



# The lens of the quantity theory of money to disentangle the perceived relationship between money growth and inflation: a PSVAR approach

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## Abstract

This paper contributes to the debate on the re-appraisal of monetization mechanism as a possible tool for dealing with macroeconomic imbalances due to close economic shocks (e.g. the Covid pandemic, the Russia-Ukraine conflict and the escalation in Israel-Hamas crisis). We analyze and empirically discuss the well-known Quantity Theory of Money (QTM), by applying the SVAR methodology to a heterogeneous panel including several Countries (Australia, China, India, Japan, United Kingdom and the United States) plus the block of Euro Zone (EZ) over the period 1992–2022. We investigate the dynamics and the impacts of the variables included in the theoretical model (inflation, GDP growth, money growth and the change in the velocity of money) through the analysis of the macro economic datasets retrieved from the OECD and Trading Economics databases. We find that money growth does not exert the decisive spillover effect on the path of inflation (i.e. common shock) throughout our sample. Moreover, our results indicate that the idiosyncratic component does not show a predominant and determining role of monetary growth in inflationary dynamics.

**Keywords** P-SVAR · Inflation · Money-growth · Quantity theory of money · Monetary finance

**JEL Classification** E02, Institutions and the macroeconomy · E31, Inflation · E51, Money supply · E58, Central banks and their policies

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## 1 Introduction

When economies experience deep crises, policymakers and economists are divided over analyses, actions to be taken to address the problem, and subsequent choices. In the past 16 years, there have been three successive relevant crises that have heavily pervaded all areas of the socio-economic sphere. Like previous crises (i.e. among the others the Great Crisis of 2008 and the Covid pandemic), also the conflict between Russia and Ukraine jeopardizes the international relationships and the financial governance (Gabel, 2023; IMF, 2023a). Adding to the disturbance of the existing picture is the recent conflict between Israel and Hamas in the Middle East. At present, its long run consequences are difficult to perceive. From a purely economic perspective, for example, the crisis resulting from the Covid 19 pandemic hit the entire World economy hard. The short-run negative impact on overall GDP was about 3.27% (constant prices) between 2019 and 2020 (IMF, 2021), and the real economic consequences of shutdowns in response to pandemic are not easy to predict (Ehnts & Paetz, 2021). Expressed in constant prices, we can briefly mention the declines of: Italy – 8.9%, Japan – 4.83%, UK – 9.92% and the United States – 3.30% (IMF, 2021). Taking the figures contained in Bolt et al. (2018), to have a comparable contraction we have to date back to the World War II period (Italy, Japan and UK) or to the Great Depression of the 30s (USA). With this in mind, and from a macroeconomic perspective, one of the crucial questions to ask is whether governments are able to respond effectively to these shocks. Especially since they are successive, exceptional and close shocks. Consistent with this concern, we analyze the dynamics in the relationships among macroeconomic variables involved in the QTM model that have occurred over the past 30 years. We investigate the possible and appropriate role of managing fiscal deficits by financing them with the traditionally opposed (and bold) measure of increasing the monetary base. This empirical assessment may be of interest in light of the inflationary fears that this more unorthodox measure might raise. The intentional starting point is the adoption of a panel that includes Countries with very different economic structures and financial regulatory frameworks. Since one of the unconventional technical solutions advanced (for the EZ) during the most severe phase of the Covid pandemic could favor a more accommodating monetary mechanism toward GDP growth (Garicano, 2020; Giavazzi & Tabellini, 2020), we discuss the relationship among the macroeconomic variables involved in the monetary mechanism through the lens of the quantity of money theory (QTM). Such an exercise seems challenging due to the pervasiveness with which certain beliefs (endorsed particularly by the Monetarist School of Thought) influence approaches to dealing with shocks. The widespread (and oversimplified) narrative related to this School of Thought argues that money-growth induces high (hyper) inflation in the economy. This proves antithetical to any “loose-monetary solution”, given the evoked inflationary fears that would result. The present paper builds on these premises to further study the relationship between inflation and monetary growth in light of the other variables and interrelationships that the QTM structurally

propose as well. To that aim, by using a heterogeneous structural panel vector autoregression (PSVAR) by Pedroni (2013), we investigate the impact of money-growth shocks on inflation considering the whole set of variables (velocity of money and GDP growth included).

To the best of our knowledge this is first work to apply a PSVAR to a panel of large economies to study their empirical relationship and explore their dynamic behavior within the set of variables included in the QTM.

Our contribution to the literature is twofold. First, we did not find a spillover effect from money shocks as the main determinant of inflation. Second, also from a country-specific perspective the analysis of the idiosyncratic component reinforces the idea that monetary growth cannot be considered the main driver of inflation mechanism. Briefly, the simplistic narrative of the purely inflationary role of "money printing" finds no empirical confirmation.

The remainder of the paper is organized as follows. The next section briefly provides the background, the literature and the QTM theory to bring the issue into focus. Section 3 provides data and methodology descriptions. Section 4 presents and comments the empirical results. Finally, Sect. 5 concludes.

## 2 Background, literature and the QTM

When a crisis hits an economy, both private and public sector are significantly affected.

From a private perspective, the resulting excessive debt rate can be considered a constraining factor on output growth, given the negative effects exerted by leverage (Hudson, 2021). On this point, there are no codified, well-defined thresholds. In the literature an attempt has been proposed by Arcand et al. (2015), who deem a maximum sustainable quantitative threshold for total credit levels to be about 100% of GDP.

For what concerns the public sector, the overall picture is extremely complex and varied. Despite the persistence of low interest rates since the 2008–2011 crises, monetary policies have not proved decisive in promoting a period of stable and sustained growth (Dell’Ariccia et al., 2018; Kuttner, 2018). Several countries have been thrown into a liquidity trap with public debt reaching historic levels (Agur et al., 2022). Thus, at the moment, all countries with high debt-to-GDP ratios (e.g., France, Italy, Portugal, and Spain in the EZ, the UK, the US, and Japan) may find it significantly difficult to sustain fiscal stimulus due to increased debt resulting from measures taken during the pandemic. This poses a growing challenge for policymakers, particularly as real interest rates are rising across the world (IMF, 2023a). An excessive bond-financed economy (high debt-GDP ratios) experiences negative effects on interest rate and debt sustainability (Palley, 2020). Especially, this is all the more true when they belong to currency unions (Afonso et al., 2019; Zezza, 2020). A dedicated analysis focusing on issues related to public fiscal stimulus in this context is proposed by Prieue (2021). On this specific point, disputes and theoretical controversies are emphasized by the fact that, even if the total stock of public debt cannot be considered a decisive constraint in limiting an

