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Commodity currencies revisited: The role of global commodity price uncertainty

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ABSTRACT

Exchange rates of commodity exporting countries, generally known as commodity currencies, are often considered to be driven by some specific commodity prices. In this paper, we show that the uncertainty common to a basket of commodity prices is also a significant driver of exchange rate dynamics for a panel of commodity exporting countries. In particular, an increase in global commodity price uncertainty leads to a short-run depreciation of the effective exchange rate in commodity currency countries, followed by a medium-term rebound. We document that this pattern is specific to commodity currencies and is not visible on benchmark currencies like the euro or the U.S. dollar, the latter acting as a typical safe haven currency. We refer to this pattern as the "commodity uncertainty currency" property.

1. Introduction

Major commodity-producing economies, as Australia or Norway, strongly rely on the exports of raw commodities (agricultural, energy or metals) as a main source of income. In this respect, business cycles in those commodity-rich economies heavily depend on fluctuations in global commodity prices. In particular, there is a widespread literature showing that the currencies of major commodity-exporting countries exhibit significant comovement with global commodity prices, known as the 'commodity currency property' (see e.g. Bodart et al., 2012; Cashin et al., 2004; Chen and Rogoff, 2003; Chen and Lee, 2018; Clements and Fry, 2008; Coudert et al., 2015; Zhang et al., 2016; among others). According to theoretical and empirical findings of the literature on 'commodity currencies', rising (falling) commodity prices result in an appreciation (depreciation) of the commodity currency in the long run; the main transmission channel being the improvement in terms of trade (i.e. increasing income from commodity exports because of higher commodity export prices, see e.g. Chen and Rogoff, 2003; Chen and Lee, 2018).

Another strand of the literature supports the view that a short-run effect might also exist, as foreign exchange (FX) market participants anticipate an immediate appreciation of the commodity currency after the occurrence of a commodity price shock (Chen and Rogoff, 2003; Devereux and Smith, 2021; Ferraro et al., 2015; Zhang et al., 2016). For instance, Ferraro et al. (2015) empirically verify the existence of oil currencies in the very short-run, by showing that oil prices are robust predictors of the exchange rates of countries whose most significant commodity export is oil, at daily, monthly and quarterly forecast horizons. Devereux and Smith (2021) identify

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a new channel through which rising commodity export prices result in an immediate appreciation of the respective commodity currency of small open inflation targeting economies. Indeed, they show that this appreciation can be attributed to a systematic monetary policy intervention to rein in domestic inflationary pressures occurring after large commodity price increases. While the literature has extensively shown that the terms of trade fluctuations comove with the currency of major commodity-exporting economies, little is known about the respective effects of global commodity price uncertainty shocks.

Three key arguments motivate our paper. First, following the findings of the literature mentioned above, we move the current strand of the 'commodity currencies' literature one step further by examining the dynamic effects of agricultural, metals and energy commodity price uncertainty shocks on 'commodity currencies'. As underlined by Delle Chiaie et al. (2022) and Ferrara et al. (2022), there is empirical evidence of a common cycle for commodity prices, for both level and volatility. Here, we aim at extracting the common volatility behavior, which we identify to be an estimate of uncertainty in commodity prices. In this respect, we estimate a two-factor Bayesian Dynamic Factor Model capturing the uncertainty comovement of major agricultural, metals and energy commodity futures markets. As in Ferrara et al. (2022), the first factor captures uncertainty comovement across the entire cross-section of agricultural, energy and metals markets, quantifying global commodity price uncertainty, while the second factor captures market-specific commodity price uncertainty (namely, agricultural, metals and energy price uncertainty).

In a second step, we examine the dynamic impact of global and market-specific uncertainty on the real broad effective exchange rates of major industrialized commodity-producing economies (namely, Australia, Canada, New Zealand and Norway) for which the relevant literature has extensively shown their 'commodity currency' property (Chen and Rogoff, 2003; Cashin et al., 2004; Wang and Cheung, 2023; among others). Our choice for this set of commodity currencies stems from the fact that they are representative examples of small open economies characterized by (i) well-developed and relatively liquid financial markets for a lengthy period (at least from the early nineties, which is when our sample starts), (ii) floating currencies since the early eighties and (iii) an inflation targeting regime since the early nineties, with Norway adopting an inflation targeting policy in 2001. In addition, all four countries can be described as commodity-producing economies, because of the large share of their production and exports accounted for by primary commodities for most of the time-period under investigation (Chen and Rogoff, 2003; Coudert et al., 2015; Wang and Cheung, 2023).

Second, recent literature has shown that the exchange rates of commodity-producing economies become more sensitive to commodity terms of trade shocks in times of heightened uncertainty in global commodity markets (Coudert et al., 2015). Unlike equity price returns (whose distributions are negatively skewed), commodity price return distributions are positively skewed with commodity investors and producers being more fearful of the right (instead of the left) tail of the return distribution, with commodity volatility risk and the corresponding prices being (instead of negatively) positively correlated (see for example Gorton and Rouwenhorst, 2006; Pindyck, 2004; Triantafyllou et al., 2015). Consequently, rising uncertainty in commodity markets is associated with increased convenience yields for holding physical inventories and with more vulnerability to price spikes in commodity markets (see Bobenrieth et al., 2013; Deaton and Laroque, 1992; Gorton et al., 2013; Milonas and Thomadakis, 1997; Triantafyllou et al., 2020). In this way, a 'commodity uncertainty currency' channel might take place, since, at least in the medium-run, the demand for 'commodity currencies' is likely to increase in case investors anticipate a higher probability of commodity inventory stock-outs and price spikes in times of heightened uncertainty in global commodity markets.

Third, the financialization of commodity markets, starting from the late nineties, highlights the importance of understanding the effects of comovement in commodity markets. While in the early eighties, commodity markets were partly disconnected and segmented from equity and bond markets, the financialization of commodities transformed commodity markets into a separate asset class. This led them to become more integrated with financial markets and contributed to a stronger comovement between agricultural, metals and energy commodity price, for both returns and volatility (Basak and Pavlova, 2016; Tang and Xiong, 2012). For all those reasons it is of interest for commodity investors and policymakers to examine the macroeconomic effects of rising commodity uncertainty comovement on major commodity currencies. Our testable hypothesis in this paper is that the synchronization of uncertainty across commodity markets will have a significant short- and medium-run effect on commodity currencies, with the sign of the effect being dependent on the hedging needs and behavior of market participants in response to commodity price movements.

In this paper, we empirically point out for the first time in the literature that commodity price uncertainty does matter for commodity currency fluctuations, using Structural Vectorial Auto-Regressive (SVAR) modelling. More specifically, our analysis highlights that a global commodity price uncertainty shock (an uncertainty shock common to all commodity markets) results in an instantaneous depreciation of commodity currencies, followed by a medium-run appreciation. It turns out that this pattern is specific to commodity currencies, as other benchmark currencies like the euro and the U.S. dollar, as well as currencies of major net commodity importers like Japan and Korea, do not react in the same way. The euro tends to be neutral to this type of shock, while the U.S. dollar and the Japanese yen act as safe haven currencies by appreciating in the wake of a global commodity price uncertainty shock, as they do after a VIX shock (Georgiadis et al., 2021). In this respect, we will refer to this stylized fact as the "commodity uncertainty currency" property. The economic interpretation of our findings possesses its roots on the investment under uncertainty implications, according to which investors postpone their investments on risky projects (the risky commodity currencies in our case) up until the commodity price uncertainty shock is being resolved (Bloom, 2009; Pindyck, 1991).

Furthermore, we try to explain the short-run appreciation and the medium-run rebound of commodity currencies by examining the respective dynamic responses of macroeconomic fundamentals like inflation, output, exports, and monetary policy rates. Since our sample of countries are advanced small open economies with flexible exchange rate regimes and inflation targeting monetary policy rules, our analysis contributes to assess the importance of an alternative channel through which commodity price uncertainty could affect commodity currencies, namely, the monetary policy channel (Devereux and Smith, 2021; Dornbusch, 1976; Bjørnland, 2009).[1] We show that monetary policy reactions, as measured by central bank interest rates, to this type of uncertainty shock are in line with the first part of this pattern (i.e. the short-term depreciation), but there is no clear evidence as regards to the second part of the movement (i.e. the medium-term appreciation). In addition, our SVAR estimates show that the responses of output, inflation and exports growth of commodity currencies are negative in the short-run, while they do not display a bounce-back behavior. Hence, they also do not provide any kind of macroeconomic explanation for the medium-run rebound of commodity currencies. This leads us to attribute this medium-term bounce-back behavior of commodity currencies to financial investment under uncertainty channel and to the classical real option value of waiting for uncertainty to be resolved and then expanding investment when the uncertainty shock is fading out, as shown in Bloom (2009).[2] According to Bloom (2009), firms pause their investment processes when faced with uncertainty shock, and then they expand their investment with the expectations of high opportunities and booming economic activity once the uncertainty is being resolved. Our findings are broadly in line with the theoretical and econometric findings of Bloom (2009), since we find that commodity investors, while postponing their investments in commodity currencies in times of heightened commodity price uncertainty, they expect high opportunities once the commodity uncertainty vanishes, leading to a strong currency demand. To assess this "financial investment under uncertainty" hypothesis, we additionally estimate the response of net Foreign Direct Investment (FDI henceforth) for our set of commodity-exporting economies to global commodity price uncertainty shocks (see also Jardet et al., 2022, for an extensive analysis of global uncertainty on FDI inflows). We find that the amount of net foreign investment to those countries after the occurrence of commodity price uncertainty shocks declines in the short-run and increases in the medium-run, ultimately contributing to the initial weakening and to the subsequent rebound of their real exchange rates. Hence, the resolution of global commodity price uncertainty shocks ultimately leads investors to revert to commodity currencies in the medium-run, increasing the demand for investment in commodity exporting countries and ultimately resulting to an appreciation of the currency of commodity-producing economies in the medium-term.

