Macroeconomic Dynamics (2024), 1–51
doi:10.1017/S1365100524000452

CAMBRIDGE UNIVERSITY PRESS

ARTICLE

Sectorial economic activity and Divisia monetary aggregates

Cosmas Dery

Department of Economics and International Business, Sam Houston State University, Huntsville, TX, USA
Email: cdery@shsu.edu

Abstract

This paper assesses the information content and predictive capabilities of Divisia monetary indicators concerning sector-specific economic activities. Although existing evidence strongly supports the informative nature and predictive potential of various Divisia indicators at an aggregate level, studies focusing on Divisia information content for specific industries are notably sparse. Sector-level data provide a more detailed insight into economic and labor market dynamics. By analyzing comprehensive sector-specific data on real GDP, value added, employment, and unemployment rates across thirteen diverse sectors in the United States, this paper investigates the predictive abilities of narrow and broad Divisia money across three categories (original, credit card-augmented, and credit card-augmented inside money). The results show that narrow Divisia money serve as robust predictors of sector-specific economic and labor market indicators, often surpassing the predictive capacity of the conventional Fed funds rate and slightly outperforming broad Divisia measures in relation to these indicators.

Keywords: Divisia monetary aggregates; narrow money; broad money; sectorial economic activity

JEL classification: E32; E37; E4; E52

1. Introduction

An important and now almost indispensable rule in the conduct and description of monetary policy is the Taylor (1993) type policy rule. According to this policy rule, the conduct and target of monetary policy are articulated in terms of a short-term interest rate, with no direct role for the aggregate quantity of money in the transmission of monetary effects. As such the advent of the Taylor rule era was occasioned by the relegation of the role of monetary aggregates in monetary and business cycle analysis. This conspicuous disappearance of money from workhorse macroeconomic models is believed to be due to the redundancy of money in the presence of a short-term interest rate (Leeper and Roush (2003)). The then simple sum monetary aggregates appear to have lost their informative value and predictive ability for economic activities, especially in the presence of short-term interest rates like the Fed funds rate.

However, following Barnett (1980) development of more theoretically consistent monetary aggregates (namely the Divisia monetary aggregates), a multitude of studies have unearthed their remarkable informational value and their strong association with overall level of economic activity. Other derivatives of Divisia provided by Barnett and Su (2017) and Barnett and Su (2020),

I wish to express my appreciation to the College of Business Administration at Sam Houston State University for generously providing a Summer Research Grant that supported this study. Additionally, I would like to thank William Barnett, Apostolos Serletis, and two anonymous referees for comments that greatly improved the paper.

including those incorporating credit card services and distinguishing between inside and outside money, have also been employed to demonstrate a similar association with overall economic activity. These Divisia monetary aggregates, inspired by Barnett's work, have been consistently demonstrated to be superior to their simple sum counterparts.[1] The vast majority of previous studies have however heavily prioritized the examination of the links between Divisia monetary aggregates and overall economic activity. This raises the question of whether the high information content and predictive capabilities of Divisia monetary aggregates observed in aggregate data also apply at the sectorial level.

This paper investigates the information content and predictive ability of both narrow and broad Divisia monetary measures for sectorial economic activity. To evaluate the relative predictive capacities of the narrowest and broadest Divisia money measures, I use disaggregated sectorial data on real GDP, value added, employment, and unemployment rates across thirteen distinct sectors/industries in the United States. This analysis covers three categories of Divisia: the original Divisia, credit card-augmented Divisia, and credit card-augmented inside money Divisia, distinguishing between supply-side and demand-side Divisia, as well as between inside and outside money. Specifically, I assess the cyclical behavior and co-movement between these categories of Divisia money and the various economic activity indicators within these thirteen sectors. I rely on Hamilton (2018) regression-based filter to obtain the cyclical components of the relevant series.

Additionally, I examine the sectorial predictive abilities of the narrow and broad Divisia monetary aggregates using the Granger causality test. The test involves assessing causality from money measures to specific sectorial economic activity indicators, following a methodology akin to that employed by Bernanke and Blinder (1992), Belongia and Ireland (2015), and Dery and Serletis (2021b). Furthermore, my investigation of sectorial predictive capabilities of narrow and broad Divisia money extends to forecasting regressions analysis. In these forecasting regressions, each Divisia monetary aggregate serves as a predictor for specific sectorial economic activity indicator within each of the thirteen sectors, enabling us to examine how variations in a particular money measure can be employed to forecast changes in specific sectorial economic activity measures up to two years in advance. The approach here closely aligns with the methodologies employed by Caldara et al. (2016) and Dery and Serletis (2021a). However, it's worth noting that while Caldara et al. (2016) and Dery and Serletis (2021a) utilized this approach to assess the impact of uncertainty on aggregate economic activity, my study employs the same methodology to explore the influence of changes in Divisia money growth on sector-level economic activity.