advanced country's economic growth (Herndon et al., 2014; Panizza & Presbitero, 2014), the combination of rising sovereign debt with stagnant (or worse declining) GDP is a particularly complex issue to manage (Canelli et al., 2022). In this context, the balance between fiscal and monetary policy is an objective to be pursued by governments and monetary authorities despite the trade-off between price stability and growth (Vo et al., 2016), and the proposal of “unconventional monetary measures” to sustain fiscal actions to promote growth has been revived in pandemic times by prominent economists (Blanchard & Pisani-Ferry, 2020; De Grauwe, 2020; Galí, 2020a; Yashiv, 2020). At the present time where we can register an upsurge in international tensions, fluctuations related to uncertainties that may be encountered in financial markets due to wars is reported, with particular reference to the equity segment. On this aspect, Brune et al. (2015) point out that an increase in the conflict likelihood tends to reduce the stock quotations, while the opposite is true when the wars break out. At the same time a recent empirical analysis between money supply and stock prices has been proposed by Han and Kim (2023). In their contribution the main interaction of an increase in money supply on stock prices was identified with the stock market of the country with which one has the most important trade relations. We are once again faced with yet another crisis -with a different genesis- but re-proposing the same problems (DeLong, 2023). The “forgotten” role of public debt monetization (i.e. the direct purchase by central banks of non-interest bearing non-redemable government bonds determining the permanent expansion of the monetary base, also known as “monetary finance” abbreviated as MF) is proposed by some authoritative economists as the most appropriated mechanism for financing a fiscal policy aimed at supporting faster economic growth under exceptional circumstances (De Grauwe, 2020; Turner, 2015). This would allow governments not to have to increase the overall level of taxation to repay the new debt issued avoiding the effects described by the Barro-Ricardo's theorem (Acocella, 2014). The Ricardian equivalence assumes that consumers have rational expectations and are aware of the government's intertemporal budget constraint and, therefore, in the event of a government deficit anticipate that taxes will be raised in the future to repay the increased debt (Hayo & Neumeier, 2017). These expectations will affect consumption and aggregate demand. The absence of any effect on inflation expectations from unconventional monetary explicit announcements during the March–December 2020 Covid pandemic period was highlighted by the empirical work of Agur et al. (2022). Although skeptical for its widespread implementation, even English et al. (2017) consider that the conditions for possible monetization mechanism application cannot be separated from severe recessionary situations such as wars. The GDP contractions we showed in the introduction seem to highlight that the circumstances were similar to wars (and the overall resulting effects have not yet worn off).

On the ability of the MF to overcome the Ricardian equivalence effect, Buiter (2014, 2020) showed its advantages in the case of partial equilibrium models, while Galí (2020b) in the case of a general equilibrium model. In brief, a debt financed tax cut leaving the monetary supply at the same level does not furnish an effective stimulus to the economy because it does not change the present discounted value of fiscal revenues due to the increase in the stock of the public debt. On the other hand,

the same tax cut financed by the monetization mechanism benefits the economy through subsequent interest savings and irredeemable ownership of the liability by the government which is not forced to raise taxes in the future. Blinder and Solow (1973) have already pointed out how this mechanism of financing budget deficits can push an economy towards full employment. To the best of our knowledge, monetization is allowed neither in the USA (Randall Wray, 2015) nor in the EU (article 123.1 of the Treaty on the Functioning of the European Union, TFEU). This clause deprives the EZ of the one policy instrument that is guaranteed to prevent or cure deflation or secular stagnation (Buiter, 2014). The adoption of a monetization mechanism is not universally accepted by economists (Turner, 2015). The most ardent opponents of this position fear the possible uncontrolled rise in inflation (or even hyperinflation) triggered by the increase in the monetary base. This conviction is rooted in the QTM which expresses the association between monetary aggregates and price levels. Its modern prevalent interpretation can be traced back to Friedman's contributions (1956, 1963a, 1963b), and the resulting School of Thought is called Monetarism. The QTM considers the well-known equation of exchange (Fisher, 1911):

$$PY = MV \quad (1)$$

where  $P$  represents the price level;  $Y$  is the real output; at this point, the  $P Y$  term represents the GDP in nominal (current) values;  $M$  represents the quantity of money;  $V$  is the velocity of money (average number of times that money moves from one entity to another over the course of a year).

Taking into account the percentage change over time in the (1), we will have:

$$\pi + y = m + v \quad (2)$$

with  $\pi$  as the inflation rate;  $y$  as the percentage change in output;  $m$  as money growth;  $v$  as the percentage change in velocity of money.

Monetarists assume that inflation ( $\pi$ ) is a purely monetary phenomenon (Davidson, 2011). Under this perspective, both  $v$  and  $y$  would play no role in the (2). Confirmation of this approach can be found in the monetary equilibrium condition  $m=\pi$  (i.e., implying  $v$  and  $y=0$ ) formalized in the macroeconomic models. In strictly mathematical terms, this condition would only be possible for not very high values of  $\pi$ . Citing Blanchard (1990), these strong assumptions are imposed more as prescriptions of “faith” than as empirical evidence. It is precisely the  $m=\pi$  identity that ignites all of the concerns about rising inflation resulting from changes in the money supply. This is commonly called as: “the neutrality of money” axiom (Davidson, 2015). Following this view, nonmonetary forces are the only factors affecting real income (GDP or total production/output), and the quantity of money is the only factor affecting the price level (Friedman, 1970). In the Monetarists' view, the “helicopter” drop of money is the parable proposed by Friedman (1948, 1969) to represent a permanent/irreversible increase in the nominal stock of fiat money base which respects the intertemporal budget constraint of the consolidated central bank and government. An analytical discussion of the “helicopter money” can be found in Buiter, (2014), where it is argued that the choice of financing the fiscal stimulus to be effective in boosting aggregate

demand must satisfy three simultaneous conditions: the positive utility function of holding money even without a non-pecuniary return motive, the irredeemable nature of fiat money and a positive price. In full evidence, the very first condition recalls Keynes' liquidity preference theory (Keynes, 1936).

A great wealth of empirical literature has explored the money growth-inflation direct relationship.

Arguing the existence of a uni-directional or of a bi-directional causal relationship between money-growth and inflation are the recent works by Falck et al. (2021), Ellington and Milas (2019) and Makin et al. (2017). Analyzing the cases pertaining different Countries, previous contributions in the same direction are those of Jiang et al. (2015), Sola and Peter (2013), Basco et al. (2009), Chang et al. (2009), Hall et al. (2009), and Guncor and Berk (2006). Of opposite view are the studies supporting the existence of short-run impact on inflation (Assenmacher-Wesche & Gerlach, 2008; Zhang et al., 2012) with those supporting long-run effect (Benati, 2009; Doan Van, 2020; Zhang, 2008, 2012). In the same sense and estimating a one-to-one long run relationship are De Grauwe and Poland (2005) and Mccandless and Weber (1995). The substantial nonexistence of a direct transmission mechanism between money growth and inflation is empirically analyzed by Focacci (2023a, 2023b). In the same direction the previous contributions by Müller and Watson (2018), Cukierman (2017), Liu and Chen (2012) and Nicoletti Altimari (2001). The existence of a negative relationship between the variables is discussed by Shuai (2002) and Wu (2002).