Last, once we account for the global commodity price uncertainty, we get that market-specific uncertainty shocks tend to diverge in the short-run: agricultural and metals' shocks lead to a depreciation of commodity currencies, while energy shocks generate a significant appreciation. To provide further empirical insights on the behavior of investors to energy uncertainty shocks, we estimate the dynamic response of net Foreign Direct Investment (FDI) and portfolio equity inflows to energy price uncertainty.[3] We empirically demonstrate that foreign investors increase their investments in countries possessing commodity-currency characteristics when confronted with heightened uncertainty regarding energy prices. Overall, our findings show that investors do not treat energy price uncertainty as a potential threat for commodity currencies, but, as an investment opportunity arising via the growth-option channel of uncertainty shocks (Bloom, 2014).[4] The growth-option channel explains firms' decision to increase investment under uncertainty by placing more weight (and potential for profitability) on the positive rather than on the negative effects of uncertainty. When it comes to oil price uncertainty, the relevant literature has identified that increasing oil price uncertainty is associated with inventory stockouts, increasing convenience yields for holding oil inventories and consequently, with subsequent large increases in the price of oil (Pindyck, 2004; Geman and Ohana, 2009; Gordon et al., 2013; among others). Thus, the rising energy price uncertainty could be perceived not as a threat, but as an opportunity for oil producers and investors to expand their investments in risky oil-related projects by placing more weight (or likelihood) on the upside part of oil volatility risk and less on the downside.[5] Consequently, the growth-option channel for the case of energy price uncertainty shocks is particularly present for Norway and Canada, which are two of the world leading exporters and producers of crude oil. Especially for large oil producing and exporting economies like Norway and Canada, we postulate that the benefits of rising oil price uncertainty outweigh the costs, at least in the very short-run. In such oil-rich economies, the expected benefits of expansionary investment when faced with increasing uncertainty surrounding oil prices, outweigh the potential cost

[1] For instance, Bernanke et al. (1997) show that the recessionary effect of oil price shocks is largely attributed to the systematic reactions of the Fed to rein in inflationary pressures of those shocks, while the recent findings of Triantafyllou and Dotsis (2017) show that the Fed funds rate increases significantly after a large increase in option implied volatility of major global commodity markets.

[2] Bloom (2009) provides further econometric evidence to his theoretical model in which the initial pause (inaction) of firms when faced with uncertainty is followed by an overinvestment when the uncertainty shock is being resolved. In particular, he estimates a monthly VAR model for the US economy and finds that an uncertainty shock results in an initial drop of US investment and production growth followed by a subsequent rebound in the medium run when the uncertainty is being resolved. In our SVAR analysis we report similar reactions of the commodity currencies to commodity uncertainty shocks. In this way, we provide further empirical evidence on the role of uncertainty shocks which supports the views and conclusions made by Bloom (2009).

[3] Historically, at least during the time period covered in our analysis, the share of net FDI inflows to the real GDP of our set of selected commodity currencies is substantial, with the net FDI to GDP ratio fluctuating from 2% to 8% for most of the time period covered in our sample, and being significantly higher on average for Australia and Canada. More details on the FDI to GDP ratios can be found at the IMF database.

[4] According to Bloom (2014), the growth-option channel is based on the premise that uncertainty could have an expansionary effect on firm investment if it encourages the overall size of potential benefit.

[5] For instance, Segal et al. (2015) decompose macroeconomic uncertainty into its good and bad counterpart (which is associated with favorable and unfavorable macroeconomic outcomes, respectively) and show that the "good uncertainty" component (activated via the growth-option channel) has an expansionary effect on investment. While we do not conduct such a decomposition, we follow the suggestions made by the literature on the Theory of Storage (Working 1948), according to which rising energy price uncertainty is associated with a higher chance of oil price spikes, which is the favorable market outcome for large oil producing countries like Canada and Norway.

reduction made by the contractionary investment decision. Therefore, under rising oil price uncertainty, potential future benefits stemming from investing outweigh future losses, ultimately leading to increases in the real option value of expanding investment (Grullon et al., 2012; Yin and Lu, 2022). Our SVAR analysis provides further support on this growth-option channel since we show that international investors increase their equity investment in energy commodity currencies under energy price uncertainty, and, ultimately, their demand pressures result in an appreciation of those currencies.

The rest of the paper is organized as follows. Section 2 describes the data and outlines the empirical methodology. Section 3 presents the empirical results, while Section 4 provides various robustness checks. Finally, Section 5 concludes.

2. Data and methodology

2.1. Commodity futures data

We get daily series for GSCI (Goldman Sachs Commodity Index) nearby commodity futures prices, retrieved from Datastream. The nearby commodity futures prices are often used as proxies for the commodity spot prices since they always converge to the corresponding commodity spot prices (Fama and French, 1987). More specifically, we obtain twelve daily GSCI series for agricultural (corn, cotton, soybeans, wheat), metals (copper, gold, silver, platinum) and energy (crude oil, heating oil, petroleum, gasoline) futures prices. The daily commodity futures dataset covers the period from 1st January 1994 to 30th June 2021.

2.2. Macroeconomic data

In this empirical work, we focus on four well-known commodity-exporting countries, namely Australia, Canada, New Zealand and Norway, and we consider the U.S. and the euro area as benchmarks. We also include in our dataset two major commodity importers with low commodity exports, namely Japan and Korea. For all those countries the target variable is the real broad effective exchange rate, meaning that an increase (decrease) in the exchange rate is associated with an appreciation (depreciation) of the local currency. For each country, we will construct a SVAR model that includes the quarterly series for the growth rate of consumer price indexes (CPI, all items), domestic short-term (policy) rates, the growth rate of total exports and the growth rate of real GDP. The macroeconomic time series dataset spans the period from 1994-Q1 to 2021-Q2 and is obtained from the Federal Reserve Bank of Saint Louis (FRED) database. Moreover, we obtain yearly series for Foreign Direct Investment (FDI) inflows for our set of selected countries from the International Monetary Fund (IMF) database. The FDI inflows represent the net increase of foreign investors' investment flows at the reporting economy. Finally, we obtain yearly data for net portfolio equity flows, which represent the net purchases (purchases minus sales) of shares made by foreign investors on the equity market of the reporting economy. Since we estimate a quarterly SVAR, we use a cubic spline interpolation method on the yearly FDI flows and Portfolio Equity flows data to extract the quarterly FDI flows used in the SVAR.[6]

2.3. Commodity price uncertainty

Following the standard approach for the estimation of commodity price uncertainty which is quite often seen in the recent and relevant literature (Bakas and Triantafyllou, 2018; Prokopczuk et al., 2019; among others), we estimate commodity price uncertainty as the quarterly realized variance of the daily returns of the commodity prices according to the following equation:

$$RV_{t,T} = \frac{1}{T}\sum_{i=1}^{T}\left(\frac{F_{t+i}-F_{t+i-1}}{F_{t+i-1}} - \overline{\frac{F_{t+i}-F_{t+i-1}}{F_{t+i-1}}}\right)^2 *252 \quad (1)$$

where F_t is the GSCI commodity future price on the trading day t. The realized variance RV is multiplied by 252 (the number of trading days during one calendar year) in order to be annualized.

2.4. Dynamic factor model

We deploy a hierarchical two-factor Dynamic Factor Model (DFM) for the estimation of a global commodity price uncertainty factor and a commodity group-specific price uncertainty factor. In more detail, using a similar approach with that of Ferrara et al. (2022), we extract these two latent factors capturing the global and group-specific comovements in the realized variance (RV) of agricultural (corn, cotton, soybeans, wheat), metals (copper, gold, silver, platinum), and energy (crude oil, heating oil, petroleum, gasoline) commodity price returns.

The specification and estimation methods draw from Kose et al. (2003) and Karadimitropoulou and León-Ledesma (2013), adapted to our factor structure. As previously mentioned, our model contains (i) a common commodity price uncertainty factor, (ii) a group-specific commodity price uncertainty factor and (iii) an idiosyncratic component. We observe one variable (the realized variance) for each of the 12 commodities, from 1994q1 to 2021q2. Our dataset takes the form of a panel of commodity volatility series, $RV_{c,t}$, where

[6] For robustness purposes, we estimate a set of yearly SVARs and mixed-frequency SVARs using our set of quarterly series along with the yearly FDI series and our main results remain unaltered. Those additional SVAR results are available upon request.

the subscript c indexes the commodity, with $c = 1, \cdots, C$, and $t = 1, \cdots, T$, so that $RV_{c,t}$ is the realized variance for any commodity c at time t. We assume that $RV_{c,t}$ can be described by the following dynamic factor model:

$$RV_{c,t} = \beta_c^C F_t^C + \beta_c^G F_{g,t}^G + \varepsilon_{c,t} \tag{2}$$

where F^C represents the common commodity factor and F^G denotes the group-specific commodity factor, with $g = 1, \cdots, G$. Coefficients β^C and β^G are the factor loadings on the common and group-specific factors, respectively. Finally, $\varepsilon_{c,t}$ is the error term and is assumed to be cross-sectionally non-correlated at all leads and lags but can be serially correlated. The error term is supposed to follow an AR(p) process:

$$\varepsilon_{c,t} = \sum_{l=1}^{p} \varphi_{c,l} \varepsilon_{c,t-l} + \epsilon_{c,t} \tag{3}$$

where $\epsilon_{c,t}$ are distributed as $N(0, \sigma_c^2)$ and the autoregressive order p is selected to be $p = 3$. The two unobserved factors F^C and F^G are also assumed to follow AR(p) processes:

$$F_t^C = \sum_{l=1}^{p} \varphi_l^C F_{t-1}^C + v_t^C \tag{4}$$

$$F_{g,t}^G = \sum_{l=1}^{p} \varphi_{g,l}^C F_{g,t-1}^G + v_{g,t}^G \tag{5}$$

with $p = 3$ and where $v_t^C, v_{g,t}^G$ $N(0, \sigma_C^2)$ and $N\left(0, \sigma_{g,G}^2\right)$ respectively. Finally, the innovations $\varepsilon_{c,t}$, v_t^C, and $v_{g,t}^G$ are supposed to be mutually orthogonal across all equations in the system.

The model described by equations (2) to (5) is estimated through a Bayesian approach with Gibbs sampling, which is a Markov Chain Monte Carlo (MCMC) method for approximating the joint and marginal distributions by sampling from conditional distributions. Using a MCMC procedure, we can generate random samples for the unknown parameters and the unobserved factors from the joint posterior distribution. This is feasible as the full set of conditional distributions is known, that is, parameters given data and factors, and factors given data and parameters.[7] The first factor captures the global (common to all commodity markets) price uncertainty comovement (referred to as GLUN, global uncertainty, in the remaining of the paper), while the second factor captures the group-specific commodity price uncertainty comovement, namely the agricultural price uncertainty (AGUN), the metals' price uncertainty (MTUN) and the energy price uncertainty (ENUN).