Lastly, within a 4-variable structural VAR framework, monetary policy shocks are identified to study their impact on sectorial economic activity. The identification process alternatively incorporates various narrow and broad Divisia money measures to capture their role and information content for monetary policy identification. The sectorial responses to this aggregate shock, using different monetary aggregates in the identification process, are then examined.

This study contributes to the literature on the predictive abilities and role of money in monetary policy and business cycle analysis. In the study conducted by Dery and Serletis (2021b), the researchers examined the relative information content of different Divisia monetary aggregate measures. Their primary focus centered on various aggregated indicators of economic activity, encompassing total industrial production, employment, unemployment, personal income, consumption, and other broad economic variables. Dery and Serletis (2021b) relied on analytical methodologies such as cyclical correlations and Granger causality to assessed the predictive abilities of Divisia money. They found broad money particularly Divisia M3 to be the most informative for aggregate economic activities. Several other studies including those by Belongia and Ireland (2014, 2015, 2016, 2018), Barnett and Chauvet (2011), Hendrickson (2014), Serletis and Gogas (2014), Ellington (2018), have diligently examined the predictive capabilities and desirable properties of Divisia monetary aggregates relative to simple sum money. Notably, all these studies, along with prior literature, have exclusively focused their attention on aggregated measures of economic activities.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

To assess whether the high information content and predictive capabilities of Divisia monetary aggregates observed in aggregate data extend to the sectorial level, this present study assesses the relationship between Divisia monetary measures and a diverse range of sector-level economic activity indicators. Consequently, it offers a more in-depth exploration of the relevance of Divisia money in the context of business cycle analysis at a granular level, thus enhancing and expanding upon the existing body of knowledge. Investigating the information content and predictive capabilities of Divisia money at the industry or sector level is necessary to demonstrate that Divisia monetary aggregates are not only informative at the aggregate level but also connect with sector-specific activity. Sector-level data offer a more detailed and fine-grained perspective on the economy, labor market dynamics, and the intricacies of supply chains. This granularity enables a more precise understanding of the performance of different segments of the economy as well as empowering policymakers, businesses, and researchers to pinpoint specific areas of strength and vulnerability within the economy. Hence, investigating how fluctuations in Divisia money measures can enhance our understanding and prediction of sector-specific economic activity is crucial for refining economic models and informing targeted policy-making.

In terms of business cycle properties, the analysis shows that both narrow and broad Divisia money measures are more effective leading indicators of sectorial economic and labor market activities than the traditional Fed funds rate. Divisia M4 is favored in more sectors than Divisia M1, while Divisia M1A and M1AI consistently outperform their broad counterparts. Furthermore, Divisia money measures outperform the Fed funds rate in predicting sectorial real GDP, value added, employment, and unemployment rates. Specifically, the Fed funds rate has predictive information for these economic and labor market indicators in at most 6 out of 13 sectors. In contrast, narrow Divisia money (M1, M1A, and M1AI) predicts at least 10 out of 13 sectors, up to a maximum of 13. Broad Divisia measures (M4, M4A, and M4AI) predict at least 5 out of 13 sectors, up to a maximum of 12. Also, the sectorial predictive abilities of both narrow and broad money measures are neither absorbed nor diminished by the presence of a short-term interest rate like the Fed funds rate.

With regards to the forecasting regression analysis, I find that narrow Divisia money measures are more effective in predicting sectorial economic activity indicators compared to broad measures. The statistical and economic significance of the forecasted results are more pronounced and persistent as well as mostly in line with economic theory and expectations when using narrow measures. Lastly, sectors exhibit heterogeneous responses to a monetary policy shock identified with different narrow and broad Divisia measures. In the largest sector, the shock produces more pronounced and persistent effects when identified with narrow Divisia money compared to broad money. In the smallest sector, the responses are relatively similar regardless of whether narrow or broad Divisia money is used for identification.

Overall, the findings reveal that Divisia money measures are potent predictors of sectorial real GDP, value added, employment, and unemployment rates across diverse sectors. Notably, narrow and broad Divisia measures in each of the three categories considered in this study often outperform the traditional Fed funds rate in predicting sectorial economic and labor market activities. Narrow money in each category shows a slight edge over their broad counterparts. This study underscores the contemporary relevance of narrow Divisia monetary aggregates. The results further support the inclusion of Divisia monetary aggregates in monetary and business cycle analysis.