Ultimately, the results of the literature are neither decisive nor unambiguous, and the issue is far from exhausted. The Monetarist derivation of the relationship between money growth and inflation appears misleading by analyzing the (2). In fact, we can derive that:

$$\pi = m + v - y \quad (3)$$

From the (3), in fact, it is possible to deduce –even assuming according to Monetarist dictates that  $v$  is stable and exogenous (Davidson, 2015)- a clear counteracting effect to rising inflation  $\pi$  exerted by output growth  $y$  when it exceeds the change in the quantity of money supply  $m$ . In this regard, Vernengo and Rochon (2001) argue that one of the theoretical reasons why the belief that is money growth that triggers inflation persists is that too little emphasis is placed on the role of demand-led growth theory (Kaldor, 2000). Excessive demand stimulus can trigger a pure inflationary effect if economies are in a point of full capacity for output and employment (Turner, 2015). From data in the following Table 1, we can see that in our current reality there is a fair amount of room for maneuver.

It is straightforward to illustrate that Countries with high unemployment rates also have the opportunity (the potential) to increase the output rate by increasing the employment rate. The higher this employment increase, the higher the overall beneficial impact through the “effective demand”.

**Table 1** Up-dated figures on unemployment and capacity utilization rates for our sample

Country/economic zone	Unemployment rate %	Date	Capacity utilization rate %	Date
Australia	3.6	Sep 2023	84.16	Sep 2023
China	5.0	Sep 2023	75.60	Sep 2023
Euro Zone	6.5	Sep 2023	80.09	Sep 2023
India	7.1	Sep 2023	73.60	Jun 2023
Japan	2.6	Sep 2023	106 points on 127.37	Aug 2023
United Kingdom	4.3	Jul 2023	Not available	–
United States	3.9	Oct 2023	79.68	Sep 2023

Source: TE (2023)

Notes: The Capacity Utilization Rate for Japan is reported in points from the source, and the average value for the (1968–2023) time span is 127.37

### 3 Data and methodology framework

#### 3.1 Data description

This paper empirically evaluates the (potential) inflationary effects originated by money growth. We test the QTM model for 6 out of 7 of the world's largest economies and one relevant Country from the Oceania continent. Germany, now ranked 5th in the overall standing, is already included in the EZ. Eventually, the sample counts about the 70% of the World GDP (TE, 2023). More in detail, the whole dataset is built with yearly data for the following Countries: Australia (AUS), People Republic of China (CHI), Euro Area (EZ), India (IND), Japan (JPN), United States (USA) and United Kingdom (UK). The time span (1992–2022) is constrained by the availability of data. In some cases, it is not possible to build longer time series in all its variables and/or members. Limiting the explanation to the European case, even due to political changes it is not possible to reconstruct reliable series on one of the most relevant Countries (Germany). At this point, it was preferred to collect homogeneous information from authoritative and standardized sources without resorting to reconstructions from series having different origins.

The variables are those having their role in the QTM. The GDP to calculate with money supply the velocity of money and its change  $v$ , inflation ( $\pi$ ) and money–supply (M1, to extract  $m1$ ) and finally GDP deflator for calculate  $y$ . In detail, the full dataset is a balanced panel with dimensions  $N=7$  and  $T=31$ .

The GDPs, corresponding deflators and inflation figures for all  $N$  are collected from IMF (2023b). The M1 data are respectively gathered for:

- AUS (OECD, 2023a);
- CHI (OECD, 2023b and TE, 2023);
- EZ (OECD, 2023c and TE, 2023);
- IND (OECD, 2023d);
- JP (OECD, 2023e and TE, 2023);

USA (OECD, 2023f);  
 UK (OECD, 2023g).

The selection of an annual periodicity is consistent with our investigation needs. A higher frequency in observations, such as in the case of monthly or (even) quarterly figures, increases the likelihood of finding spurious causal relationship (Schwartz and Szakmary, 1994).

### 3.2 Methodology

We will proceed in three subsequent steps.

Firstly, we derive the velocity of money  $V$  on the basis both of the macroeconomic variables detectable from the databases and the QTM theory. This preliminary step is necessary to complete the set of variables to use. Taking the GDP in current terms and the money supply ( $M1$ ), we calculate the velocity of money  $V$  from the (1) as:

$$V = (PY) / M \text{ or, equivalently, } V = GDP / M \quad (4)$$

Thus, having  $V$ ,  $GDP$  (with the related deflator) and  $M$ , we can get  $v$ ,  $y$  and  $m$  by their percentage changes. Adding inflation data as gathered from sources, we build the whole dataset to our goal. From this first step we cannot assume the  $v=0$  axiom as in the pure Monetarist interpretation of QTM. A recent empirical contribution by Moosa and Al-Nakeeb (2020), analyzes US inflation dynamics by estimating a declining velocity of circulation of money (even these authors do not consider  $v=0$ ).

Secondly, we first test whether there is cross-sectional dependence in the relationship across our panel Countries. Taking into account the possible presence of CSD is very important, because it probably results from the fact that individual panel members react not only to their own member-specific idiosyncratic shocks but also to shocks that are common across the other members. Toward that end, we apply the cross-sectional dependence (CSD) tests of Breusch and Pagan (1980), Pesaran (2021) and Pesaran et al. (2008). On this aspect, it must be added that if there is cross-sectional heterogeneity in the panel (individual dynamics are heterogeneous), aggregating or pooling slopes can lead to biased estimates (Pesaran & Smith, 1995). To investigate these issues, we proceed through the slope homogeneity test by Pesaran and Yamagata (2008) which is an extended version of the Swamy (1970) test. By assuming that error terms follow a normal distribution, such a procedure is appropriate for any  $N$  and  $T$ .

Finally, we use the panel SVAR method of Pedroni (2013) to investigate the impact relationships across variables. This methodology allows the structural shocks (named as composite shocks) and impulse responses to be decomposed into member-specific (idiosyncratic) and common shocks that determine CSD across members. The common and idiosyncratic shocks are mutually orthogonal to one another. At this point we have a complete representation of the panel dynamics in that through the responses to the idiosyncratic shocks we can observe the specific (individual) behaviors of the panel members, while with the common shocks we see what effects are shared across them. Another important distinguishing feature of this

type of panel analysis is that the heterogeneity is probably not limited to “simple” fixed effects (as in the case of the conventional micro panel approach), but is also likely to extend to all of the dynamics.