2.5. Structural VAR modelling

To measure the dynamic effects of commodity price uncertainty shocks on commodity currencies, we estimate in a second step a structural VAR (SVAR) model, in which, in addition to the exogenously determined commodity price and uncertainty shocks, we also include domestic inflation, policy rates, export growth and real GDP growth as endogenous variables. Our SVAR model is given in equation (6) below:

$$A_0 Y_t = c + A_1 Y_{t-1} + \ldots + A_k Y_{t-k} + \varepsilon_t \tag{6}$$

where c is a vector of constants, Y_t is the vector of endogenous variables, A_0 is the matrix of contemporaneous variables, A_1 to A_k are matrices of coefficients and ε_t is the vector of serially uncorrelated disturbances, with zero mean and variance–covariance matrix $E\left(\varepsilon_t, \varepsilon_t^{'}\right) = \sigma_\varepsilon^2 I$. Following Hamilton (2003), we incorporate a full year (4 quarters of lags) in the SVAR in order to allow for sufficient dynamics driving the interactions between commodity prices, uncertainty shocks and the real economy. We estimate an 8-variable SVAR model with the following ordering:

$$Y_t = [\ VIX_t COMRET_t\ GLUN_t FX_t\ INFL_t IR_t EXP_t GDP_t] \tag{7}$$

where VIX is the VIX index, COMRET is the quarterly growth rate of the broad GSCI commodity price index, GLUN is the global commodity price uncertainty factor previously estimated, FX stands for the quarterly growth rate of the real effective exchange rate, INFL is the domestic inflation rate measured as the annual growth rate of Consumer Price Index, IR is the change in the domestic monetary policy (short-term) rate, EXP is the growth rate of total exports and GDP is the quarterly growth rate of real Gross Domestic Product. We estimate the same SVAR model for Australia, Canada, New Zealand, and Norway. We finally estimate the same set of SVAR models assessing sequentially the effects of agricultural, metals and energy-specific commodity price uncertainty shocks on commodity currencies. To do so, we use instead of GLUN, the AGUN, ENUN and MTUN factors (the group-specific agricultural, energy and metals price uncertainty factors, respectively), and instead of COMRET, we include AGRET, ENRET and METRET, which are the quarterly log-returns of the quarterly GSCI agricultural, energy and metals commodity price index, respectively.

To recover orthogonal shocks, we use a classical Cholesky decomposition. We assume that a global financial uncertainty shock (a VIX shock) is driving uncertainty in global commodity markets, hence we place the VIX first in our SVAR ordering of variables. Our

[7] For further details on the selected methodology, see Kose et al. (2003).

assumption on the VIX driving commodity market uncertainty within the quarter is in line with the recent findings in the commodity literature according to which the changes in the VIX cause fluctuations in the option-implied volatility of major global commodity futures markets (Robe and Wallen, 2016; Covindassamy et al., 2017). Moreover, by placing the variables COMRET and GLUN second and third in the SVAR, we assume strict exogeneity of first and second moment shocks in commodity markets on the domestic economies under investigation. This assumption is in line with the relevant literature, according to which the small open inflation targeting economies (like those included in our analysis) are assumed to be (commodity) price takers and not price makers.[8] Lastly, the assumptions behind our SVAR ordering are that shocks instantaneously influence the (highly flexible) exchange rate market, then inflation and then quantities (exports and real GDP growth). We impose that monetary policy reaction takes place after observing inflationary pressures taking into consideration the fact that all our selected countries in the analysis have been carrying out inflation targeting monetary policy since the early 1990s.

In addition to this benchmark model, we estimate a SVAR model in which we allow for Foreign Direct Investment (FDI) net inflows to respond instantaneously to global commodity price uncertainty shocks. The net FDI inflows represent the net investments made by foreign investors to the resident economy (each of our four commodity currencies). In this way, we empirically examine whether the channel through which commodity price shocks result to changes in real exchange rates of commodity-dependent economies, passes through changes in financial investment flows of foreign investors to those countries in response to GLUN shocks. The ordering for our 9-variable SVAR model in which we include the quarterly growth rate of FDI net inflows is shown in equation (8) below:

$$Z_t = [\,VIX_t COMRET_t\, GLUN_t\, FDI_t FX_t\;\, INFL_t IR_t EXP_t GDP_t] \tag{8}$$

This 9-variable SVAR model has an ordering like our baseline SVAR model presented in equations (6) and (7), with the only additional endogenous variable being the FDI, which represents the quarterly growth of net FDI inflows. Like our baseline SVAR, we also use the same Cholesky identification strategy for our set of structural shocks in the SVAR. Using this identification strategy in our 9-variable SVAR model, we allow for GLUN shocks to have an instantaneous effect on FDI inflows and then on exchange rates, inflation and output. In this way, we allow for second round effects of GLUN shocks to FDI, which could ultimately be an additional channel through which the effect of GLUN shocks is amplified and transmitted to commodity currencies (since increasing FDI inflows ultimately leads to currency appreciation of the resident economy, which is the net receiver of FDI inflows).

3. Empirical analysis

3.1. Descriptive statistics

In this section, we provide some descriptive statistics for the time series involved in our analysis. More specifically, Table 1 below shows the descriptive statistics of the commodity related variables used in the SVAR analysis, including the VIX, while Fig. 1 shows the estimated GLUN, AGUN, ENUN and MTUN factors along with their confidence bounds (namely the 33 % and 66 % quantiles) as obtained from our Dynamic Factor Model.

From Table 1 we show that we reject the hypothesis of a unit root at 1 % significance level for all our commodity related variables used in our analysis, implying thus that our SVAR models only deal with stationary time series (all macro variables are similarly shown to be stationary). Global commodity uncertainty (proxied by the estimated GLUN factor) exhibits large spikes during recessionary periods, including the Great Recession of 2007–2008 and the recent COVID-19 period. The estimated ENUN factor also spikes during the COVID-19 period, capturing the increased uncertainty surrounding energy markets and the many sudden swings in energy prices during the COVID outbreak. The MTUN factor spikes during the 2006 commodity boom period, during the 2008 Great Recession and on the recent COVID-19 outbreak, suggesting a strong business-cycle component of metals price fluctuations (Fama and French, 1988; Kucher and McCoskey, 2017; among others). On the other hand, as expected, our AGUN factor does not exhibit significant spikes during recessions and displays more regular variations, reflecting the fact that agricultural price uncertainty is partly driven by crop and harvesting periods (Karali and Thurman, 2010; Triantafyllou et al., 2015; among others).

3.2. Response of commodity currencies to commodity price uncertainty shocks

In this section we present the results of the SVAR model showing the dynamic impulse response functions (IRFs) of commodity currencies, namely the Australian (AUS), Canadian (CAN), New Zealand (NZEAL) and Norwegian (NOR) real effective exchange rates, to a global commodity price uncertainty shock (GLUN shock). Fig. 2 below shows the estimated IRFs of AUS, CAN, NZEAL and NOR real exchange rates along with their respective 90 % bootstrapped confidence intervals.

The estimated IRFs of Fig. 2 show a statistically significant response of our set of commodity currencies to a global commodity price uncertainty shock. More specifically, the Australian and New Zealand exchange rates depreciate approximately by 1.2 % and 1.0 % respectively in response to a one standard deviation in the GLUN factor; the response remaining negative and statistically significant

[8] Some studies in the literature (see Zhang et al., 2016) identify bi-directional linkages between commodity prices and their corresponding commodity currencies, implicitly assuming that large commodity-producers and exporters could influence global commodity prices. Our SVAR results do not qualitatively change when relaxing the strict exogeneity assumption of commodity-related shocks, allowing for exchange rates to have an instantaneous effect on commodity price fluctuations. These additional results can be provided upon request.

Table 1
Descriptive statistics.

	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	ADF test
GLUN	−0.0001	−0.006	0.258	−0.059	0.034	3.90	26.50	−6.625***
AGUN	−0.0004	−0.007	0.089	−0.078	0.027	0.76	3.87	−6.958***
MTUN	0.0001	−0.009	0.144	−0.050	0.031	2.35	9.93	−6.174***
ENUN	−0.0006	−0.003	0.150	−0.046	0.023	3.64	23.08	−7.613***
AGRET	−0.0100	−0.018	0.213	−0.389	0.082	−0.25	6.22	−8.865***
ENRET	−0.0008	0.023	0.357	−0.677	0.156	−1.33	6.96	−8.632***
METRET	0.0032	−0.005	0.150	−0.160	0.058	0.46	3.29	−8.680***
VIX	0.1949	0.174	0.586	0.103	0.072	1.89	9.41	−4.378***

Note: In the Augmented Dickey-Fuller (ADF) unit root test we denote with *, ** and *** the rejection of the unit root hypothesis at the 10 %, 5 % and 1 % confidence level respectively. The descriptive statistics presented in this table correspond to the quarterly full (1994Q1- 2021Q2) dataset.

for two quarters after the GLUN shock. Canadian and Norwegian exchange rates reduce much less in response to a GLUN shock; the negative effect still being short-lived. Overall, our findings are the first to show the negative short-run response of commodity currencies to global commodity price uncertainty shocks. While the relevant literature so far has extensively shown that commodity currencies exhibit significant comovement with global commodity prices (i.e. rising commodity prices result in an appreciation of the commodity currency, see Chen and Rogoff, 2003, Coudert et al., 2015; Zhang et al., 2016; among others), we additionally show here in opposition that rising uncertainty in global commodity markets has a negative short-run effect on commodity currencies. This empirical finding is in line with the theoretical and empirical literature on investment under uncertainty, according to which investors, after observing a rise in commodity market uncertainty, initially postpone their investment in 'risky' commodity currencies up until the uncertainty shock is resolved (Bloom, 2009; Pindyck, 1991). Another possible channel of transmission to exchange rates of a global uncertainty shock goes through the monetary policy reaction (see Section 3.3.).

We also note that our baseline SVAR results presented in Fig. 2 clearly show a subsequent rebound of commodity currencies a few quarters after the initial GLUN shock. More specifically, according to our SVAR analysis, a GLUN shock results in an initial depreciation of the commodity currencies in the short-run (1–2 quarters after the shock) followed by a subsequent appreciation in the medium-run (4–6 quarters after the shock), with the effect of the GLUN shock turning from negative to positive about 4 quarters after the shock. For instance, the response of the Australian dollar is significantly negative for the first two quarters after the GLUN shock, then becomes positive five quarters after the shock, reaching an appreciation of about 0.7 %. These results are also in line with the literature focusing on the macroeconomic impact of uncertainty shocks, according to which an increase in macroeconomic uncertainty shock leads to an immediate drop and a subsequent bounce-back of economic activity in the medium-run (Bloom, 2009),[9] especially in advanced economies (Carrière-Swallow and Céspedes, 2013).

This medium-term bounce-back on commodity currencies is likely to come from the uncertainty resolution channel, according to which the resolution of uncertainty reduces the hedging needs of financial market participants (Beber and Brandt, 2009). Hence, the resolution of the global uncertainty is likely to lead investors to revert to commodity currencies, increasing the demand for commodity currencies and ultimately generating an appreciation of the currency of commodity-producing economies in the medium-run. Since in our baseline VAR analysis we do not control for the responses of foreign investors, we estimate an additional 9-variable SVAR model in which we show that the response of foreign investors (their net investment in our set of commodity-exporting economies) to GLUN shocks is also negative in the short-run and becomes positive in the medium run. These additional SVAR estimates are shown in Section 3.6 of the paper and verify our hypothesis regarding the uncertainty resolution channel driving the medium-run rebound of commodity currencies through increasing investment.