The remainder of this paper is structured as follows: Section 2 deals with the data and offers graphical representations of the differences between the narrow and broad Divisia money measures. This section also furnishes summary statistics that underscore the sectorial heterogeneity. Section 3 outlines the Kydland and Prescott (1990) methodology for cyclical correlations and the Hamilton (2018) regression-based filter for obtaining the cyclical components. Additionally, the results of the cyclical correlation analysis are presented within this section. Moving on to Section 4, I first introduce the Granger causality testing methodology employed to explore the

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

information content of interest rates and both narrow and broad Divisia money measures. In the latter part of Section 4, my attention shifts to the forecasting regression approach, serving as an alternative method for assessing the sectorial information content of narrow and broad Divisia money. Section 5 present a structural VAR model to identify monetary policy shock and study sectorial responses to the aggregate shock. Finally, Section 6 closes the paper with a summary and concluding remarks.

2. The data

I use quarterly data from 2005Q1 to 2022Q4 to examine the cyclical behavior and predictive abilities of seven policy (predictor) variables across thirteen sectors/industries in the United States.[2] My analysis focused on their impact on sectorial economic activities, which are proxied with sectorial real Gross Domestic Product (GDP), real value added, employment, and the unemployment rate. I chose this specific sample period and data frequency to ensure a consistent datasets across all sectors, driven by data availability considerations.

I acquired monthly employment and unemployment rate data for all sectors from the Bureau of Labor Statistics (BLS). However, sectorial real GDP and value-added data, obtained from the Bureau of Economic Analysis (BEA), are reported on a quarterly basis. To align the datasets, I converted the BLS monthly employment and unemployment data into quarterly using period averages.

The Divisia money measures are from the Centre for Financial Stability (CFS). These Divisia monetary aggregates, originally constructed by Barnett (1980), depart from the assumption of perfect substitutability inherent in simple sum aggregates. Instead, a weighting scheme based on monetary component user costs is used. See Barnett et al. (2013) and CFS[3] for a detailed discussion of the data and the methodology for the calculation of these monetary aggregates.

Whereas the CFS and Barnett et al. (2013) provided eight levels of Divisia monetary aggregation, my analysis of the predictive abilities of narrow and broad Divisia money measures for sectorial economic activities focuses on the predictive abilities of the narrowest and broadest Divisia money measures across three categories of Divisia monetary aggregation. Specifically, this includes an evaluation of the sectorial predictive capabilities at the original Divisia monetary aggregation level (Divisia M1 vs. M4), the credit card-augmented Divisia monetary aggregation level (Divisia M1A vs. M4A), and the credit card-augmented Divisia inside money aggregation level (Divisia M1AI vs. M4AI). In this context, a distinction is made between supply-side (Divisia M1A, M4A, M1AI, and M4AI) and demand-side (M1 and M4) measures of Divisia, as well as between inside and outside money (see Barnett and Su (2017) and Barnett and Su (2020) for details on credit card-augmented Divisia). Several studies including Barnett (2016), Keating et al. (2019), Jadidzadeh and Serletis (2019), Dery and Serletis (2021b), and Liu et al. (2020), have recommended the use of broad Divisia money for monetary and business cycle analysis. I compare the information content of the highly recommended broad Divisia money measures to narrow Divisia measures for sectorial economic activities. Additionally, since Liu et al. (2020) asserts that credit card-augmented Divisia measures of money are more informative for predicting real economic activity than original Divisia monetary aggregates, particularly in the period following the 2007–2009 financial crisis, the predictive abilities of these credit card-augmented Divisia money measures are assessed at the sectorial level.

Figure 1 (original Divisia), Figure 2 (credit card-augmented Divisia), and Figure 3 (credit card-augmented inside money Divisia) display the logged levels of the narrowest and broadest Divisia monetary aggregates across these three categories. The logged values for the original Divisia (Figure 1) are normalized to 2005Q1, while the augmented Divisia values (Figures 2 and 3) are normalized to 2006Q3. These figures show distinct paths between narrow and broad