The Pedroni model has extensively been applied and discussed in many previous contributions (Pérez-Montiel & Manera Erbina, 2022; Wu & Xu, 2021; Ha et al., 2019 and Roch, 2019 among others), hence we only propose its basic methodology.

Let  $w$  alternatively denote the  $mI$ ,  $vI$  or  $y$ , we model the dynamic relationship between inflation (we adopt the label  $\text{infl}_r$  in graphs and Tables instead than the mathematical symbol  $\pi$ ) and  $w$  as a bivariate heterogeneous PSVAR:

$$B_i z_{i,t} = A_i(L)z_{i,t-1} + \varepsilon_{i,t} \tag{5}$$

where  $A_i(L) = \sum_{s=0}^{S_i} A_{i,s} L^s$  is a lag polinomial allowing for country-specific lag lengths,  $i = 1, \dots, N_i$  and  $t = 1, \dots, T_i$ . The subscripts  $i$  and  $t$  on the time and cross-section dimensions take into account that the panel may be not balanced. Hence, for any  $x$ , the time average  $\bar{x}_i = T_i^{-1} \sum_{t=1}^{T_i} x_{i,t}$ . The vector  $z_{i,t} = (\text{infl}_r - \bar{\text{infl}_r}, w_{i,t} - \bar{w}_i)$  contains the demeaned endogenous variables to account for country fixed effects. To disentangle common and idiosyncratic dynamics, which are akin to spillover and country-specific effects, we can decompose each composite structural white noise shock in the vector  $\varepsilon_{i,t}$  into a common shock  $\bar{\varepsilon}_{.,t}$  and a country-specific idiosyncratic shock,  $\widetilde{\varepsilon}_{i,t}$ :

$$\varepsilon_{i,t}^\pi = \lambda_i^\pi \bar{\varepsilon}_{.,t} + \widetilde{\varepsilon}_{i,t}^\pi \tag{6}$$

$$\varepsilon_{i,t}^w = \lambda_i^w \bar{\varepsilon}_{.,t} + \widetilde{\varepsilon}_{i,t}^w \tag{7}$$

with  $\lambda_i^\pi$  and  $\lambda_i^w$  representing the country-specific loadings for the common structural shocks. For any  $x$ , the cross-sectional average is denoted as  $\bar{x}_{.,t} = N_t^{-1} \sum_{i=1}^{N_t} x_{i,t}$ .

To obtain the structural residuals and responses, we estimate a set of  $N+1$  reduced-form VARs;

One for each country  $i$  and one for the cross-section average:

$$z_{i,t} = B_i^{-1} A_i(L)z_{i,t-1} + u_{i,t} \tag{8}$$

⋮

$$z_{N,t} = B_N^{-1} A_N(L)z_{N,t-1} + u_{N,t}$$

$$\bar{z}_{.,t} = \bar{B}^{-1} \bar{A}(L)\bar{z}_{.,t-1} + \bar{u}_{.,t}$$

We recover the structural composite and common uncertainty shocks from the reduced-form residuals,  $u_{i,t} = B_i^{-1} \varepsilon_{i,t}$  and  $\bar{u}_{.,t} = \bar{B}_i^{-1} \bar{\varepsilon}_{.,t}$ . In line with the literature (Bloom, 2009; Carrière-Swallow & Céspedes, 2013), we rely on recursive restrictions assuming that uncertainty is predetermined with respect to the macroeconomic

aggregates in our heterogeneous PSVAR. Next, we construct the loading matrix for the common factors,  $\Lambda_i$  from sample correlations between the structural residuals for each Country  $i$ :

$$\Lambda_i = \begin{pmatrix} \rho(\varepsilon_{i,t}^\pi, \bar{\varepsilon}_{\cdot,t}^\pi) & 0 \\ 0 & \rho(\varepsilon_{i,t}^w, \bar{\varepsilon}_{\cdot,t}^w) \end{pmatrix} \quad (9)$$

To better specify the model between a short-run (polynomial  $A_i(L)$  with  $L=0$  such that  $A_i(0)=A_{0,i}$ ) or long-run restriction ( $L=1$  such that  $A_i(1)=\lim_{Q_i \rightarrow \infty} \sum_{s=0}^{Q_i} A_{i,s}$ ), we analyze the presence of unit roots and cointegration in the panel. Finally, according to Pedroni (2013), we use the general to specific (GTOS) information criteria to fit the appropriate (member-specific) lag truncation.

## 4 Empirical results

In this Section, we present results for the second and the third step explained in Sect. 3.2. The calculation of the  $\nu$  is a simple derivation of values needed for proceeding in the analysis and is taken for granted (data are always available upon request).

As far as the possibility of CSD and slope homogeneity is concerned, Table 2 resumes the results for both tests. The outcomes confirm the existence of CSD.

As a necessary corollary of the previous point, we have to consider that the assumption of cross-sectional homogeneity is a possible source of unreliable panel estimation findings. The Pesaran and Yamagata slope homogeneity test supports the presence of a certain Country-specific heterogeneity at 1 percent significance level. Theoretically, the only economic area sharing common paths (across its members) in our sample should be the EZ. However, as already pointed out in literature (Boyer, 2013), we expect a certain degree of heterogeneity for EZ as well.

To proceed further in the PSVAR specification, considering the presence of CSD, we run a couple of “unit root second generation” tests: the Bai and Ng

**Table 2** Tests for CSD and homogeneity

Test	Statistic	Prob
Cross-sectional dependence tests		
Breusch-Pagan LM	38.88	0.01*
Pesaran CD	2.76	0.01*
Pesaran scaled LM	4.74	0.00*
Homogeneity tests (Pesaran and Yamagata slope homogeneity)		
$\Delta$	1.73	0.08
$\Delta$ adj	3.23	0.00*

Notes: \* denote rejection of the null hypothesis of no cross-sectional dependence at the 1% significance level. For the Pesaran and Yamagata the \* denote the rejection of the null hypothesis of slope homogeneity at the 1% significance level

(2010, 2004) and the Pesaran (2007) test. These procedures are characterized by the rejection of the cross-sectional independence hypothesis (Hurlin & Mignon, 2007). The results are resumed in the following Table 3. To better understand the tables and graphs, inflation is not shown with the mathematical symbol ( $\pi$ ) but with the label *infl\_r* from here onward.

Additionally, the Table 4 contains the findings for the Pedroni (1999) panel cointegration test.

Overall, since from the combined results it is not possible to draw an incontrovertible profile regarding the dynamic restrictions to be used for PSVAR identification, our precautionary choice is to propose two models with both conditions: Model 1 (short-run restriction) and Model 2 (long-run restriction). Incidentally, this also allows us to be consistent with the (theoretical) approach that there is, however, a long-run effect of money growth on inflation (this assumption is widely shared by both Monetarists and “Traditionalists”).