3.3. *Responses of output, trade and monetary policy to commodity uncertainty*

In order to disentangle the possible channels through which commodity price uncertainty impacts the currencies of commodity-rich economies, we report the IRF of output, trade and the policy rate to a GLUN shock estimated from our baseline SVAR model presented in Section 2. Fig. 3 below reports the estimated IRFs of real GDP growth, inflation, exports growth and monetary policy rate for our set of commodity-rich economies.

As we can see from Fig. 3, it turns out that all the countries share similar patterns in their responses, except the fact that New Zealand appears to be more volatile. Overall, there is a significant drop for most of our set of macroeconomic variables, that is inflation, output and exports, but without any subsequent rebound. The fact that output and prices go in the same direction leads us to think that a global commodity price uncertainty shock is likely to act as a negative demand shock in the short-run (see also Ferrara et al., 2022). While the significant reduction of short-run economic activity in commodity-rich economies might be a potential explanation of the short-run currency depreciation, there is no clear evidence that the subsequent bounce-back in currencies might be related to a strong medium-term economic recovery.

However, when focusing on the IRFs of the central bank interest rates of the four countries presented in the second column of Fig. 3,

[9] In his theoretical model, Bloom (2009) provides analytical explanations on the theoretical channels through which uncertainty shocks could lead to initial decline and a long run rebound of economic activity.

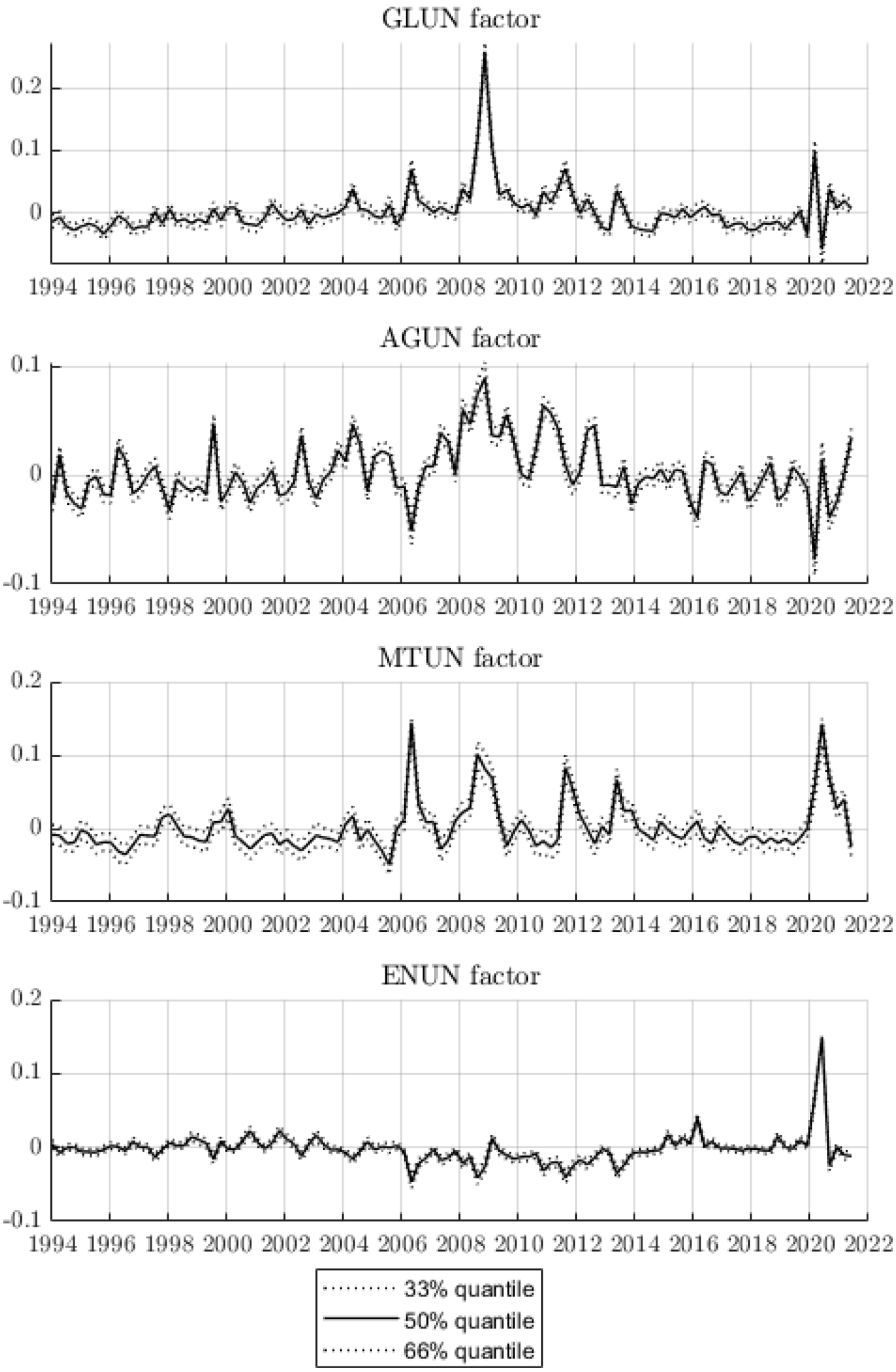


Fig. 1. Global, agricultural, energy and metals commodity price uncertainty factors This plot shows the quarterly series of the estimated global commodity price uncertainty (GLUN), agricultural price uncertainty (AGUN), metals price uncertainty (MTUN) and energy price uncertainty (ENUN) factors estimated via our Bayesian Dynamic Factor Model.

we note that the responses tend to somewhat mimic the shape of the currency responses presented in Fig. 2, even if they are not always clearly significant, except for New Zealand. Thus, this suggests that monetary policy could possibly be a driver of the response of commodity currencies after a global commodity shock, even if the force driving the short-run depreciation is stronger than the one driving the medium-run appreciation.

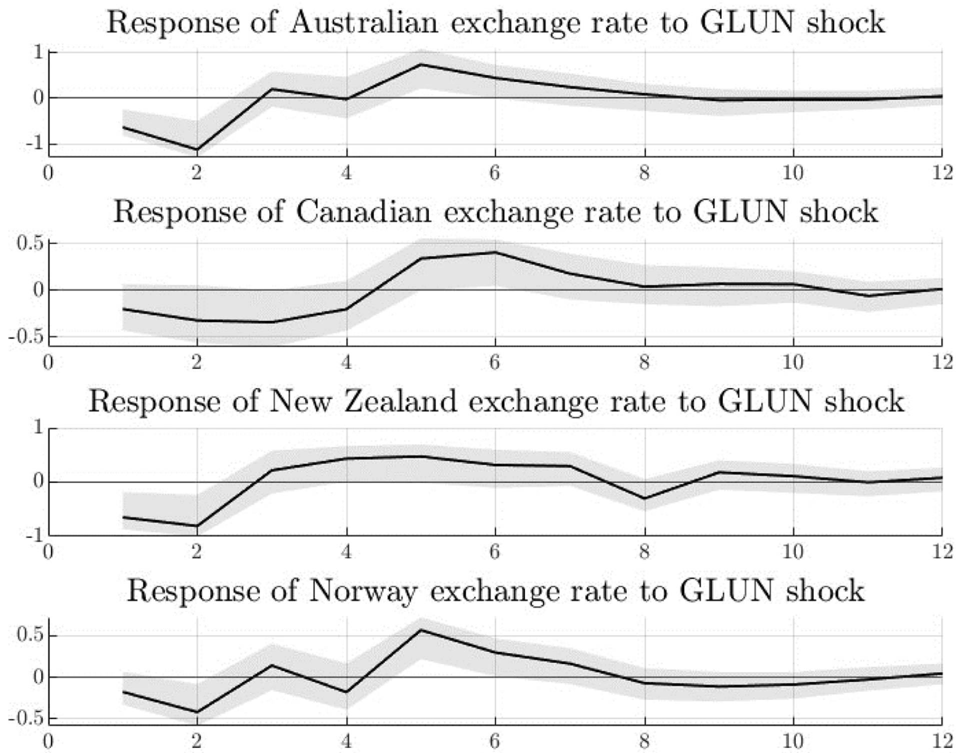


Fig. 2. Response of commodity currencies to GLUN shock This graph shows the estimated Orthogonalized Impulse Response Functions of the quarterly growth rate of Australia, Canada, New Zealand and Norway real broad effective exchange rates to one standard deviation shock in GLUN. The estimated responses are expressed in percentages (%). The shaded area shows 90 % bootstrapped confidence intervals using 1000 repetitions.

Those results reinforce the view that the main channel through which commodity price uncertainty leads to a medium-term appreciation is that foreign exchange investors treat commodity price uncertainty shocks as an opportunity to invest in commodity currencies in the medium-run, once the uncertainty shock fades away.

3.4. Commodity currencies vs non-commodity currencies

To assess whether the significant effects of commodity price uncertainty shocks only hold for commodity-producing economies, we conduct the same type of SVAR analysis for two major non-commodity currencies, namely the U.S. dollar and the euro (in real effective terms). Moreover, following the relevant literature that identifies the role of the U.S. dollar as the safe haven currency in times of heightened macroeconomic uncertainty (Georgiadis et al., 2021), we also present the responses of U.S. and euro real exchange rates to a VIX shock along with the respective responses to a GLUN shock.[10] Fig. 4 below shows the time series plots of the GLUN factor vs a commodity currency (Australian exchange rate) and a non-commodity currency (U.S. dollar).

By eyeballing Fig. 4 it seems that, while the spikes of GLUN quite often coincide with subsequent spikes of the U.S. dollar (highlighting the well-known safe haven property), the opposite seems to prevail for the Australian dollar. The opposite reactions of U.S. and Australian dollars to GLUN spikes are more pronounced in turbulent periods, including the 2007–2008 Great Recession and the recent COVID-19 outbreak. To confirm this empirical observation, Fig. 5 below reports the estimated IRFs of euro and U.S. dollar to GLUN and VIX shocks.

We observe that, in line with the relevant literature, the U.S. dollar significantly appreciates after a VIX shock, confirming the role of the U.S. dollar as a safe haven currency during financial turmoil. Interestingly, we show that the U.S. dollar also appreciates in the short-run after a global commodity price uncertainty shock (GLUN shock, top left in Fig. 5). In this way we show that the U.S. dollar is not only a safe haven asset in times of heightened financial uncertainty, but also in times of increasing global commodity price uncertainty. Interestingly, the inverse hump shaped response of the U.S. dollar to GLUN and VIX shocks (an initial appreciation followed by a medium-run depreciation) is the exact opposite of the commodity currencies' response. This result suggests that FX investors, when faced with high commodity price uncertainty, shift from commodity currencies (risky FX assets) to safe haven currencies (as the U.S. dollar) in order to hedge their exposure on commodity price uncertainty. This results in an immediate depreciation of commodity currencies and immediate appreciation of the typical safe haven currency. In the medium run (i.e. after about one year), when the

[10] Furthermore, in our SVAR model, we make the assumption that the VIX is driving the global commodity market uncertainty.

