h p_{it}^{shock} + \epsilon_{it}$, with τ_{ht} is a time-fixed effect, Δ_h defined as $\Delta_h x_t = x_t - x_{t-h}$ and $h \in \{1, \ldots, 5\}$. The commodity-price shock p_{it}^{shock} is defined as $\sum_{g \in Commodity} \frac{P_{gt-h}^{USD} X_{git-h}}{GDP_{it-h}^{USD}} \Delta_h \log \frac{P_{gt}^{USD}}{CPI_{it}^{US}}$ where P_{gt}^{USD} represents the price of commodity g in U.S. dollars at time t, and X_{git-h} is the export volume of commodity g in country i at time $t-h$. The numerator, export revenue from commodity g of country i, divided by GDP_{it-h}, the value added in U.S. dollars, CPI_t^{US} is the U.S. consumer price index. The estimation period is 2000–2022. Standard errors clustered at the country level in parentheses. ***denote significance at the 1% level.

Table A.5: Consumption risk sharing by each sector: regression model including time-fixed effects

	(1)	(2)	(3)
	Consumption risk sharing	Risk sharing of each sector, overall	
Sectors:		Commodity	Non-commodity
$\Delta_1 \log \text{GDP}_{it}$	$0.64^{\#\#\#}$	1.22^{a}	$0.51^{\#\#\#}$
	(0.08)	(0.15)	(0.07)
$\Delta_2 \log \text{GDP}_{it}$	$0.56^{\#\#\#}$	0.94^{a}	$0.49^{\#\#\#}$
	(0.07)	(0.20)	(0.06)
$\Delta_3 \log \text{GDP}_{it}$	$0.47^{\#\#\#}$	0.87^{a}	$0.41^{\#\#\#}$
	(0.07)	(0.18)	(0.07)
$\Delta_4 \log \text{GDP}_{it}$	$0.42^{\#\#\#}$	0.84^{a}	$0.36^{\#\#\#}$
	(0.07)	(0.16)	(0.06)
$\Delta_5 \log \text{GDP}_{it}$	$0.38^{\#\#\#}$	0.75^{a}	$0.33^{\#\#\#}$
	(0.06)	(0.18)	(0.06)
Observations		406	

Aggregate risk sharing is calculated as $1-\gamma^{U,h}$, where the $\gamma^{U,h}$ coefficients are estimated from the regression model $\Delta_h \log \text{CONS}_{it} = \mu_{ht} + \gamma^{U,h} \Delta_h \log \text{GDP}_{it} + u_{it,h}$, with μ_{ht} denoting time-fixed effects, Δ_h defined as $\Delta_h x_t = x_t - x_{t-h}$, and $h \in \{1,\ldots,5\}$; CONS_{it} (GDP_{it}) is aggregate consumption (GDP) in country i in year t. Risk sharing for the commodity and non-commodity sectors is estimated likewise, where GDP in the equation above is substituted by GDP^{com} and GDP^{ncom}, respectively. Column (1) reports aggregate consumption risk sharing with the world; Columns (2)–(3) report sectoral risk sharing with the world for commodity- and non-commodity-sector GDP, respectively. commodity-sector GDP is defined as $\Delta \log \text{GDP}^{com} = \tau_{ht} + \beta_h \Delta_h p_{it}^{shock}$ and non-commodity-sector GDP is $\Delta \log \text{GDP}^{ncom} = \Delta \log \text{GDP} - \Delta \log \text{GDP}^{com}$. $\Delta_h p_{it}^{shock}$ is defined as $\sum_{g \in Commodity} \frac{P_{gt-h}^{USD} X_{git-h}}{GDP_{it-h}^{USD}} \Delta_h \log \frac{P_{gt}^{USD}}{CPI_{it}^{US}}$ where P_{gt}^{USD} represents the price of commodity g in U.S. dollars at time t, and X_{git-h} is the export volume of commodity g in country i at time $t-h$. The numerator, export revenue from commodity g of country i, divided by GDP_{it-h}, the value added in U.S. dollars, CPI_t^{US} is the U.S. consumer price index. Standard errors, clustered at the country level, are reported in parentheses. Subscript $^{\#\#\#}$ denotes that the coefficient is significant at the 1 percent level for a test of the null hypothesis of full risk sharing ($1-\gamma^{U,h}=1$). Superscript a denotes that full risk sharing is not rejected at the 10% level.

Table A.6: Channels of risk sharing. Overall versus sectors: regression model includes time-fixed effects

	(1)	(2)	(3)
	Aggregate Consumption risk sharing	Sector-level risk sharing with the world	
Sectors:		Commodity	Non-commodity
Panel a. Net factor income channel			
$\Delta_1 \log \text{GDP}_{it}$	0.03	0.08	0.02
	(0.02)	(0.05)	(0.02)
$\Delta_5 \log \text{GDP}_{it}$	0.03**	0.04	0.03**
	(0.01)	(0.03)	(0.01)
Panel b. International net transfers channel			
$\Delta_1 \log \text{GDP}_{it}$	0.00	–0.04	0.02
	(0.02)	(0.04)	(0.02)
$\Delta_5 \log \text{GDP}_{it}$	0.03*	0.01	0.03*
	(0.02)	(0.02)	(0.02)
Panel c. Savings channel			
$\Delta_1 \log \text{GDP}_{it}$	0.60***	1.18***	0.48***
	(0.08)	(0.24)	(0.10)
$\Delta_5 \log \text{GDP}_{it}$	0.32***	0.70**	0.27***
	(0.06)	(0.28)	(0.06)
Observations		406	