Our focus is on the response of the *infl\_r* to the different shocks, and to better disentangle the effects, we show the common-type shock (how the member of the panel respond to shocks that are common across them) and the idiosyncratic-type shocks (member specific shocks). We have not included composite shocks results for reasons of space, but they are available upon request.

Next in Figs. 1, 2, 3 and 4, we depict the Model 1 with the median common impulse response functions (IRFs) along with the 95% confidence bands to a positive shock (dashed lines based on 1000 sample bootstrap), time horizon in *x*-axis (we estimate for 10 years ahead). All the subsequent models share the same technical features. As far as the common shocks (spillover effects) are concerned, the higher impact comes from *y*. The effect of *m1* is substantially risible along the whole time path. The spillover is more originated by *y* that from a change in money-supply. By the 7th period, this momentum seems to be exhausted (with a rising prevalence of *v1*), to decline later.

Below, within the Figs. 5, 6, 7 and 8, we show Model 1 with idiosyncratic impulse responses. From the IRF graphs, we can see that for the Model 1 (in the short run) and the country-specific (idiosyncratic) shock a change into *m1* has a first impact on *infl\_r* in the 3rd year. A further peak effect occurs at the 7th year after the shock. However, this is not the prevailing effect, in fact, we can note that the main impact on *infl\_r* comes from *y* after 10 periods. The *v1* dynamics is quite flat along the whole time horizon. The effect and the intensity of *y* is remarkable to highlight the importance of output growth on the economic systems.

In the following Figs. 9, 10, 11 and 12, the common shocks in Model 2 are proposed.

The common shocks within Model 1 in the long-run restriction scenario show that the *m1* substantially does not affect the inflation path. Also the *v1* is quite flat along the whole time path. The impact of *y* is higher than *m1* with significant effects from period 4 onwards. More in detail, we can highlight that *m1* path is almost always asymptotically close to zero. The *v1* path shows a detectable effect, but—however—in a lower magnitude than *y*.

Finally, the idiosyncratic shocks of Model 2 are depicted in Figs. 13, 14, 15 and 16.

**Table 3** Second generation unit root tests for panel stationarity

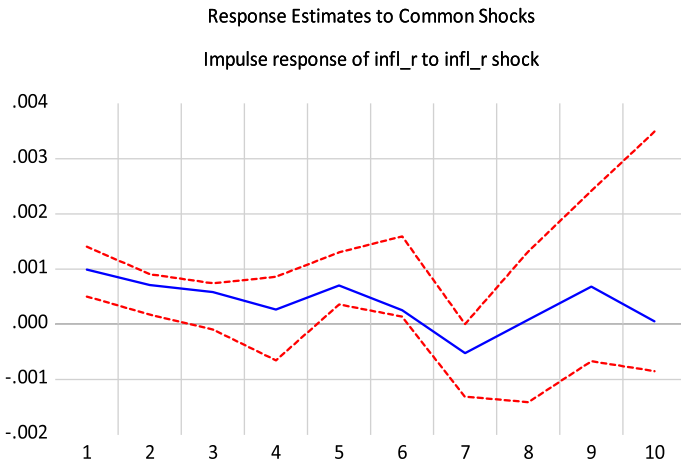
Variable	Test	Statistic	Prob	Variable	Test	Statistic	Prob
<i>infl_r</i>	Bai and Ng (PANIC)	0.50	0.62	<i>v/l</i>	Bai and Ng (PANIC)	1.91	0.06
	Pesaran				Pesaran		
	CIPS (truncated)	-1.72	> = 0.10*		CIPS (truncated)	-2.90	< 0.01
	Cross-sectional ADF (truncated)				Cross-sectional ADF (truncated)		
	AUS	-1.60	> = 0.10*		AUS	-2.54	> = 0.10*
	CHI	-1.06	> = 0.10*		CHI	-4.45	< 0.01
	EZ	-1.72	> = 0.10*		EZ	-0.82	> = 0.10*
	IND	-2.24	> = 0.10*		IND	-1.92	> = 0.10*
	JPN	-1.21	> = 0.10*		JPN	-1.00	> = 0.10*
	USA	-1.78	> = 0.10*		USA	-3.68	< 0.05
	UK	-2.25	> = 0.10*		UK	-5.86	< 0.01
	Bai and Ng (PANIC)	11.17	0.00*	<i>y</i>	Bai and Ng (PANIC)	7.70	0.00*
	Pesaran				Pesaran		
	<i>ml</i>	CIPS (truncated)	-2.97	< 0.01		CIPS (truncated)	-2.11
Cross-sectional ADF (truncated)					Cross-sectional ADF (truncated)		
AUS		-0.96	> = 0.10*		AUS	-1.96	> = 0.10*
CHI		-3.68	< 0.05		CHI	-3.79	< 0.05
EZ		-3.63	< 0.05		EZ	-2.03	> = 0.10*
IND		-2.85	> = 0.10*		IND	-1.48	> = 0.10*
JPN		-3.35	< 0.10		JPN	-1.20	> = 0.10*
USA		-1.59	> = 0.10*		USA	-1.86	> = 0.10*
UK		-4.60	< 0.01		UK	-2.40	> = 0.10*

Notes: Bai and Ng-PANIC: the \* rejects the null of no cointegration of the idiosyncratic errors (unit root null) at 5% significance level. Pesaran: the \*accepts the null hypothesis of no unit root at the reported significance level

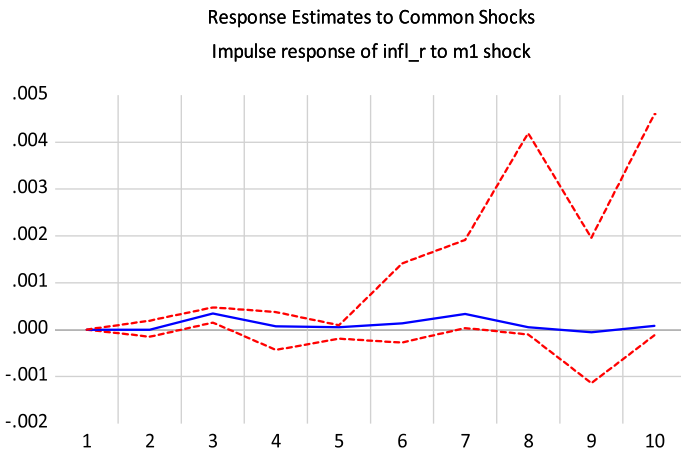
**Table 4** Panel cointegration tests

Test	Statistic	Prob
Pedroni Panel cointegration		
Panel v	0.13	0.45
Panel rho	-1.99	0.02*
Panel PP	-4.27	0.00*
Panel ADF	-2.03	0.02*
Group rho	-1.40	0.08
Group PP	-5.99	0.00*
Group ADF	-1.39	0.08