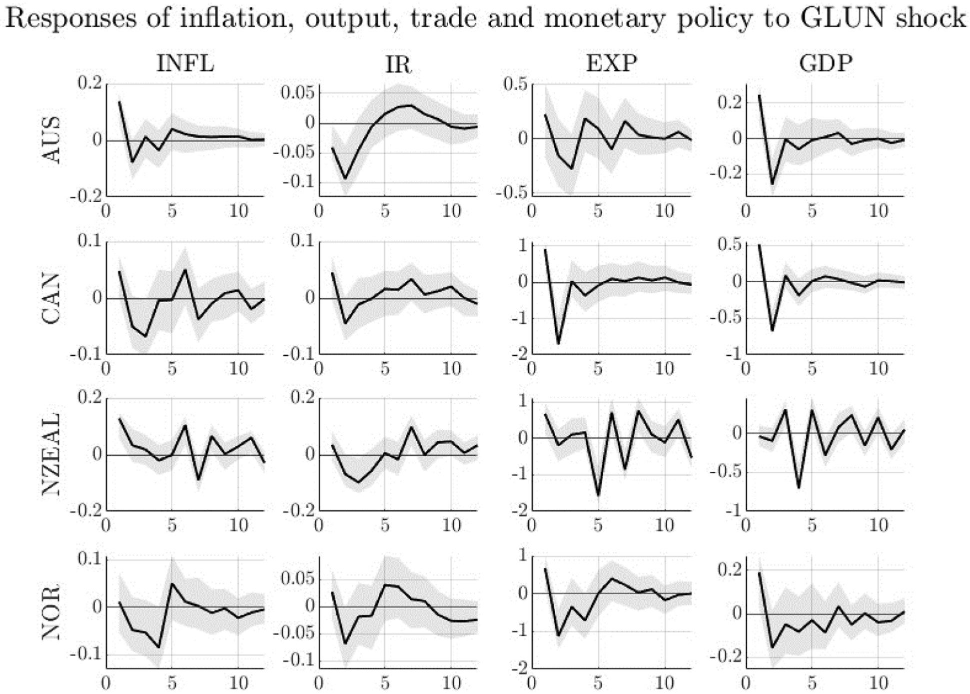


Fig. 3. Response of output, inflation, trade and monetary policy to GLUN shock This graph shows the estimated Orthogonalized Impulse Response Functions of the quarterly growth rate of Australia, Canada, New Zealand and Norway real GDP growth (GDP), inflation (INFL), exports growth (EXP) and of the short-term (policy) rate (IR) to a one standard deviation shock in GLUN. The estimated responses are expressed in percentages (%). The shaded area shows the 90 % bootstrapped confidence intervals using 1000 repetitions.

uncertainty shock fades away, that is uncertainty is resolved on global commodity markets, investors shift away from the U.S. dollar and go back towards commodity currencies. This movement results in a medium-run appreciation of commodity currencies as well as a medium-term depreciation of the safe haven currency. As a benchmark, we also estimate the response of the euro to GLUN and VIX shocks. It turns out that we report a non-significant response to both types of uncertainty shocks. This finding strengthens the common wisdom that the euro is less sensitive to global shocks and is not considered by market participants, at least so far, as a safe haven currency.

3.5. Agricultural, metals and energy commodity price uncertainty

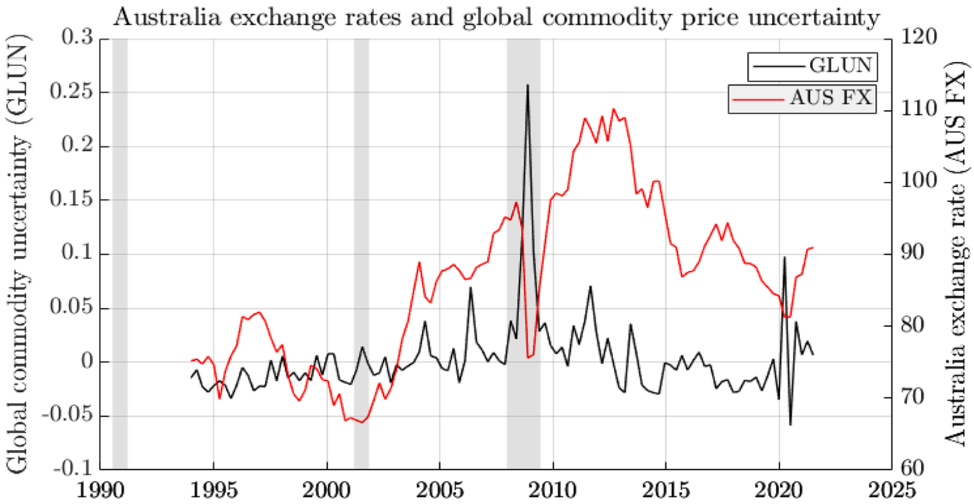
We continue our empirical analysis by assessing the impact of uncertainty shocks on market-specific commodities, once the global uncertainty component has been removed (see also Ferrara et al., 2022). Practically, we estimate SVAR models by sequentially replacing the GLUN factor by the AGUN, ENUN and MTUN factors as our endogenous variable capturing uncertainty in agricultural, energy and metals commodity markets, respectively. In this way we examine the dynamic impact of commodity group-specific uncertainty on major commodity currencies.

All our selected commodity-producing countries export a wide range of agricultural, metals and energy commodities. Australia and Canada are more industrialized economies mainly concentrated on the production and exports of metals and energy commodities, while New Zealand is focused on the production of agricultural products, playing a significant role as a major exporter of agricultural commodities. On the other hand, Norway is among the largest crude oil exporters in the world. Given this type of commodity dependencies of those economies, we expect for instance, that the exchange rates of New Zealand and Norway will be more responsive to AGUN and ENUN shocks, respectively. Fig. 6 below shows the results of our market-specific commodity uncertainty SVAR models.

The estimated IRFs presented in Fig. 6 show a significant short-run negative impact of metals price uncertainty shocks on commodity currencies, followed by a significant bounce-back behavior of commodity currencies about five quarters after the initial MTUN shock. This pattern of short-term depreciation followed by medium-term appreciation resembles the observed pattern obtained after the common commodity price uncertainty shock. The currency responding the most strongly to MTUN shocks is the Australian dollar: it depreciates by approximately 1 % two quarters after the MTUN shock and then appreciates by 0.4 % six quarters after the initial MTUN shock. This result is somewhat expected, given the fact that Australia has been for many years a major producer of precious metals, being the richest country in the world in terms of gold resources.

Interestingly, our SVAR analysis identifies a short-run positive response of commodity currencies to ENUN shocks, showing in this way the unique nature of energy commodities like crude oil and natural gas. For instance, according to our results, the Australian dollar appreciates by approximately 1.3 % after a one standard deviation ENUN shock. Even more interestingly, we find that the New Zealand

Panel A



Panel B

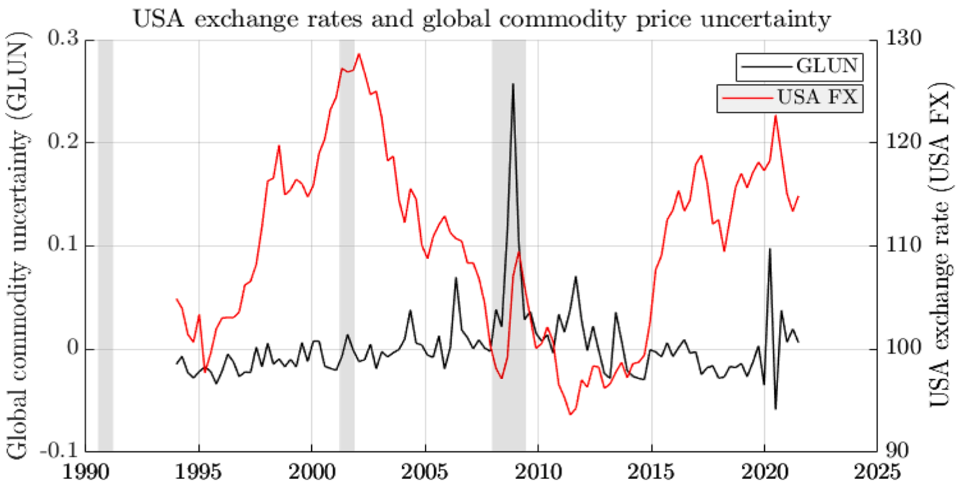


Fig. 4. Australian and U.S. real broad effective exchange rates and global commodity price uncertainty.

dollar also appreciates by approximately 0.6 % two quarters after an ENUN shock. The latter finding is puzzling given that New Zealand is not concentrated on the production of energy commodities, hence one would expect the New Zealand dollar to be relatively immune to energy price uncertainty shocks. The fact that the exchange rates of both energy and non-energy producing economies appreciate in response to energy price uncertainty shocks suggests that investors do treat energy commodities differently. Indeed, investors seem to not interpret energy price uncertainty as a potential threat for commodity currencies, but instead as a potential opportunity: investing in commodity currencies with the expectation that the energy sector prices will be booming in the near future, increasing thus their demand for commodity currencies after the occurrence of ENUN shocks. The underlying economic mechanism explaining the rising demand for oil currencies when energy price uncertainty increases has its roots in the real growth-option of expanding investment under uncertainty (Bloom, 2014). That is the option to increase their investment to benefit from potential increases in the oil price.[11] The other two real options (choices of firms) are either to postpone or reduce their investment when faced with rising oil price uncertainty. Their contraction option could be a defending mechanism for firms and investors alike. However, oil is

[11] Overall, when uncertainty increases firms are faced with the real option to contract, postpone or expand their investments in risky projects (Pindyck, 1991). Bloom (2014) was the first to identify and built a theoretical model formalizing this growth-option channel for firms by showing that rising uncertainty increases the level of potential profits thereby prompts investment. In line with this premise, several recent empirical studies find that oil price uncertainty increases stock profits, firm's revenues, and executive compensation (Kang et al., 2017; Wong and Hasan, 2021; Hasan et al., 2022).