Column (1) shows channels of country-level consumption risk sharing and Columns (2)–(3) show channels of sectoral risk sharing for commodity and non-commodity sectors, respectively. Each panel reports the slope derived, for instance for the aggregate, from the univariate regressions $\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GNI}_{it} = \mu_{ht} + \gamma^{F,h} \Delta_h \log \text{GDP}_{it} + u_{it,h}$. Panel (a) shows risk sharing from net factor income) : $\Delta_h \log \text{GNI}_{it} - \Delta_h \log \text{NNDI} = \mu_{ht} + \gamma^{T,h} \Delta_h \log \text{GDP}_{it} + u_{it,h}$. Panel (b) shows risk sharing from international net transfers: $\Delta_h \log \text{NNDI}_{it} - \Delta_h \log \text{CONS}_{it} = \mu_{ht} + \gamma^{S,h} \Delta_h \log \text{GDP}_{it} + u_{it,h}$. Panel (c) shows risk sharing from savings. μ_{ht} denotes time-fixed effects, Δ_h is defined as $\Delta_h x_t = x_t - x_{t-h}$, and $h \in \{1, \ldots, 5\}$. Risk sharing for commodity and non-commodity sector sectors is estimated likewise, where GDP is substituted with GDP^{com} and GDP^{ncom}, respectively. commodity-sector GDP, $\Delta \log \text{GDP}^{com}$ is the fitted value from a regression of $\Delta \log \text{GDP}$ on $\Delta_h p_{it}^{shock}$, including time-fixed effects, and non-commodity-sector GDP is $\Delta \log \text{GDP}^{ncom} = \Delta \log \text{GDP} - \Delta \log \text{GDP}^{com}$. $\Delta_h p_{it}^{shock}$ is defined as $\sum_{g \in Commodity} \frac{P_{gt-h}^{USD} X_{git-h}}{GDP_{it-h}^{USD}} \Delta_h \log \frac{P_{gt}^{USD}}{CPI_{it}^{US}}$ where P_{gt}^{USD} is the price of commodity g in U.S. dollars at time t, and X_{git-h} is the export volume of commodity g in country i at time $t-h$. The numerator, export revenue from commodity g of country i, divided by GDP_{it-h}, the value added in U.S. dollars, CPI_t^{US} is the U.S. consumer price index. The estimation period is 2000–2022. Standard errors, clustered at the country level, in parentheses. ***, **, and * denote significance at 1%, 5%, and 10%; respectively, for the null of no risk sharing from the relevant channel.

Table A.7: Contribution of sources and uses of savings to risk-sharing: regression model with time-fixed effects

	(1)	(2)	(3)	(4)	(5)
Consumption risk	Commodity sector		Non-commodity sector		
Panel a. Savings' sources	Private	Government	Private	Government	Obs
$\Delta_1 \log \text{GDP}_{it}$	0.19	0.99***	0.15**	0.32***	264
	(0.11)	(0.10)	(0.06)	(0.08)	
$\Delta_5 \log \text{GDP}_{it}$	0.19	0.52***	0.10**	0.17**	248
	(0.17)	(0.04)	(0.04)	(0.06)	
Panel b. Savings' uses	Current account	Investment	Current account	Investment	Obs
$\Delta_1 \log \text{GDP}_{it}$	1.07***	0.11	0.41***	0.06	382
	(0.19)	(0.12)	(0.14)	(0.07)	
$\Delta_5 \log \text{GDP}_{it}$	0.50*	0.20***	0.19**	0.08**	374
	(0.25)	(0.06)	(0.09)	(0.04)	