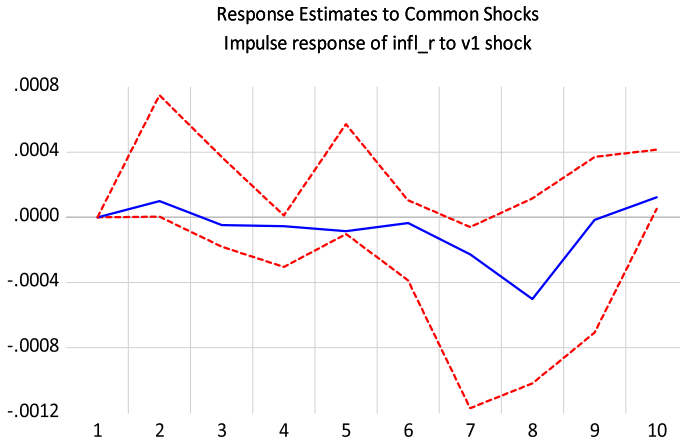
Notes: \* denotes rejecting the null of no cointegration at the 5% significance level



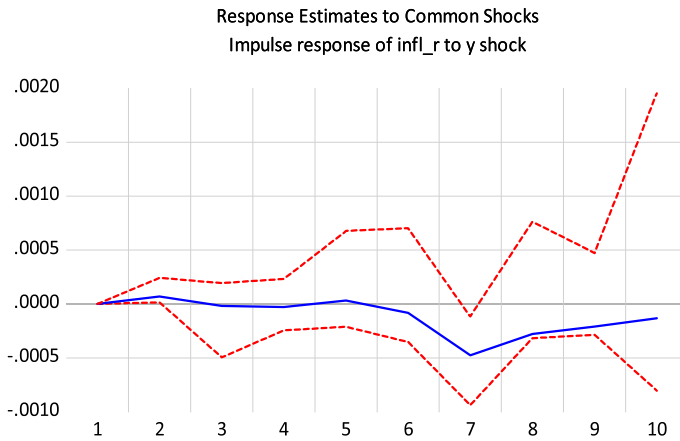
**Fig. 1** Model 1 response of *infl\_r* to a shock in *infl\_r*



**Fig. 2** Model 1 response of *infl\_r* to a shock in *m1*



**Fig. 3** Model 1 response of  $infl\_r$  to a shock in  $v1$



**Fig. 4** Model 1 response of  $infl\_r$  to a shock in  $y$

In these cases, idiosyncratic shocks highlight a meaningful and prevailing effect of  $y$  (period 3 and from 5 onwards). The  $m1$  is quite relevant at the period 6 (with a negative effect) and then flattens out thereafter. The  $v1$  influence is substantially absent; a meaningful effect can be detected only from period 8 onwards.

Summarizing, we can say that as a member-specific factor (idiosyncratic shock) the money-supply is a factor in inflationary dynamics only with a short-run restriction and for the first periods after a shock. There is no similar effect in all the remaining cases, and this influence does not appear to be persistent and of strong intensity with respect to the other variables. The results are resumed within following Table 5.

Focusing on our research goal, we cannot claim that during the period analyzed changes in money-supply proved to be the main (and determining) drivers in

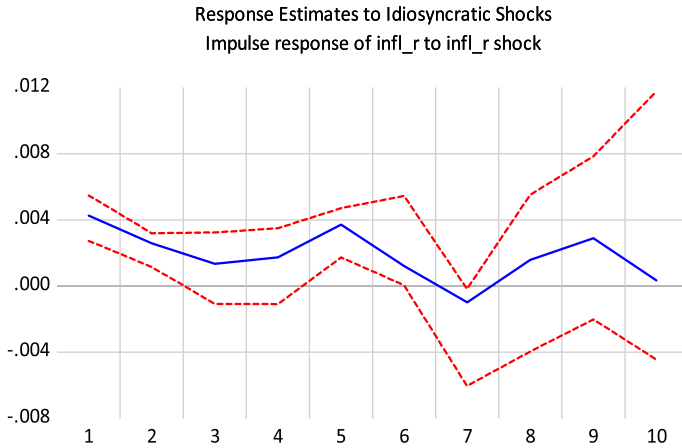


Fig. 5 Model 1 response of  $infl\_r$  to a shock in  $infl\_r$

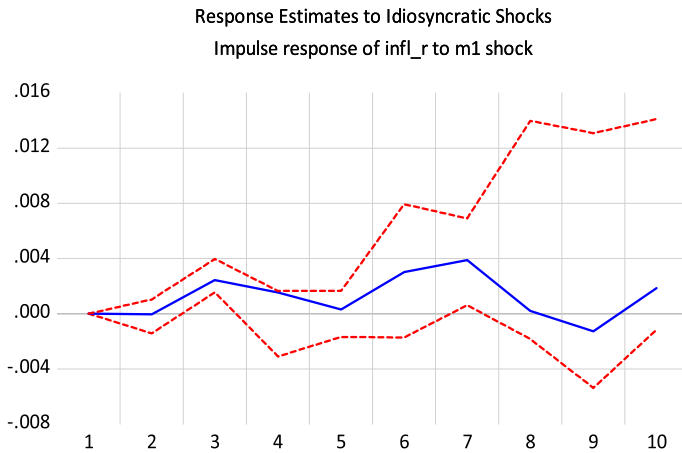
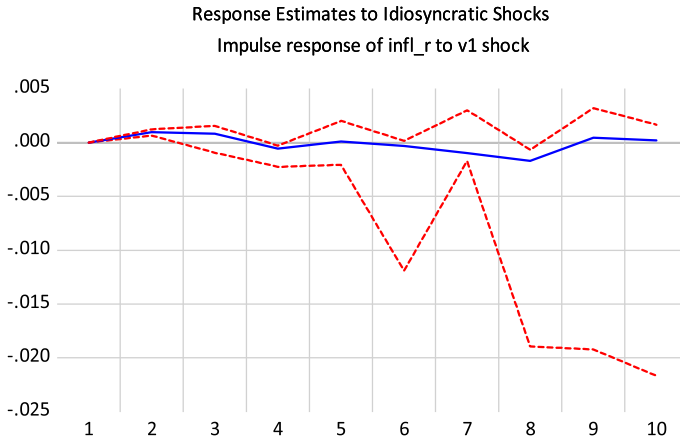