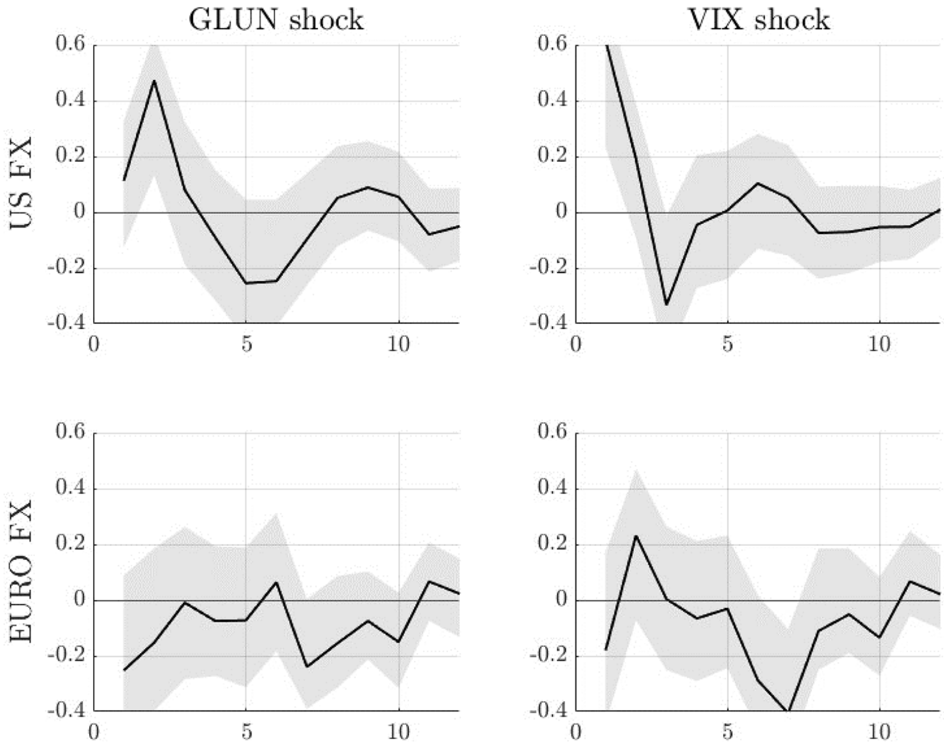


Fig. 5. Response of U.S. and Euro (non-commodity currencies) exchange rates to GLUN shock This graph shows the estimated Orthogonalized Impulse Response Functions of the quarterly growth rate of US and EURO real-broad effective exchange rates to one standard deviation shock in GLUN. The estimated responses are expressed in percentages (%). The shaded area shows the 90 % bootstrapped confidence intervals using 1000 repetitions.

a major commodity investment, which has an important role in promoting growth opportunities in the financial markets. In addition, unlike equity markets, in the crude oil market the rising uncertainty is associated with higher convenience yield for holding oil inventories hence with more vulnerability to oil price spikes (Geman and Ohana, 2009; Pindyck, 2004; among others). Consequently, oil producers and investors assign higher probability on the occurrence of oil price increases compared to decreases when faced with higher uncertainty in the crude oil market. As a result, firms and investors would be more willing to seize growth opportunities rather than exercise the contraction option by limiting future investment.[12]

In the coming section (Section 3.6) we provide further empirical evidence on the response of FDI and net Portfolio Equity (PE) inflows (net purchases of local shares by foreign investors) to ENUN shocks and we empirically show that there is an increased demand of foreign investors towards investing in large oil producing economies, like Canada and Norway, in response to rising energy price uncertainty. Finally, the IRFs presented in Fig. 6 show that AGUN shocks lead to a significant depreciation of commodity currencies on impact, but the effect rapidly fades away after one or two quarters.

3.6. Foreign Direct investment under commodity price uncertainty

In order to empirically examine our conjecture reported in the earlier sections of the paper, according to which the medium-run rebound of commodity currencies in response to uncertainty shocks is not attributed to macroeconomic fundamentals, but to financial investors behavior and responses to global commodity price uncertainty, we estimate a SVAR model (described in Equation (8) of the methodology section) in which we allow for possible dynamic interactions between commodity uncertainty, commodity currencies and foreign investors' (FDI) inflows to currencies in response to commodity price uncertainty shocks. In this model, we want to empirically examine whether FDI inflows might be the financial channel explaining the medium-run rebound of commodity currencies in response to GLUN shocks (since those currency appreciations cannot be explained by the respective responses of macroeconomic fundamentals like output and exports). The estimated IRFs of FDI inflows to GLUN shocks when using our 9-variable SVAR model are given in Fig. 7 below.

As we observe from Fig. 7, a GLUN shock results in an initial drop of FDI inflows for all our commodity-dependent economies,

[12] In addition, on the consumption side, the relevant literature has shown that when households are facing rising energy price uncertainty, quite often they cut their current energy consumption following their precautionary savings motives, which in turn increases investment in the short-run (Edelstein and Kilian, 2009).

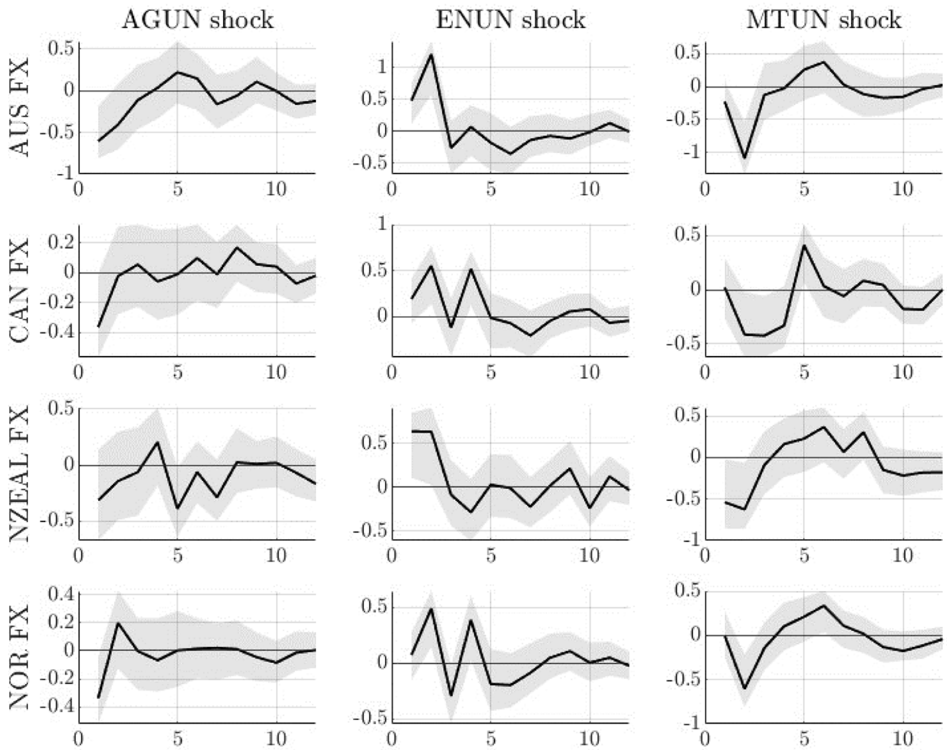


Fig. 6. Response of commodity currencies to AGUN, ENUN and MTUN shocks This graph shows the estimated Orthogonalized Impulse Response Functions of the quarterly growth rate of Australia, Canada, New Zealand and Norway real broad effective exchange rates to one standard deviation shock in AGUN, ENUN and MTUN. The estimated responses are expressed in percentages (%). The shaded area shows the 90 % bootstrapped confidence intervals using 1000 repetitions.

followed by a subsequent increase in the medium-run (4 to 6 quarters after the GLUN shock). For example, a one standard deviation GLUN shock results in a 12 % and 22 % reduction in Canada and New Zealand's FDI inflow growth, respectively, one quarter after the shock, followed by an approximate 10 % increase in the respective inflows five and six quarters after the shock, respectively. The FDI reactions to GLUN shocks in Australia are of smaller size but more persistent than for Canada and New Zealand. FDI reactions to GLUN shocks are overall less persistent and of smaller magnitude in Norway, where the effect is overall insignificant. These results shed more light and empirical support on our conjecture made in the previous section of the paper, in which we attribute the medium-run rebound of commodity currencies to the increased positions of financial investors to those economies, when the commodity uncertainty is being resolved.

According to our analysis, the sign and magnitude of the dynamic response of FDI inflows to GLUN shocks is similar to that of the respective commodity currencies. Our analysis shows for the first time in the literature that the net investment inflows made to commodity currencies in response to commodity price uncertainty resolution is positive. This strengthens those commodity-dependent economies and ultimately leads to an appreciation of their real exchange rate in the medium-run (4–6 quarters after the initial GLUN shock). In conclusion, the FDI inflow responses empirically support our hypothesis about the resolution channel of the global commodity price uncertainty, which leads investors to revert to commodity currencies, increasing in turn the demand for investment in those countries (through rising FDI inflows), ultimately generating an appreciation of their currencies in the medium-run.

Moreover, we estimate the same set of 9-variable SVARs in which we examine the dynamic impact of our group-specific uncertainty factors on FDI inflows. In this respect, instead of the GLUN factor, we use our group specific AGUN, ENUN and MTUN factors and instead of the returns of the broad commodity price index (COMRET), we include AGRET, ENRET and METRET for the estimation of agricultural, metals and energy first moment shocks, respectively. Fig. 8 below reports the dynamic responses of FDI inflows to AGUN, ENUN and MTUN shocks, respectively.