The table reports decompositions of sectoral risk sharing from savings: commodity-sector GDP in Columns (1)–(2), and non-commodity-sector GDP in Columns (3)–(4). Panel (a) estimates the decomposition by private/government sources. For the commodity sector, each column reports the slope from the regression $\Delta_h \frac{\text{Savings}^k_{it}}{\text{CONS}_{it}} = \mu_{ht} + \gamma^h_k \Delta_h \log \text{GDP}^{com}_{it} + u_{it,h}$, where $k \in \{\text{priv}, \text{gov}\}$, μ_{ht} denotes time-fixed effects, and Δ_h defined as $\Delta_h x_t = x_t - x_{t-h}$, and $h \in \{1, \ldots, 5\}$ for generic x. $\gamma^h_{priv} + \gamma^h_{gov}$ approximates the coefficients $\gamma^{S,h}$. $\gamma^{S,h}$ is estimated from $\Delta_h \log \text{NNDI}_{it} - \Delta_h \log \text{CONS}_{it} = \mu_{ht} + \gamma^{S,h} \Delta_h \log \text{GDP}^{com}_{it} + u_{it,h}$, where $\Delta_h \frac{S^{\text{gov}}_{it}}{\text{CONS}_{it}} + \Delta_h \frac{S^{\text{priv}}_{it}}{\text{CONS}_{it}}$ is a linear approximation to $\Delta_h \log \text{NNDI}_{it} - \Delta_h \log \text{CONS}_{it}$). Panel (b) reports risk sharing by uses of savings, either invested abroad through the current account (CA) or invested domestically (INV). It reports the slope from the regressions $\Delta_h \frac{\text{CA}_{it}}{\text{CONS}_{it}} = \mu_{ht} + \gamma^h_{\text{CA}} \Delta_h \log \text{GDP}^{com}_{it} + u_{it,h}$ and $\Delta_h \frac{\text{INV}_{it}}{\text{CONS}_{it}} = \mu_{ht} + \gamma^h_{\text{INV}} \Delta_h \log \text{GDP}^{com}_{it} + u_{it,h}$. $\gamma^h_{\text{CA}} + \gamma^h_{\text{INV}}$ approximate the coefficients $\gamma^{S,h}$. $(\Delta_h \frac{\text{CA}_{it}}{\text{CONS}_{it}} + \Delta_h \frac{INV_{it}}{\text{CONS}_{it}})$ is a linear approximation to $\Delta_h \log \text{NNDI}_{it} - \Delta_h \log \text{CONS}_{it}$.) For the non-commodity sector GDP^{com} is substituted by GDP^{ncom}. commodity-sector GDP is the fitted value from a regression of $\Delta^h \log \text{GDP}$ on $\Delta_h p^{shock}_{it}$, including time-fixed effects, and non-commodity-sector GDP is $\Delta \log \text{GDP}^{ncom} = \Delta \log \text{GDP} - \Delta \log \text{GDP}^{com}$. $\Delta_h p^{shock}_{it}$ is defined as $\sum_{g \in Commodity} \frac{P^{USD}_{gt-h} X_{git-h}}{GDP^{USD}_{it-h}} \Delta_h \log \frac{P^{USD}_{gt}}{CPI^{US}_{it}}$, where P^{USD}_{gt} is the price of commodity g in U.S. dollars at time t, and X_{git-h} is the export volume of commodity g in country i at time $t-h$. The numerator, export revenue from commodity g of country i, is divided by GDP_{it-h} in U.S. dollars and CPI^{US}_t is the U.S. consumer price index. Estimation period is 2000–2022. Standard errors in parentheses are clustered by country. The γ-coefficients (and standard errors) are rescaled such that their sum equates the coefficients $\gamma^{S,h}$ from Table A.6. ***, **, and * denote significance at 1%, 5%, and 10%; respectively, for the null of no contribution from the relevant source or use.

A.2 Relation between sector- and country-level coefficients

The formula for the OLS estimate is (suppressing subscripts):

$$\gamma^U = \frac{cov(\Delta \log \text{CONS}, \Delta \log \text{GDP})}{var(\Delta \log \text{GDP})} = \frac{cov(\Delta \log \text{CONS}, P_Z \Delta \log \text{GDP}) + Cov(\Delta \log \text{CONS}, M_Z \Delta \log \text{GDP})}{var(\Delta \log \text{GDP})}$$

because the covariance is linear in both terms, which then by multiplying and dividing gives

$$\gamma^U = \frac{cov(C, P_Z \Delta \log \text{GDP})}{Var(P_Z \Delta \log \text{GDP})} \frac{Var(P_Z \Delta \log \text{GDP})}{Var(\Delta \log \text{GDP})} + \frac{cov(C, M_Z \Delta \log \text{GDP})}{Var(M_Z \Delta \log \text{GDP})} \frac{Var(M_Z \Delta \log \text{GDP})}{Var(\Delta \log \text{GDP})}$$

which implies (in regular notation):

$$\gamma^U = \gamma^U_{com} \frac{Var(P_Z \Delta \log \text{GDP})}{Var(\Delta \log \text{GDP})} + \gamma^U_{ncom} \frac{Var(M_Z \Delta \log \text{GDP})}{Var(\Delta \log \text{GDP})}. \tag{22}$$

The overall amount of risk shared is a weighted average of the risk shared from commodity shocks and the risk shared from non-commodity shocks, with the weights representing the relative contributions to the overall variance. (Because P_Z and M_Z are orthogonal, $Var(\Delta \log \text{GDP}) = Var(P_Z \Delta \log \text{GDP}) + Var(M_Z \Delta \log \text{GDP})$).

A.3 Magnitude of estimated channel coefficients

Consider a stripped-down decomposition:

$$y_{it} = y_{it} - c_{it} + c_{it}$$

where y_{it} could be $\log \text{GDP}_{it}$ and c_{it} could be $\log \text{CONS}_{it}$.

Multiply by $y_{it} - \mu_t$ where μ_t is the period t cross-sectional mean of y_{it} (equivalent to a time-fixed effect) and take expectations (cross-sectional average) at period t. This gives

$$var(y)_t = cov(y, y - c)_t + cov(y, c)_t .$$

So in a cross-sectional regression that takes the form:

$$y_{it} - c_{it} = \mu_t + \gamma^S y_{it} + \varepsilon_{it}$$

$$c_{it} = \mu_t + \gamma^U y_{it} + \varepsilon_{it},$$

where ε_{it} is an error term. The coefficients, which are the covariances divided by the vari-

ance of y, sum to unity. Moreover, in a panel, the coefficients will be weighted averages of the cross-sectional coefficients, so the coefficients will still sum to unity. This was shown in ASY for the GDP decomposition.