Fig. 6 Model 1 response of  $infl\_r$  to a shock in  $m1$

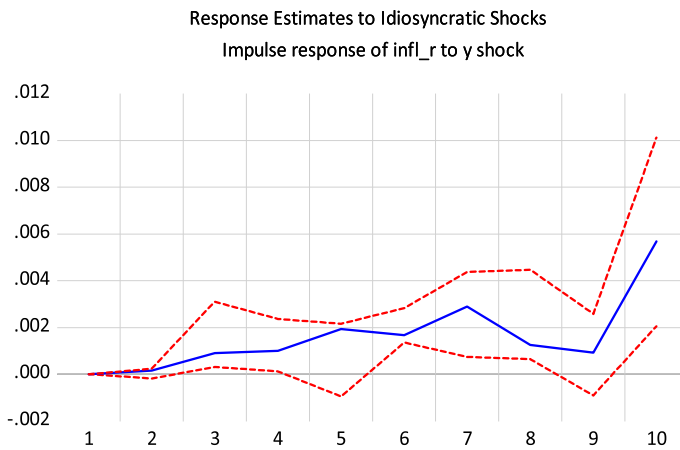
inflation dynamics. Nor does it appear that a distinction can be made between short and long term as we have seen to be shared opinion, and the most influential factor seems to be the variation in output.

### 5 Conclusions

The pandemic, the Russia-Ukraine conflict and (now) the Israel-Hamas crisis induced new economic and social costs, but the same is repeated with every crisis. The main question is how to deal with the macroeconomic stabilization goals that are jeopardized by the inherent problems triggered by the deep crises that occur at very short intervals. Some economists (Monetarists) identify the “uncontrolled”



**Fig. 7** Model 1 response of  $infl\_r$  to a shock in  $v1$



**Fig. 8** Model 1 response of  $infl\_r$  to a shock in  $y$

issuance of money as the main concern assuming that “new money equals to new inflation”. This mechanism would stimulate inflation, but would also be capable of inducing hyperinflation. In our work, we analyze the “money-supply and inflation” mechanism through the lens of the well-known Fisher’s QTM. By adopting a heterogeneous PSVAR model for several major (and heterogeneous) economies, our results do not support the Monetarist view in a radical interpretation of equation of exchange. The full version of the QTM supports us in thinking that increased output can be a countervailing force to the explosion of price dynamics. At least, up to the limit of full employment. Our results confirm what other authors have pointed out. More in detail, as can be found in Agur et al (2022), “the association between money growth and inflation crucially depends on economic conditions and institutional considerations”. For the period analyzed, our empirical results show

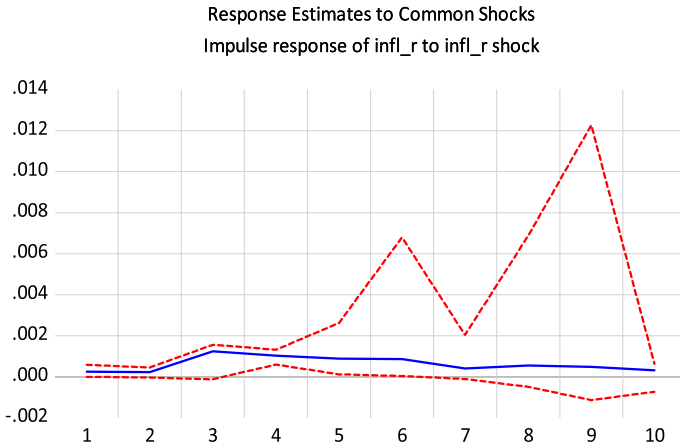


Fig. 9 Model 2 response of *infl\_r* to a shock in *infl\_r*

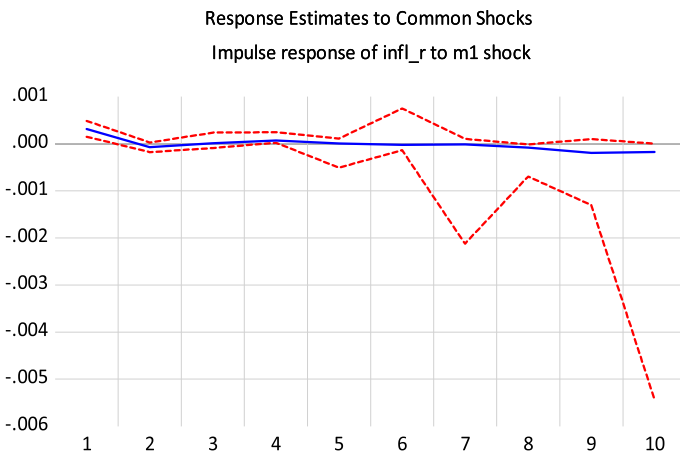
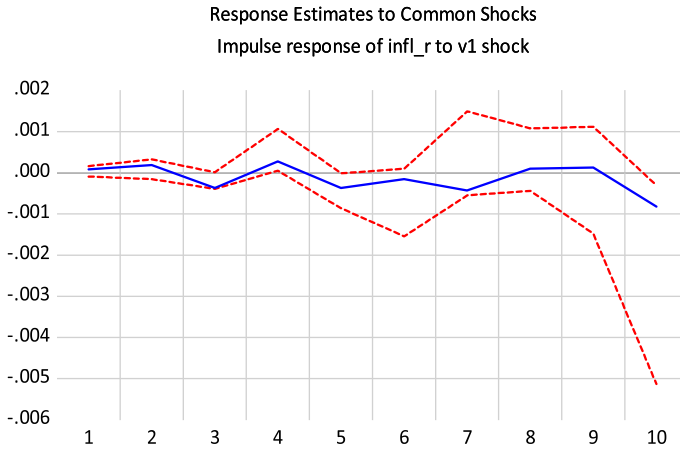


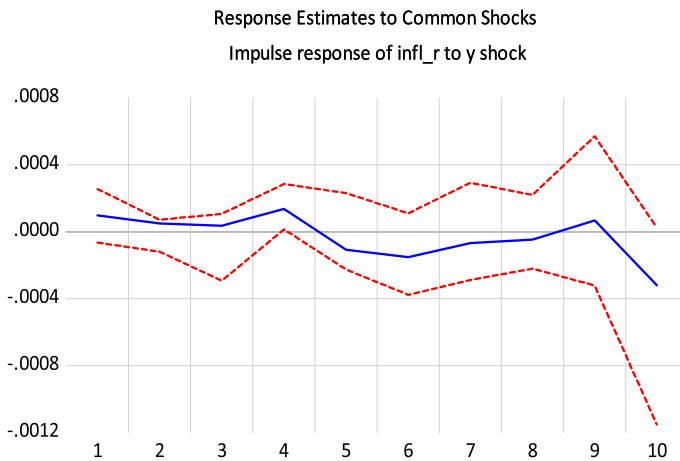
Fig. 10 Model 2 response of *infl\_r* to a shock in *m1*

that the magnitude of GDP growth  $y$  has always been larger than the change in money supply  $m1$  within the mechanism describing inflation (both for common and idiosyncratic effects). This allows to highlight the crucial importance of liquidity in determining the flow of production and employment (Davidson, 2015). At the same time and in terms of economic policy options, the pros and the cons of the monetary and fiscal actions must be well-balanced. Amid these concerns, we can consider that boosting inflation can hardly be attributed to an excess of money or demand. Presumably, supply reductions and bottlenecks on global supply chains are the real problems to be addressed (Barbier-Gauchard et al., 2021; Celasun et al., 2022).