The estimated IRFs for FDI inflows shown in Fig. 8 indicate that while the rising agricultural and metals price uncertainty has a negative short-run effect on FDI inflows, the rising energy price uncertainty (ENUN shock) leads to sharp increases in Australia, New

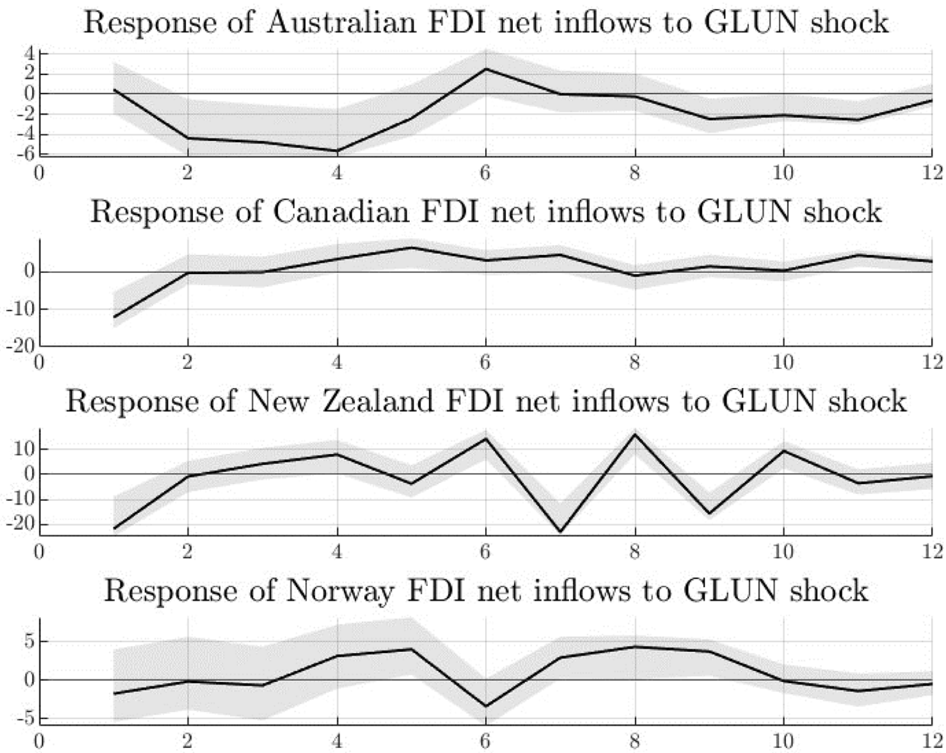


Fig. 7. Response of net Foreign Direct Investment inflows to GLUN shock This graph shows the estimated Orthogonalized Impulse Response Functions of the quarterly growth rate of Australia, Canada, New Zealand and Norway net FDI inflows to one standard deviation shock in GLUN. The estimated responses are expressed in percentages (%). The shaded area shows 90 % bootstrapped confidence intervals using 1000 repetitions.

Zealand and Norway FDI inflows.[13] These results provide further support to our findings and hypothesis on the possible channels driving and amplifying the effect of ENUN shocks on commodity currencies in the way presented in the previous section (Section 3.5) of the paper. Our FDI results show that the rising energy price uncertainty activates the 'growth-option channel' (Bloom, 2014) for foreign investors who tend to increase their investments in energy-producing economies, like Australia, New Zealand, and Norway with the expectation of higher economic gains. Therefore, the increased foreign investment in those energy-producing economies further strengthens their 'commodity' currency.

In order to provide robustness to our findings on the role of FDI inflows, we utilize another alternative measure of foreign direct investment (except from FDI inflows) which is the net portfolio equity (PE). The net PE inflows include the net purchases (purchases minus sales) of stocks and shares made by foreign investors on the local stock markets.[14] This type of financial liability flow is not reported as direct investment hence it is not included in the FDI inflows presented previously. Following our argument made in the beginning of Section 3.6, according to which the responses of commodity currencies to global commodity price uncertainty can be explained by the behavior of global financial investors when faced with increased commodity price uncertainty, we estimate an identical SVAR model in which we allow for possible dynamic interactions between commodity price uncertainty, real exchange rates and net PE inflows of the respective economy. Figs. 9 and 10 below report the responses of net PE inflows to shocks in GLUN and commodity-group specific (AGUN, MTUN and ENUN) shocks, respectively.

The estimated responses shown in Fig. 9 display a significant drop on Canadian PE inflows in the short-run, followed by a rebound in the medium-run, after the occurrence of a GLUN shock. We additionally observe a similar but less significant response of Norway's and New Zealand's net PE inflows to GLUN shocks. These results are broadly in line with our results on Canadian FDI inflows and strengthen further our conjecture on the financial transmission channel between commodity price uncertainty shocks and commodity currencies.

Our commodity group-specific results shown in Fig. 10 are also broadly in line with our findings showing the positive effect of

[13] On the contrary, our SVAR analysis reports a statistically insignificant short-run effect of Canadian FDI inflows to ENUN shock. While this result does not support our conjecture on the FDI inflows explaining the significant positive response of commodity currencies to ENUN shock, in our subsequent analysis dealing with the respective response of net portflolio equity (PE) inflows we report a significant increase of Canadian PE inflows after the occurrence of ENUN shocks (see Fig. 10).

[14] For more details on the definition and on the types of shares and stocks included on net portfolio equity flows please visit the IMF database which is our data source for this type of liability flow.

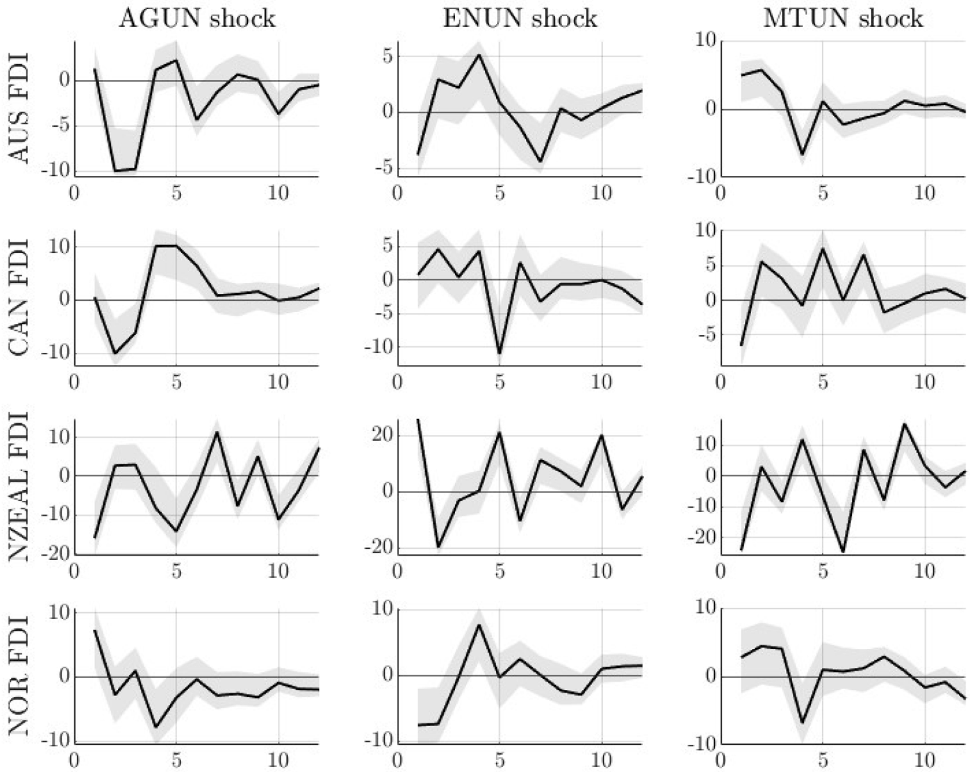


Fig. 8. Response of net Foreign Direct Investment inflows to AGUN, ENUN and MTUN shocks This graph shows the estimated Orthogonalized Impulse Response Functions of the quarterly growth rate of Australia, Canada, New Zealand and Norway net FDI inflows to a one standard deviation shock in AGUN, ENUN and MTUN. The estimated responses are expressed in percentages (%). The shaded area shows the 90 % bootstrapped confidence intervals using 1000 repetitions.

ENUN shocks on commodity currencies. We find that a one standard deviation shock in ENUN results in a significant short-run increase of net PE inflows of the Canadian and Norwegian stock markets. According to our SVAR results, the increased demand of international investors for buying shares in the Norwegian and Canadian stock markets when facing rising energy price uncertainty, is another verification of our hypothesis that financial factors and not macro-factors are the main underlying forces explaining the appreciation of the currency of large oil exporters, like Canada and Norway, in times of heightened energy price uncertainty. Overall, the significant positive response of FDI and net PE inflows to ENUN shocks reinforces our view according to which, foreign investors do not perceive the rising energy price uncertainty a threat, but as an opportunity to invest in commodity exporting economies, like, Canada and Norway.

3.7. *Commodity-importing economies*

In order to conclude that the depreciation and the subsequent rebound of commodity currencies in response to global commodity price uncertainty shocks is a specific commodity currency property, we estimate our baseline SVAR model (presented in Equations (6) and (7)) for a set of commodity-producing countries with few commodity exports (hence with a persistently negative commodity trade balance). In this way, we not only examine whether the significant impact of GLUN shocks exists only for countries which have the 'commodity currency property', but also whether commodity price uncertainty shocks could have a dampening effect on the real exchange rate of large commodity importers. More specifically, we report the estimated IRFs of Japanese and Korean real broad effective exchange rates to a GLUN shock. The estimated IRFs can be found in Fig. 11 below.

As we see from Fig. 11, the response of the Korean exchange rate to GLUN shocks is not significant for all subsequent quarters, while the GLUN shock has a positive effect on the Japanese yen, with the Japanese real exchange rate appreciating by almost 1 % two quarters after the shock. The response of the Japanese Yen after the occurrence of GLUN shock is like that of the US dollar (see Section 3.4). Our findings on the positive response of the Yen to commodity price uncertainty shocks is broadly in line with the literature showing that the Japanese Yen acts as a safe haven currency for investors in times of heightened financial market uncertainty (Cho and Han, 2021; Ranaldo and Söderlind, 2010; among others).

Overall, our results show that the exchange rates of commodity-importing countries are relatively immune to changes in commodity price uncertainty. Hence, the 'commodity uncertainty property', which we show and present in our paper, is specific to commodity-exporting countries and is not applicable for commodity importers. We additionally estimate our SVAR for some other

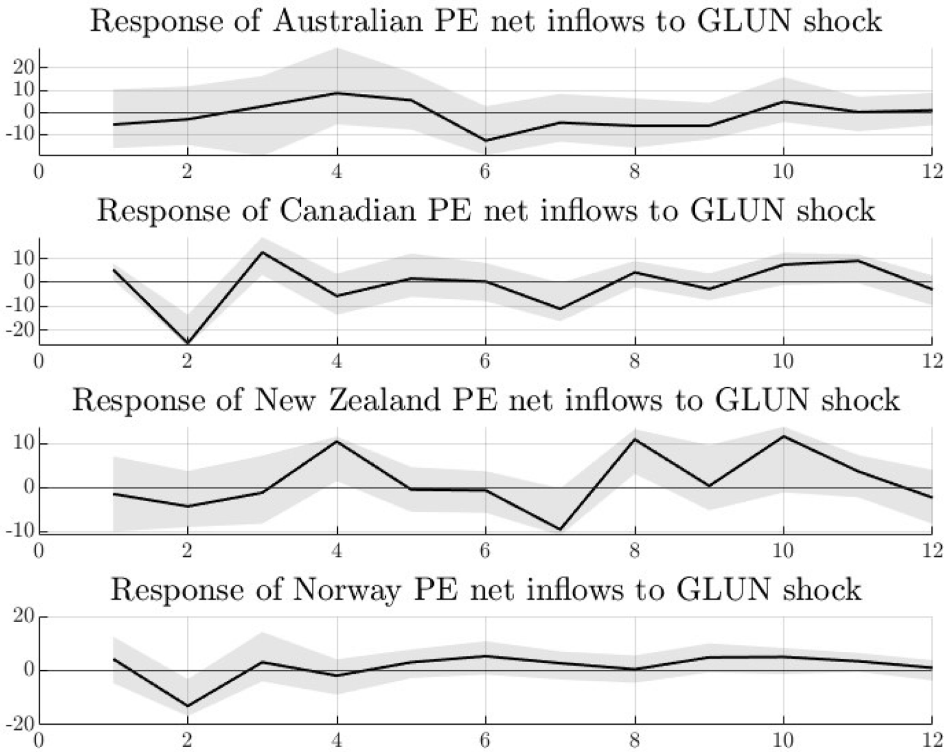


Fig. 9. Response of portfolio Equity (PE) net inflows to GLUN shock This graph shows the estimated Orthogonalized Impulse Response Functions of the quarterly growth rate of Australia, Canada, New Zealand and Norway net Portfolio Equity (PE) inflows to one standard deviation shock in GLUN. The estimated responses are expressed in percentages (%). The shaded area shows 90 % bootstrapped confidence intervals using 1000 repetitions.

commodity-importing countries like China, United Kingdom and Germany and our conclusions on the non-significance of commodity price uncertainty for commodity importers remains valid.[15]

4. Robustness checks

In this section we report the various robustness checks we carried out based on our SVAR models. First, we carried out a subsample analysis using the pre- and post-2004 sample for the estimation of the SVAR. Indeed, the year 2004 is often considered as the start of the financialization of commodity markets (see Delle Chiaie et al., 2022). We do not observe any significant changes in our IRFs estimated over both sub-samples.