If instead we subtract y_t^W (world GDP) from y and subtract c_t^W (world consumption) from c to capture that we define full risk sharing with the world as $c_{it} = c_t^W$, and run the regressions:

$$y_{it} - c_{it} = const + \gamma^S (y_{it} - y_t^W) + \varepsilon_{it}$$
$$c_{it} - c_t^W = const + \gamma^U (y_{it} - y_t^W) + \varepsilon_{it},$$

we have

$$y_{it} - y_t^W = (y_{it} - c_{it}) + (c_{it} - c_t^W) + (c_t^W - y_t^W).$$

Multiplying by $y_{it} - y_t^W - m_t$, where m_t is time t cross-sectional average of $(y_{it} - y_t^W)$ and taking the cross-sectional average yields

$$var(y_{it} - y_t^W) = cov(y_{it} - y_t^W, y_{it} - c_{it}) + cov(y_{it} - y_t^W, c_{it} - c_t^W) + cov(y_{it} - y_t^W, c_t^W - y_t^W),$$

where var and cov are the time t empirical variance and covariances. In Section 2.2, we showed that the γ OLS coefficients are covariances divided by the variance of the regressors, so we have:

$$1 = \gamma^S + \gamma^U + \frac{cov(y_{it} - y_t^W, c_t^W - y_t^W)}{var(y_{it} - y_t^W)}.$$

The cross-sectional covariance of the last term is zero so the estimated channels still sum to unity.

Online appendix

The online appendix provides additional robustness checks for the baseline analysis.

Table B.1 displays a more detailed analysis than that of Table 2, classifying the countries according to their main exports. The results are that energy and metals exporting countries smooth consumption at the one-year horizon substantially, with 71 percent and 63 percent of risk shared by energy and metals exporters, respectively. This falls by 10–20 percentage points over the 5-year horizon. Agricultural exporters share only a small amount of risk, and the coefficient is insignificant. Commodity importers have 25 percent of risk shared at the one-year horizon, also falling to 18 percent over a 5-year horizon. This is significantly less than for energy and metal exporting countries. Luttini et al. (2026) explore consumption smoothing across these groups of countries in more detail.

Tables B.2 and B.3 present the same specifications as Tables 4 and 5, respectively, but using more observations (an unbalanced sample across time horizons). This is a robustness check for whether our decision to use the same number of observations (406) across horizons may have impacted the results, as we lose some countries that do not have data for earlier years. The results are very similar in terms of coefficient values and significance, with slightly higher risk sharing levels at the 5-year horizon.

Another robustness check considers whether the use of export shares as weights on commodity-price shocks may impact the results. We want to ensure that any potential endogeneity in the GDP-weight of our benchmark specification does not influence the results of our preferred instrument. Tables B.4 to B.7 run the same set of regressions as in Tables 3 to 6, but the instrument has an alternative weight: the country's commodity exports to total commodity exports rather than to its GDP. The weights will be larger so that the coefficient on the price shock in Table B.4 will mechanically be smaller than in Table 3, but it is equally significant. The amount of aggregate consumption risk sharing is the same (compare Columns (1) of Tables 4 and B.5). However, the commodity sector risk sharing at the 5-year horizon is slightly smaller with the alternative instrument compared to the baseline (0.76 of Column (2), last row, Table B.5 compared to 0.86 in Column (2) last row of Table 4). The coefficients for the channels of risk sharing of the commodity sector are only slightly larger (comparing Column (2) of Table B.6 with Column (2) of Table 5). Likewise, the difference in risk sharing magnitudes looking at sources or uses of savings when using the alternative instrument p_{it}^{shock2} compared to our baseline p_{it}^{shock} is very small (comparing Table B.7 with Table 6), suggesting that the way we constructed the Bartik-type weight is not driving our main result.

Table B.1: Consumption risk sharing in energy, metal, and agricultural exporting and importing countries

	(1)	(2)	(3)	(4)
Consumption risk	Energy	Metal	Agricultural exporting countries	Commodity importers
$\Delta_1 \log \text{GDP}_{it} - \Delta_1 \log \text{GDP}_t^{world}$	$0.71^{\#\#\#}$	$0.63^{\#\#\#}$	0.09	$0.25^{\#\#\#}$
	(0.10)	(0.10)	(0.06)	(0.05)
$\Delta_2 \log \text{GDP}_{it} - \Delta_2 \log \text{GDP}_t^{world}$	$0.61^{\#\#\#}$	$0.62^{\#\#\#}$	0.10	$0.21^{\#\#\#}$
	(0.09)	(0.11)	(0.04)	(0.04)
$\Delta_3 \log \text{GDP}_{it} - \Delta_3 \log \text{GDP}_t^{world}$	$0.51^{\#\#\#}$	$0.63^{\#\#\#}$	0.09	$0.20^{\#\#\#}$
	(0.09)	(0.12)	(0.04)	(0.04)
$\Delta_4 \log \text{GDP}_{it} - \Delta_4 \log \text{GDP}_t^{world}$	$0.45^{\#\#\#}$	$0.59^{\#\#\#}$	0.08	$0.19^{\#\#\#}$
	(0.08)	(0.11)	(0.04)	(0.04)
$\Delta_5 \log \text{GDP}_{it} - \Delta_5 \log \text{GDP}_t^{world}$	$0.42^{\#\#\#}$	$0.51^{\#\#\#}$	0.09	$0.18^{\#\#\#}$
	(0.08)	(0.10)	(0.04)	(0.04)
Observations			1801	