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

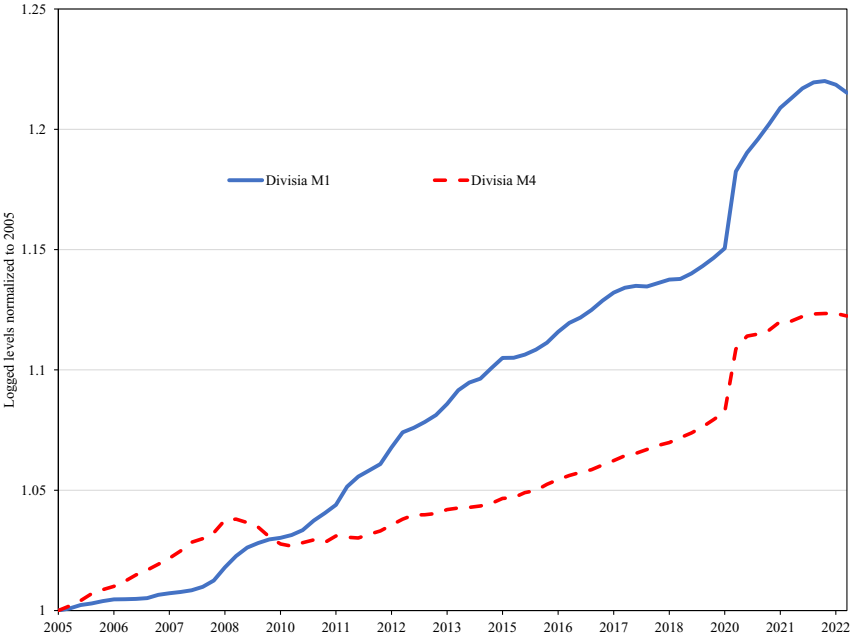

Figure 1. Logged level of Divisia M1 and M4 money measures.

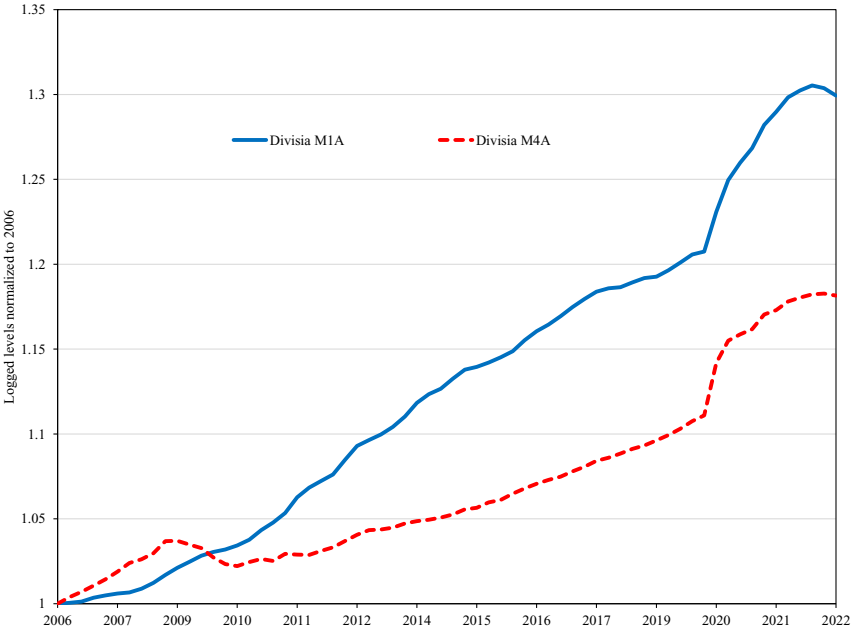

Figure 2. Logged level of Divisia M1A and M4A money measures.

money. In all cases, narrow money has increased steadily more than broad money since 2009. Figures 4 to 6 present their respective year-on-year growth rates. In summary, the aggregates are clearly distinguishable in both logged levels and growth rates.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

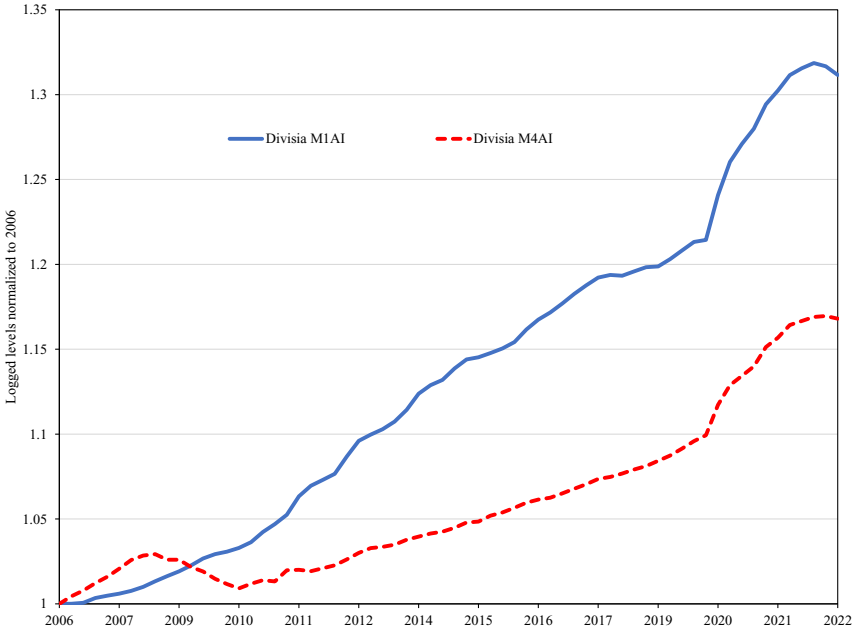

Figure 3. Logged level of Divisia M1AI and M4AI money measures.