Second, instead of the VIX index, we used various alternative proxies for global economic uncertainty in our SVAR model, including the global Economic Policy Uncertainty (EPU) index of Baker et al. (2016) and the global geopolitical risk index of Caldara and Iacoviello (2022). Again, we didn’t observe any significant changes from the IRFs.

Third, following the strand of the literature identifying the terms of trade as the major channel through which commodity price fluctuations impact the exchange rate of commodity producing economies (Bodart et al., 2012; Cashin et al., 2004; Chen and Rogoff, 2003; Chen and Lee, 2018; Coudert et al., 2015), we substituted export growth by terms of trade as our endogenous variable capturing trade shocks in the SVAR model. Again, our results remain qualitatively unchanged. Fourth, we additionally performed the SVAR analysis using alternative variable orderings and our results remain qualitatively the same.

Fifth, motivated by the strand of the literature which identifies the reverse channel of causality between exchange rates and commodity prices (Chen et al., 2010; Chen and Lee, 2018; Clements and Fry, 2008), we endogenized commodity price uncertainty by allowing exports and terms of trade shocks to have an instantaneous effect on commodity uncertainty. The results of our model with endogenously determined commodity price uncertainty shocks also remain roughly identical.

Finally, in order to implicitly examine the indirect effect of the COVID-19 outbreak on the dynamic relationship between commodity uncertainty and commodity currencies, we performed the same SVAR analysis as the one presented in Subsection 3.2 for the pre-COVID period but with our time series ending in 2019q4. In this way we implicitly examined whether the inclusion (or not) of the

[15] These additional SVAR results can be provided upon request.

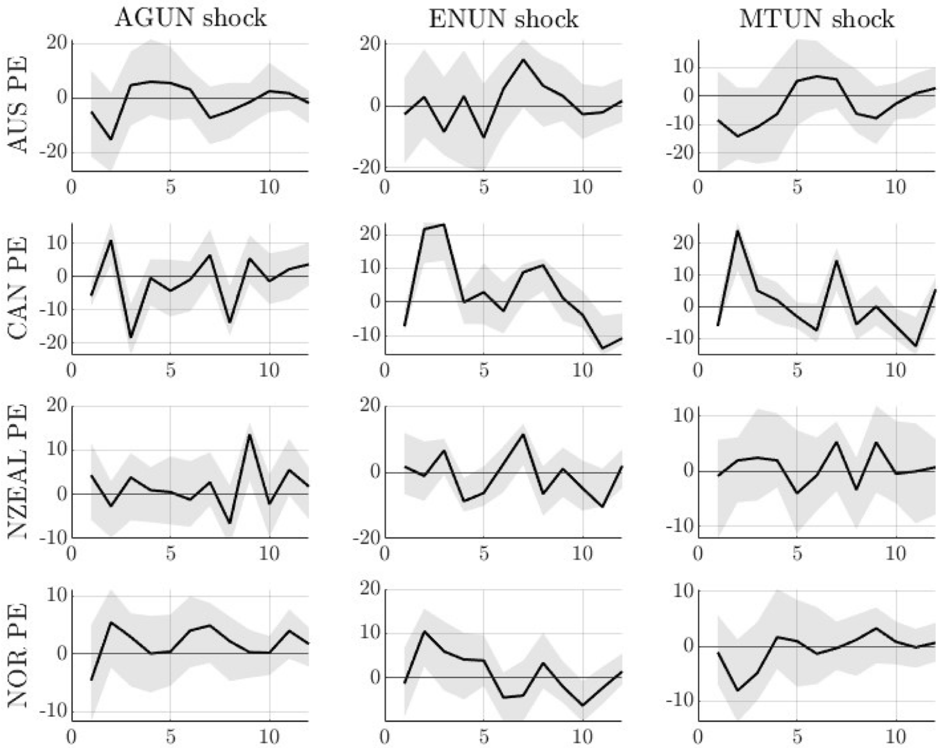


Fig. 10. Response of portfolio Equity (PE) net inflows to AGUN, ENUN and MTUN shocks This graph shows the estimated Orthogonalized Impulse Response Functions of the quarterly growth rate of Australia, Canada, New Zealand and Norway net Portfolio Equity (PE) inflows to a one standard deviation shock in AGUN, ENUN and MTUN. The estimated responses are expressed in percentages (%). The shaded area shows the 90 % bootstrapped confidence intervals using 1000 repetitions.

COVID period into our time series sample is likely to either amplify or to tame the impact of commodity price uncertainty shocks on exchange rate fluctuations. We get that while the dynamic impact of commodity price uncertainty shocks on commodity currencies remains similar, the safe haven property of the U.S. dollar significantly deteriorates if we exclude the COVID-19 outbreak from our analysis. These results are in line with those of Georgiadis et al. (2021) who identify the significant safe haven property of the U.S. currency during the COVID-19 period.

5. Conclusions

In this paper, we empirically show that a global commodity price uncertainty shock results in a short-run depreciation for a panel of commodity currencies, followed by a medium-run appreciation. This pattern appears to be specific to commodity currencies, as other benchmark currencies like the euro and the U.S. dollar do not react in the same way. Indeed, the euro tends to be neutral to this type of shock, while the U.S. dollar acts as a safe haven currency by appreciating in the wake of a global commodity price uncertainty shock, as it does after a VIX shock (Georgiadis et al., 2021). We refer to this pattern as the “commodity uncertainty currency” property.

We also get that macroeconomic fundamentals and monetary policy reactions to this type of uncertainty shock are in line with the first part of this pattern (i.e. the short-term depreciation), but there is no clear macroeconomic explanation as regards the second part of the movement, i.e. the medium-term appreciation. Our analysis suggests that medium-term currency appreciation is linked to a rise in foreign direct investment and net portfolio equity inflows within those countries once the global uncertainty shock has been resolved. Thus, it is likely that this medium-term bounce-back can be attributed, at least partly, to the classical growth-option theory put forward in Bloom (2009), according to which certain investors might expect higher opportunities in the wake of a commodity uncertainty shock. Last, we get that, once we account for the global commodity price uncertainty, market-specific uncertainty shocks tend to generate divergent effects in the short-run: agricultural and metals’ shocks generally lead to a depreciation of commodity currencies, while energy shocks generate a significant appreciation.

CRediT authorship contribution statement

Theodora Bermpei: Data curation, Formal analysis, Methodology, Validation. **Laurent Ferrara:** Conceptualization, Supervision, Writing – original draft. **Aikaterini Karadimitropoulou:** Conceptualization, Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing. **Athanasios Triantafyllou:** Data curation, Formal analysis, Methodology, Validation,

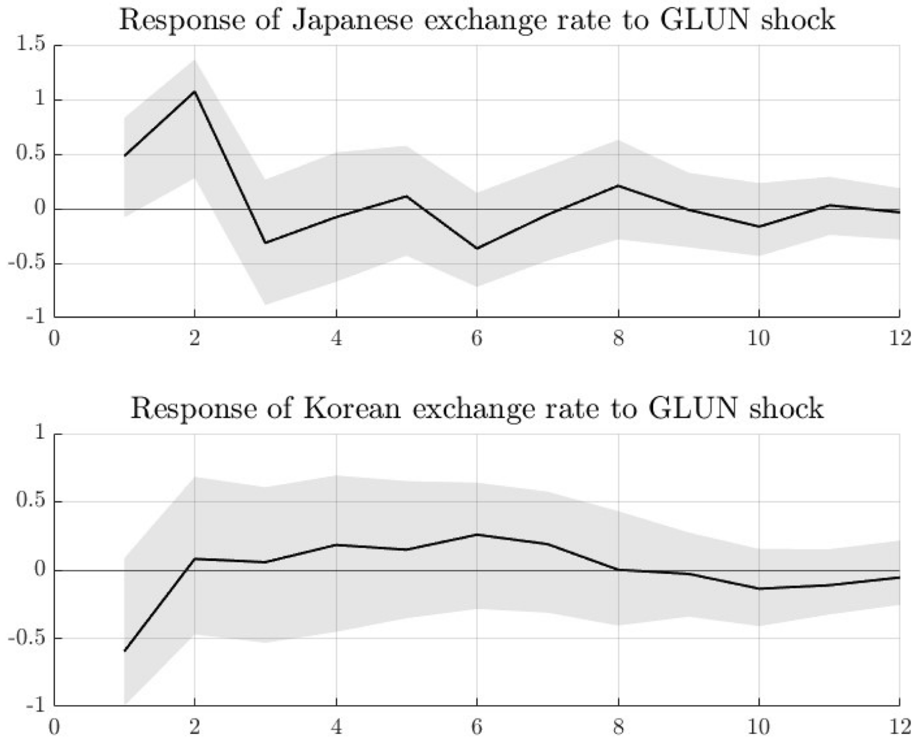


Fig. 11. Response of Japanese and Korean exchange rates to GLUN shock This graph shows the estimated Orthogonalized Impulse Response Functions of the quarterly growth rate of Japan and of Republic of Korea real broad effective exchange rates to one standard deviation shock in GLUN. The estimated responses are expressed in percentages (%). The shaded area shows 90 % bootstrapped confidence intervals using 1000 repetitions.

Writing – original draft.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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