Risk sharing for energy, metal, and agricultural exporting and commodity-importing countries. Risk sharing is calculated as $1 - \beta^{U,h}$, where the $\beta^{U,h}$ coefficients are estimated from the regression model $\Delta_h \log \text{CONS}_{it} - \Delta_h \log \text{CONS}_t^{world} = const^h + \sum_{G \in Group} \beta_G^{U,h} \left(\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GDP}_t^{world}\right) \times I_i^G + u_{it,h}$, with Δ_h defined as $\Delta_h x_t = x_t - x_{t-h}$ and $h \in \{1, \ldots, 5\}$. I^G is an indicator function for energy, metal, and agricultural exporters, and commodity importers. For the case of energy exporters, group G includes the three commodity types $(coal, oil, nat.gas)$. CONS_{it} (GDP_{it}) is aggregate consumption (GDP) in country i in year t. $\Delta_h \log \text{CONS}_t^{world}$ ($\Delta_h \log \text{GDP}_t^{world}$) is the cross-sectional average of consumption (GDP) growth of all the countries in the sample. Estimation period is 2000–2022. Standard errors, clustered at the country level, are shown in parentheses. $^{\#\#\#}$ denote significance at the 1% level for the null hypothesis of full risk sharing ($1 - \beta_G^{U,h} = 1$) where G indicates commodity export category).

Table B.2: Consumption risk sharing of aggregate, commodity-, and non-commodity-sector GDP: different number of observations across horizons

	(1)	(2)	(3)	(4)
	Aggregate Consumption risk sharing	Sector-level risk sharing with the world		
Sectors:		Commodity	Non-commodity	Obs
$\Delta_1 \log \text{GDP}_{it} - \Delta_1 \log \text{GDP}_t^{world}$	$0.59^{\#\#\#}$	1.02^{a}	$0.38^{\#\#\#}$	566
	(0.10)	(0.07)	(0.08)	
$\Delta_2 \log \text{GDP}_{it} - \Delta_2 \log \text{GDP}_t^{world}$	$0.54^{\#\#\#}$	0.91^{a}	$0.41^{\#\#\#}$	540
	(0.09)	(0.06)	(0.10)	
$\Delta_3 \log \text{GDP}_{it} - \Delta_3 \log \text{GDP}_t^{world}$	$0.50^{\#\#\#}$	0.93^{a}	$0.39^{\#\#\#}$	515
	(0.08)	(0.07)	(0.08)	
$\Delta_4 \log \text{GDP}_{it} - \Delta_4 \log \text{GDP}_t^{world}$	$0.50^{\#\#\#}$	0.93^{a}	$0.40^{\#\#\#}$	488
	(0.07)	(0.07)	(0.06)	
$\Delta_5 \log \text{GDP}_{it} - \Delta_5 \log \text{GDP}_t^{world}$	$0.47^{\#\#\#}$	0.87^{a}	$0.39^{\#\#\#}$	463
	(0.07)	(0.09)	(0.06)	

See notes to Table 4.

Table B.3: Channels of risk sharing at the aggregate and sector level: different number of observations across horizons

	(1)	(2)	(3)	(4)
	Aggregate channels of risk sharing	Channels of risk sharing with world, overall		
Sectors:		Commodity	Non-commodity	Obs
Panel a. Net factor income channel				
$\Delta_1 \log \text{GDP}_{it} - \Delta_1 \log \text{GDP}_t^{world}$	0.02	0.05**	–0.02	566
	(0.02)	(0.02)	(0.02)	
$\Delta_5 \log \text{GDP}_{it} - \Delta_5 \log \text{GDP}_t^{world}$	0.04***	0.04**	0.02	463
	(0.01)	(0.02)	(0.02)	
Panel b. International net transfers channel				
$\Delta_1 \log \text{GDP}_{it} - \Delta_1 \log \text{GDP}_t^{world}$	0.00	–0.04*	0.04	535
	(0.03)	(0.02)	(0.03)	
$\Delta_5 \log \text{GDP}_{it} - \Delta_5 \log \text{GDP}_t^{world}$	0.01	–0.00	0.03	431
	(0.02)	(0.01)	(0.02)	
Panel c. Savings channel				
$\Delta_1 \log \text{GDP}_{it} - \Delta_1 \log \text{GDP}_t^{world}$	0.56***	0.77***	0.11	535
	(0.12)	(0.12)	(0.08)	
$\Delta_5 \log \text{GDP}_{it} - \Delta_5 \log \text{GDP}_t^{world}$	0.41***	0.43***	0.24***	431
	(0.08)	(0.12)	(0.08)	

See notes to Table 5.