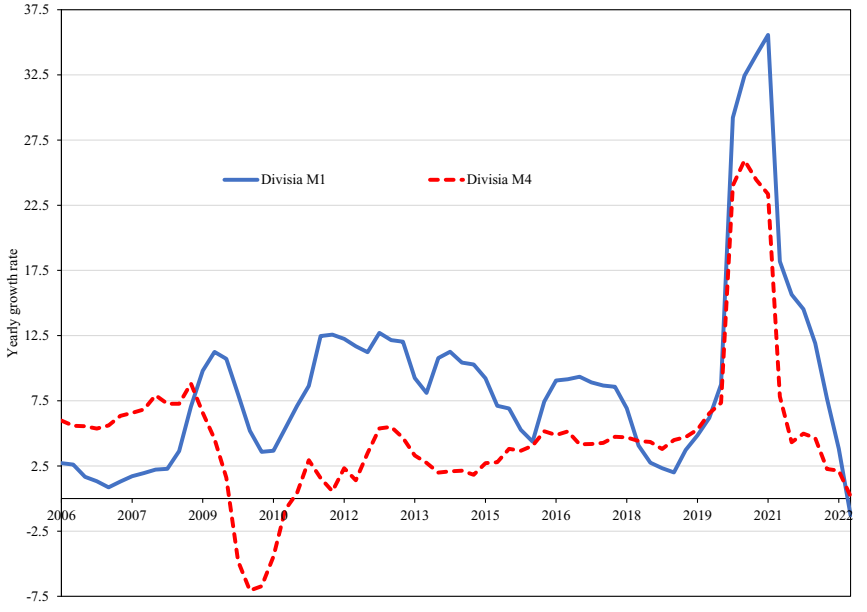

Figure 4. Growth rate of Divisia M1 and M4 money measures.

In an attempt to assess whether the high information content and predictive capabilities of Divisia monetary aggregates observed in aggregate data extend to the sectorial level, I examine disaggregated sectorial data across thirteen sectors with four measures of economic activities and

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

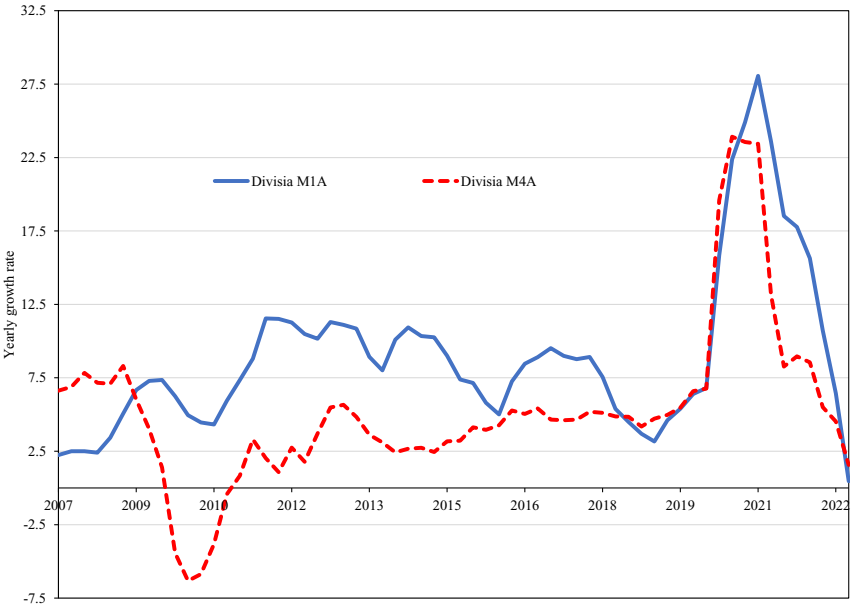

Figure 5. Growth rate of Divisia M1A and M4A money measures.