We are in a condition where an increase in aggregate nominal demand (a fiscal stimulus financed through a MF mechanism) could trigger an increase in output as well as price, then some increase in real output may also be induced to the



**Fig. 11** Model 2 response of  $infl\_r$  to a shock in  $v1$



**Fig. 12** Model 2 response of  $infl\_r$  to a shock in  $y$

benefit of the whole economy. A little inflation can help (indeed is necessary) to manage high debts (Randall Wray, 2015). The monetization mechanism seems feasible and adequate in all circumstances where it is necessary to stimulate faster nominal demand growth. The current economic context (repeated and close crises that increase debt and do not stimulate a stable growth) seems an undoubted technical case for using MF. At the same time, before its implementation, it is necessary to define its boundaries well in order to guard against its dangerous

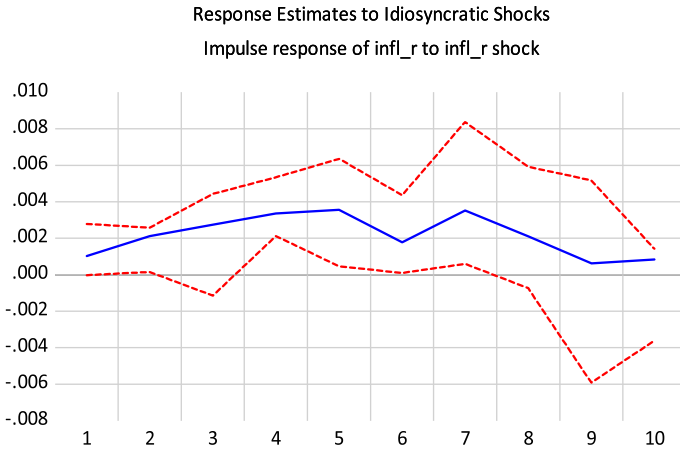


Fig. 13 Model 2 response of  $infl\_r$  to a shock in  $infl\_r$

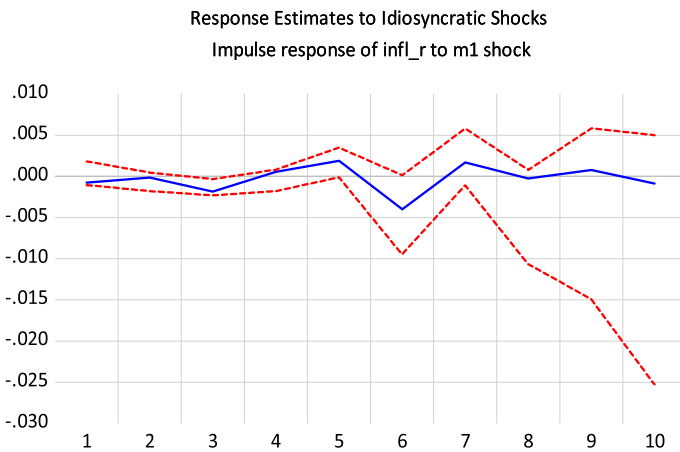


Fig. 14 Model 2 response of  $infl\_r$  to a shock in  $m1$

misuse (Turner, 2015). Trying to read the current situation through the lens of the QTM, a key macroeconomic prerequisite to control price dynamics is the growth of economic systems. Without growth, debt burden cannot decline (DeGrauwe, 2011), and economic revitalization will help manage the increase in debt (both private and public) that has occurred to deal with multiple shocks.

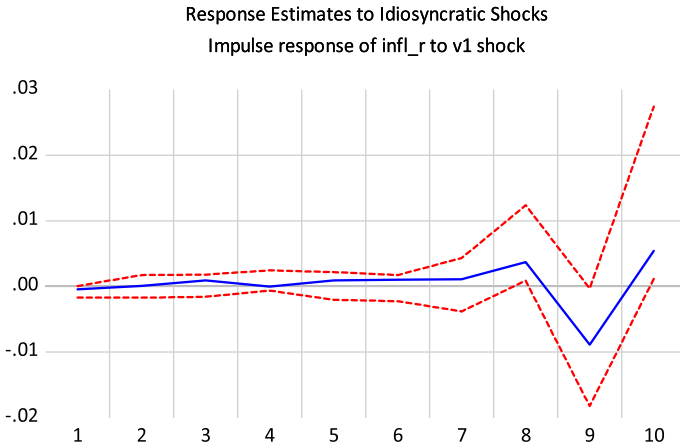


Fig. 15 Model 2 response of  $infl\_r$  to a shock in  $v1$

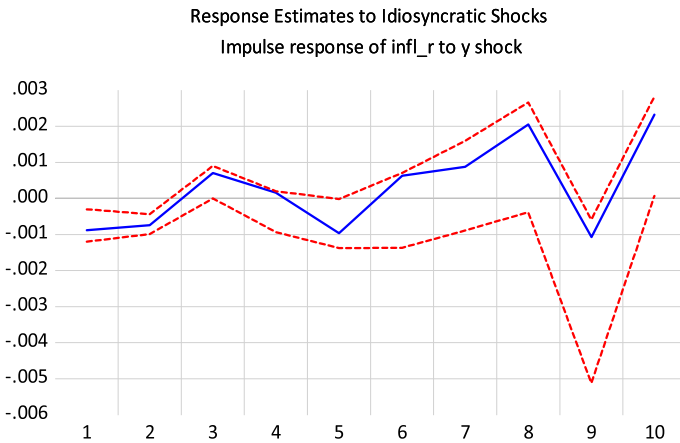


Fig. 16 Model 2 response of  $infl\_r$  to a shock in  $y$

Table 5 Summary of the outcomes

Effect on inflation	Common Shocks	Idiosyncratic shocks
Model 1		
$m1$	Low	High
$v1$	High	Low
$Y$	Moderate	Moderate (higher in the long term)
Model 2		
$m1$	Low	Moderate
$v1$	Moderate	Low (with higher intensity in the long term)
$Y$	Moderate but higher than $m1$	High

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**Data availability** The used data are available from the corresponding author from request.

## Declarations

**Conflict of interest** On behalf of all authors, the corresponding author states that there is no conflict of interest. No funding has been received for this project and there are no competing interests.

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