Table B.4: OLS projection of commodity-price shocks on GDP growth: instrument's alternative weighting scheme

	(1)	(2)	(3)	(4)	(5)
	$\Delta_1 \log \text{GDP}_{it}$	$\Delta_2 \log \text{GDP}_{it}$	$\Delta_3 \log \text{GDP}_{it}$	$\Delta_4 \log \text{GDP}_{it}$	$\Delta_5 \log \text{GDP}_{it}$
commodity-price shock	0.22***	0.24***	0.26***	0.28***	0.29***
	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)
R-squared	0.44	0.43	0.41	0.41	0.39
Observations			406		

β_h coefficients are estimated from the regression $\Delta_h \log \text{GDP}_{it} = const^h + \beta_h \Delta_h p_{it}^{shock2} + \epsilon_{it}$, with Δ_h defined as $\Delta_h x_t = x_t - x_{t-h}$ and $h \in \{1,\dots,5\}$. The commodity-price shock $\Delta_h p_{it}^{shock2}$ is defined as $\sum_{g \in Commodity} \frac{P_{gt-h}^{USD} X_{git-h}}{\sum_{g \in Commodity} P_{gt-h}^{USD} X_{git-h}} \Delta_h \log \frac{P_{gt}^{USD}}{CPI_{it}^{US}}$ where P_{gt}^{USD} represents the price of commodity g in U.S. dollars at time t, and X_{git-h} is the export volume of commodity g in country i at time $t-h$, CPI_t^{US} is the U.S. consumer price index. The estimation period is 2000–2022. Standard errors clustered at the country level in parentheses. ***denote significance at the 1%level.

Table B.5: Consumption risk sharing of aggregate, commodity-, and non-commodity-sector GDP: instrument's alternative weighting scheme

	(1)	(2)	(3)
	Aggregate Consumption risk sharing	Sector-level risk sharing with the world	
Sectors:		Commodity	Non-commodity
$\Delta_1 \log \text{GDP}_{it} - \Delta_1 \log \text{GDP}_t^{world}$	$0.70^{\#\#\#}$	1.06^{a}	$0.57^{\#\#\#}$
	(0.08)	(0.07)	(0.06)
$\Delta_2 \log \text{GDP}_{it} - \Delta_2 \log \text{GDP}_t^{world}$	$0.62^{\#\#\#}$	0.98^{a}	$0.50^{\#\#\#}$
	(0.08)	(0.09)	(0.05)
$\Delta_3 \log \text{GDP}_{it} - \Delta_3 \log \text{GDP}_t^{world}$	$0.53^{\#\#\#}$	0.90^{a}	$0.45^{\#\#\#}$
	(0.08)	(0.08)	(0.07)
$\Delta_4 \log \text{GDP}_{it} - \Delta_4 \log \text{GDP}_t^{world}$	$0.48^{\#\#\#}$	$0.83^{\#}$	$0.41^{\#\#\#}$
	(0.08)	(0.10)	(0.07)
$\Delta_5 \log \text{GDP}_{it} - \Delta_5 \log \text{GDP}_t^{world}$	$0.44^{\#\#\#}$	$0.76^{\#\#}$	$0.41^{\#\#\#}$
	(0.07)	(0.11)	(0.07)
Observations		406	

Aggregate risk sharing is calculated as $1-\gamma^{U,h}$, where the $\gamma^{U,h}$ coefficients are estimated from the regression model $\Delta_h \log \text{CONS}_{it} - \Delta_h \log \text{CONS}_t^{world} = const^h + \gamma^{U,h}\left(\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GDP}_t^{world}\right) + u_{it,h}$, with Δ_h defined as $\Delta_h x_t = x_t - x_{t-h}$ and $h \in \{1,\ldots,5\}$; CONS_{it} (GDP_{it}) is aggregate consumption (GDP) in country i in year t. $\Delta_h \log \text{CONS}_t^{world}$ ($\Delta_h \log \text{GDP}_t^{world}$) is the cross-sectional average of consumption (GDP) growth of all the commodity-exporting countries in the sample of Table 2. Risk sharing for the commodity and non-commodity sectors is estimated likewise, where GDP in the equation above is substituted by GDP^{com} and GDP^{ncom}, respectively. Column (1) reports aggregate consumption risk sharing with the world; Columns (2)-–(3) report sectoral risk sharing with the world for commodity and non-commodity-sector GDP, respectively. commodity-sector GDP is defined as $\Delta_h \log \text{GDP}^{com} = const^h + \beta_h \Delta_h p_{it}^{shock2}$ and non-commodity-sector GDP is $\Delta \log \text{GDP}^{ncom} = \Delta \log \text{GDP} - \Delta \log \text{GDP}^{com}$. $\Delta_h p_{it}^{shock2}$ is defined as $\sum_{g \in Commodity} \frac{P_{gt-h}^{USD} X_{git-h}}{\sum_{g \in Commodity} P_{gt-h}^{USD} X_{it-h}^{USD}} \Delta_h \log \frac{P_{gt}^{USD}}{CPI_{it}^{US}}$ where P_{gt}^{USD} represents the price of commodity g in U.S. dollars at time t. The export share is X_{git-h} (the export volume of commodity g in country i at time $t-h$); divided by X_{it-h}, total exports in U.S. dollars. CPI_t^{US} is the U.S. consumer price index. Standard errors, clustered at the country level, are reported in parentheses. Subscripts $^{\#\#\#}$, $^{\#\#}$, and $^{\#}$ denote that the coefficient is significant at the 1%, 5%, and 10% percent level for a test of the null hypothesis of full risk sharing ($1-\gamma^{U,h}=1$). Superscript a denotes that full risk sharing is not rejected at the 10% level.