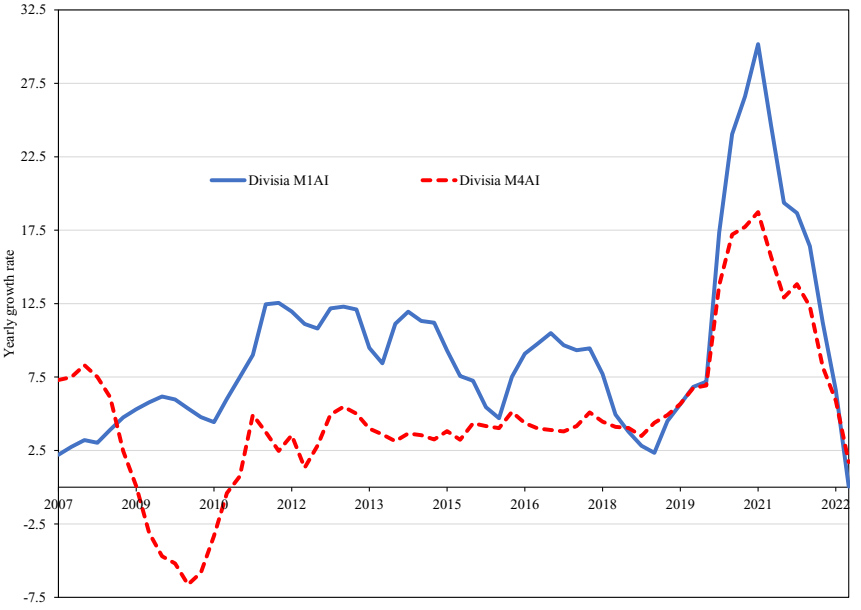

Figure 6. Growth rate of Divisia M1AI and M4AI money measures.

six measures of Divisia money. Given the consensus in the literature on the superiority of Divisia money over simple sum money measures, I consider this distinction trivial and, therefore, do not assess the sector-specific information content and predictive prowess of simple sum money measures relative to Divisia money measures.[4]

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Throughout the analysis, I employ the Fed funds rate as a benchmark policy variable and account for the impact of price level changes by incorporating the Consumer Price Index (CPI). Since the sample period includes instances of the zero lower bound, particularly during the 2007-2009 financial crisis and the COVID-19 period, the shadow Fed funds rate from the Atlanta Fed, as measured by Wu and Xia (2016), is used in all cases as the effective Fed funds rate. The CPI data are sourced from FRED (Federal Reserve Economic Data). In all cases, I offer a corresponding analysis for the same sample period by utilizing aggregate economic indicators. These aggregated indicators, including real GDP, value added, employment, and unemployment data, are sourced from the BEA and FRED.

Table 1 presents the full list of the 13 sectors/industries along with a brief overview of the typical economic activities conducted within each sector. Table 2 provides a summary of the statistics for the various measures of sector-specific economic activities. For each sector, the table displays the mean values of the economic activity measures, with the corresponding standard deviations presented in parentheses. Additionally, the minimum and maximum values for each sector are enclosed in square brackets beneath their respective mean values.

As shown in Table 2, the sector with the highest real GDP is manufacturing, with average GDP of approximately $5.9 trillion. It is followed closely by the finance sector, with a GDP averaging around $5.3 trillion. In contrast, the utilities sector ranks as the smallest, with a GDP of approximately half a trillion dollars. In terms of value added, agriculture exhibits the lowest value added (approximately $173 billion). On the other hand, finance, professional and business services, manufacturing, and education emerge as the top four value adding sectors, each contributing significantly with values of $3.6 trillion, $2.2 trillion, $2.1 trillion, and $1.5 trillion, respectively.

In terms of employment, the education sector stands out as the largest employer, with an average of 21.3 million employees. It is closely followed by professional and business services, which average 19.1 million employees. Retail and hospitality sectors also rank high in employment, with mean figures of 15.2 million and 14.3 million employees, respectively. In contrast, agriculture employs the fewest individuals. Similar to other indicators of sectorial economic activity, unemployment rates within these sectors vary significantly, ranging from 2.7% in the utilities sector to 9.5% in the construction and finance sectors.

In this paper, I investigate whether the differences in levels and growth rates of the three categories of Divisia aggregates (original Divisia, credit card-augmented Divisia, and credit card-augmented inside money Divisia), as shown in Figures 1 to 6 are relevant for their predictive abilities across a range of highly distinct and heterogeneous sectors, as outlined in Table 2.

3. The cyclical behavior of money

I begin the analysis of the relationship between Divisia monetary aggregates and sectorial economic activities by first examining their respective cyclical characteristics. In this endeavor, I adopt the approach outlined by Kydland and Prescott (1990) to explore the cyclical properties of both narrow and broad Divisia monetary aggregates.

To derive the cyclical components of each sector's economic activity metrics, as well as the Divisia monetary aggregates, I employ the novel regression filter introduced by Hamilton (2018). This filter extract the cyclical components from nonstationary time series(y_t) through OLS regression. Specifically, the methodology involves performing an OLS regression of y_t on four lags of itself back-shifted by 8 quarter as follows:

$$y_t = \beta_0 + \beta_1 y_{t-8} + \beta_2 y_{t-9} + \beta_3 y_{t-10} + \beta_4 y_{t-11} + v_t.$$

Such that the regression residuals, $\hat{v}_t$,

$$\hat{v}_t = y_t - \hat{\beta}_0 - \hat{\beta}_1 y_{t-8} - \hat{\beta}_2 y_{t-9} - \hat{\beta}_3 y_{t-10} - \hat{\beta}_4 y_{t-11}$$

is the desired cyclical component of the series.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table 1. List and description of sectors