Table B.6: Channels of risk sharing at the aggregate and sector level: instrument's alternative weighting scheme

	(1)	(2)	(3)
	Aggregate channels of risk sharing	Channels of risk sharing with world, overall	
Sectors:		Commodity	Non-commodity
Panel a. Net factor income channel			
$\Delta_1 \log \text{GDP}_{it} - \Delta_1 \log \text{GDP}_t^{world}$	0.05**	0.07**	–0.01
	(0.02)	(0.03)	(0.02)
$\Delta_5 \log \text{GDP}_{it} - \Delta_5 \log \text{GDP}_t^{world}$	0.04***	0.08***	0.01
	(0.01)	(0.02)	(0.02)
Panel b. International net transfers channel			
$\Delta_1 \log \text{GDP}_{it} - \Delta_1 \log \text{GDP}_t^{world}$	–0.00	–0.04**	0.02
	(0.02)	(0.02)	(0.02)
$\Delta_5 \log \text{GDP}_{it} - \Delta_5 \log \text{GDP}_t^{world}$	0.02	–0.00	0.03*
	(0.01)	(0.02)	(0.02)
Panel c. Savings channel			
$\Delta_1 \log \text{GDP}_{it} - \Delta_1 \log \text{GDP}_t^{world}$	0.65***	0.72***	0.26**
	(0.09)	(0.15)	(0.11)
$\Delta_5 \log \text{GDP}_{it} - \Delta_5 \log \text{GDP}_t^{world}$	0.38***	0.55***	0.18**
	(0.07)	(0.12)	(0.08)
Observations		406	

Column (1) shows channels of country-level consumption risk sharing and Columns (2)–(3) show channels of sectoral risk sharing for commodity and non-commodity sectors, respectively. Each panel reports the slope derived, for instance for the aggregate, from the univariate regressions $\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GNI}_{it} = const^h + \gamma^{F,h} \Delta_h \left(\log \text{GDP}_{it} - \log \text{GDP}_t^{world} \right) + u_{it,h}$. Panel (a) shows risk sharing from net factor income) : $\Delta_h \log \text{GNI}_{it} - \Delta_h \log \text{NNDI} = const^h + \gamma^{T,h} \left(\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GDP}_t^{world} \right) + u_{it,h}$. Panel (b) shows risk sharing from international net transfers: $\Delta_h \log \text{NNDI}_{it} - \Delta_h \log \text{CONS}_{it} = const^h + \gamma^{S,h} \left(\Delta_h \log \text{GDP}_{it} - \Delta_h \log \text{GDP}_t^{world} \right) + u_{it,h}$. Panel (c) shows risk sharing from savings. Δ_h is defined as $\Delta_h x_t = x_t - x_{t-h}$ and $h \in \{1, \ldots, 5\}$. $\Delta_h \text{GDP}_t^{world}$ is the cross-sectional average of log differenced GDP of all countries included in the sample of Table 2. Risk sharing for commodity and non-commodity sector sectors is estimated likewise, where GDP is substituted with GDP^{com} and GDP^{ncom}, respectively. Commodity-sector GDP, $\Delta \log \text{GDP}^{com}$, is the fitted value from a regression of $\Delta \log \text{GDP}$ on $\Delta_h p_{it}^{shock2}$ and non-commodity-sector GDP is $\Delta \log \text{GDP}^{ncom} = \Delta \log \text{GDP} - \Delta \log \text{GDP}^{com}$. $\Delta_h p_{it}^{shock2}$ is defined as $\sum_{g \in Commodity} \frac{P_{gt-h}^{USD} X_{git-h}}{\sum_{g \in Commodity} P_{gt-h}^{USD} X_{it-h}^{USD}} \Delta_h \log \frac{P_{gt}^{USD}}{CPI_{it}^{US}}$, where P_{gt}^{USD} represents the price of commodity g in U.S. dollars at time t. It is weighted by the export share, which is X_{git-h} (the export volume of commodity g in country i at time $t-h$); divided by X_{it-h}, total exports in U.S. dollars. CPI_t^{US} is the U.S. consumer price index. The estimation period is 2000–2022. Standard errors, clustered at the country level, in parentheses. ***, **, and * denote significance at 1%, 5%, and 10%; respectively, for the null of no risk sharing from the relevant channel.