BEA Official Name	Short name in paper	BEA Industry Description
Agriculture, forestry, fishing, and hunting	Agriculture	This industry primarily focus on cultivating crops, raising livestock, harvesting timber, and harvesting fish and other animals from either a farm, ranch, or their natural habitats.
Construction	Construction	Activities in the construction industry include the construction of new residential, commercial, industrial, and institutional buildings, as well as making additions and alterations to existing structures. It also includes engineering projects like highways, utility systems, and dams, along with site preparation and structural improvements. Additionally, within this industry, there is secondary involvement in tasks such as the maintenance and repair of existing structures, in-house software development, and research and development efforts.
Educational services, health care, and social assistance	Education	This sector comprises of educational services and health care and social assistance . Educational services can encompass privately owned and operated institutions, whether for profit or not for profit. These institutions provide various forms of education and training. On the other hand, health care and social assistance establishments offer a range of services, including inpatient and outpatient health care, nursing care, and social assistance for individuals. Notably, public educational or health care services are excluded from this classification.
Finance, insurance, real estate, rental, and leasing	Finance	The finance, insurance, real estate, rental, and leasing sector, often abbreviated as FIRE, encompasses two major categories: finance and insurance and real estate and rental and leasing. Businesses within these industries are primarily involved in financial transactions, facilitating finance-related activities, offering rental or leasing services, and providing access to tangible or intangible assets. Additionally, the industry group includes the production of owner-occupied housing.
Arts, entertainment, recreation, accommodation, and food services	Hospitality	Major categories in this industry includes arts, entertainment, and recreation and accommodation and food services . Establishments in these industries are primarily involved in cultural, entertainment, and recreational activities, as well as providing lodging, and preparing meals, snacks, and beverages for immediate consumption on- or off-premises. These sectors cater to various aspects of leisure and hospitality.
Information	Information	The information sector encompasses a range of industries, including publishing industries except internet (includes software) with related activities such as book publishing, newspaper and magazine publishing, and software production, motion picture and sound recording industries (creation, production, and distribution of motion pictures and sound recording), broadcasting and telecommunications, and data processing, internet publishing, and other information services . Establishments in this sector are involved in various aspects of producing and distributing information, cultural products, data, and communications, as well as processing data.
Manufacturing	Manufacturing	Manufacturing broadly consists of two main categories: durable goods and nondurable goods. Within this industry, the process involves taking raw materials or materials in various stages of processing and transforming them into new products, typically on a large scale. Durable goods are products that are designed to last for three or more years, while nondurable goods are items that are quickly consumed or typically have a lifespan of less than three years.
Mining	Mining	Mining encompasses three main categories: oil and gas extraction, other mining excluding oil and gas, and support activities for mining. Within this industry, tasks undertaken may include but not limited to extraction of naturally existing minerals, quarrying, mineral property preparation, and exploration and development. The range of naturally occurring minerals mined spans mineral solids, such as coal, and mineral liquids, such as crude petroleum.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table 1. Continued

BEA Official Name	Short name in paper	BEA Industry Description
Professional and business services	Professional and business services	The professional and business services sector, normally abbreviated as PROF, is a combination of three key categories: professional, scientific, and technical services (includes a wide range of professional services, scientific research, and technical expertise, such as legal services, engineering, architecture, scientific research and development, and consulting); management of companies and enterprises; and administrative and waste management services (including office administration, employment services, travel arrangement, and waste management and remediation services).
Retail trade	Retail trade	Retail trade encompasses businesses involved in the retailing of merchandise to consumers, typically without altering the products, and also offering services that are related to the sale of merchandise. The industry's output is calculated as sales revenue minus the cost of goods sold. Retail trade includes various sub-sectors such as motor vehicle and parts dealers, food and beverage stores, general merchandise stores, and other retail.
Transportation and warehousing	Transportation and warehousing	The transportation and warehousing sector covers a broad range of industries including air, rail, water, truck, transit and ground passenger, and pipeline transportation. It also encompasses scenic and sightseeing activities, various support services for transportation (such as airport operations, cargo handling, towing, etc.), couriers and messengers, and warehousing and storage. The primary function of establishments within this sector is to provide transportation services for both passengers and cargo.
Utilities	Utilities	The utilities sector includes businesses involved in various essential services, such as electric power generation, transmission, and distribution, as well as natural gas distribution. It also encompasses activities related to steam supply production and/or distribution, privately owned water supply treatment and distribution, and the management of sewage collection, treatment, and disposal through sewer systems and sewage treatment facilities.
Wholesale trade	Wholesale trade	Wholesale trade includes businesses that are involved in the distribution of merchandise without altering it, and they may also provide services related to the sale of merchandise. The wholesale process acts as an intermediate step in the distribution of goods. The industry's output is typically determined by subtracting the cost of goods sold from sales revenue.