Table B.7: Contribution of sources and uses of savings to risk-sharing across commodity and non-commodity sectors with the world, overall: Instrument's alternative weighting scheme

	(1)	(2)	(3)	(4)	(5)
Consumption risk	Commodity sector		Non-commodity sector		
Panel a. Savings' sources	Private	Government	Private	Government	Obs
$\Delta_1 \log \text{GDP}_{it} - \Delta_1 \log \text{GDP}_t^{world}$	0.23***	0.49**	0.19	0.06	264
	(0.08)	(0.21)	(0.11)	(0.32)	
$\Delta_5 \log \text{GDP}_{it} - \Delta_5 \log \text{GDP}_t^{world}$	0.20***	0.35*	0.06	0.12	248
	(0.07)	(0.17)	(0.06)	(0.10)	
Panel b. Savings' uses	Current account	Investment	Current account	Investment	Obs
$\Delta_1 \log \text{GDP}_{it} - \Delta_1 \log \text{GDP}_t^{world}$	0.64***	0.08*	0.22*	0.03	382
	(0.15)	(0.04)	(0.12)	(0.05)	
$\Delta_5 \log \text{GDP}_{it} - \Delta_5 \log \text{GDP}_t^{world}$	0.32**	0.23***	0.13	0.04	374
	(0.12)	(0.05)	(0.09)	(0.03)	

The table reports decompositions of sectoral risk sharing from savings: commodity-sector GDP in Columns (1)–(2), and non-commodity-sector GDP in Columns (3)–(4). Panel (a) estimates the decomposition by private/government sources. For the commodity sector, each column reports the slope from the regression $\Delta_h \frac{\text{Savings}_{it}^k}{\text{CONS}_{it}} = const^h + \gamma_k^h \Delta_h \left(\log \text{GDP}_{it}^{com} - \Delta_h \log \text{GDP}_t^{world} \right) + u_{it,h}$, where $k \in \{\text{priv}, \text{gov}\}$, and Δ_h defined as $\Delta_h x_t = x_t - x_{t-h}$, and $h \in \{1, \ldots, 5\}$ for generic x. $\gamma_{priv}^h + \gamma_{gov}^h$ approximates the coefficients $\gamma^{S,h}$. $\gamma^{S,h}$ is estimated from $\Delta_h \log \text{NNDI}_{it} - \Delta_h \log \text{CONS}_{it} = const^h + \gamma^{S,h} \left(\Delta_h \log \text{GDP}_{it}^{com} - \Delta_h \log \text{GDP}_t^{world} \right) + u_{it,h}$, where the $\Delta_h \frac{S_{it}^{\text{gov}}}{\text{CONS}_{it}} + \Delta_h \frac{S_{it}^{\text{priv}}}{\text{CONS}_{it}}$ is a linear approximation to $\Delta_h \log \text{NNDI}_{it} - \Delta_h \log \text{CONS}_{it}$). Panel (b) reports risk sharing by uses of savings, either invested abroad through the current account (CA) or invested domestically (INV). It reports the slope from the regressions $\Delta_h \frac{\text{CA}_{it}}{\text{CONS}_{it}} = const^h + \gamma_{\text{CA}}^h \Delta_h \left(\log \text{GDP}_{it}^{com} - \log \text{GDP}_t^{world} \right) + u_{it,h}$ and $\Delta_h \frac{\text{INV}_{it}}{\text{CONS}_{it}} = const^h + \gamma_{\text{INV}}^h \left(\Delta_h \log \text{GDP}_{it}^{com} - \Delta_h \log \text{GDP}_t^{world} \right) + u_{it,h}$. $\gamma_{\text{CA}}^h + \gamma_{\text{INV}}^h$ approximate the coefficients $\gamma^{S,h}$. ($\Delta_h \frac{\text{CA}_{it}}{\text{CONS}_{it}} + \Delta_h \frac{INV_{it}}{\text{CONS}_{it}}$) is a linear approximation to $\Delta_h \log \text{NNDI}_{it} - \Delta_h \log \text{CONS}_{it}$.) For the non-commodity sector, GDP GDP^{com} is substituted by GDP^{ncom}. commodity-sector GDP is the fitted value from a regression of $\Delta^h \log \text{GDP}$ on $\Delta_h p_{it}^{shock2}$ and non-commodity-sector GDP is $\Delta \log \text{GDP}^{ncom} = \Delta \log \text{GDP} - \Delta \log \text{GDP}^{com}$. $\Delta_h p_{it}^{shock2}$ is defined as $\sum_{g \in Commodity} \frac{P_{gt-h}^{USD} X_{git-h}}{\sum_{g \in Commodity} P_{gt-h}^{USD} X_{it-h}^{USD}} \Delta_h \log \frac{P_{gt}^{USD}}{CPI_{it}^{US}}$ where P_{gt}^{USD} represents the price of commodity g in U.S. dollars at time t. It is weighted by the export share, which is X_{git-h} (the export volume of commodity g in country i at time $t-h$); divided by X_{it-h}, total exports in U.S. dollars. CPI_t^{US} is the U.S. consumer price index. The estimation period is 2000–2022. Standard errors in parentheses are clustered by country. The γ-coefficients (and standard errors) are rescaled such that their sum equates the coefficients $\gamma^{S,h}$ from Table B.6. ***, **, and * denote significance at 1%, 5%, and 10%; respectively, for the null of no contribution from the relevant source or use.