After obtaining the cyclical components of the chosen narrow and broad Divisia monetary aggregates, as well as the cyclical components of various economic activity indicators across the 13 sectors of the US economy, the next step involves evaluating the extent of cyclical correlation between a particular measure of money and the relevant indicator of sectorial economic activity. As noted in the data section, the narrowest and broadest Divisia measures from each of the three categories are utilized. For each sector, I gauge the level of cyclical co-movement between these money measures and sectorial real GDP, value added, employment, and the unemployment rate. The magnitude of the correlation coefficient serves as a measure of the degree of this cyclical co-movement, allowing us to assess the cyclical properties with the following:

$$\rho(M_t, Y_{t+j}) \quad \text{, for } j = -8, -4, 0, 4, 8$$

In the context of this analysis, the correlation coefficient $\rho(M_t, Y_t)$ provides insights into the degree of contemporaneous co-movement between the monetary measure (M_t) and the economic activity indicator (Y_t). Specifically:

- If $\rho(M_t, Y_t) > 0$, it suggests that M_t is procyclical, indicating that it tends to move in the same direction as economic activity.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table 2. Summary statistics of sectorial indicators of economic activity

	Real GDP	Value Added	Employment	Unemployment rate
Aggregate	30,828.6 (2778.1)	17,778.0 (3452.2)	147486.1 (6283.8)	6.0 (2.1)
	[26,846.4 36,331.3]	[12,767.3 26,138.0]	[137554.0 158788.0]	[3.6 13.0]
Agriculture	489.9 (34.8)	172.5 (39.1)	52.2 (5.7)	9.2 (3.5)
	[431.5 550.1]	[121.1 302.6]	[44.7 66.7]	[3.9 19.4]
Construction	1308.4 (159.3)	719.6 (147.5)	6772.8 (788.7)	9.5 (5.2)
	[1025.2 1586.2]	[512.2 1045]	[5451.7 7835.3]	[3.5 25.6]
Education	2331.1 (275.8)	1509.5 (335.9)	21,325.75 (2114.6)	4.0 (1.4)
	[1844.2 2774.8]	[952.5 2212]	[17,485.3 24,748]	[2.3 9.9]
Finance	5299.9 (483.1)	3622.3 (776.3)	8263.6 (400.6)	9.5 (5.2)
	[4551.9 6226.6]	[2560.3 5233.6]	[7677.7 9094.7]	[3.5 25.6]
Hospitality	1155.1 (142.7)	694.9 (169.6)	14,325.9 (1393.5)	9.1 (4.2)
	[694.4 1488.3]	[471.2 1123.6]	[10,136.3 16,749.7]	[4.8 34.7]
Information	1591.2 (392.8)	909.9 (222.4)	2839.5 (141.5)	5.5 (2.2)
	[1105.3 2475.3]	[633.5 1439.4]	[2624.0 3121.7]	[2.2 11.3]
Manufacturing	5882.6 (264.4)	2064.6 (296.9)	12,604.2 (811.5)	5.7 (2.7)
	[5113.4 6324.8]	[1667.3 2894.5]	[11,455.3 14,266.3]	[2.5 12.7]
Mining	599.2 (95.5)	316.9 (76.2)	668.0 (94.3)	6.1 (3.5)
	[445.1 784.0]	[139.4 538.7]	[500.8 847.4]	[1.7 16.2]
Professional and	3336.8 (636.4)	2180.0 (524.5)	19,136.2 (1785.6)	6.5 (2.4)
business Services	[2571.0 4833.0]	[1413.5 3418.3]	[16,508.7 22,798.7]	[3.2 11.8]
Retail trade	1569.1 (205.4)	1018.1 (188.8)	15,219.8 (457.0)	6.6 (2.2)
	[1249.6 1971.6]	[819.9 1516.5]	[13,777.9 15,851]	[3.7 15.7]
Transportation and	1064.8 (119.8)	532.5 (121.6)	4923.7 (706.1)	6.1 (2.5)
warehousing	[861.0 1325.0]	[357.7 839.6]	[4133.1 6717.1]	[2.9 15.2]
Utilities	477.4 (23.5)	294.9 (56.5)	552.6 (4.5)	2.7 (1.3)
	[417.6 516.7]	[189.5 469.4]	[541.1 563.2]	[0.7 6.4]
Wholesale trade	1668.7 (233.9)	1075.8 (228.3)	5731.2 (166.8)	4.5 (1.7)
	[1186.7 2088.9]	[741.9 1649.0]	[5377.6 6022.5]	[1.7 8.4]
N in each sector		72		

Notes: Real GDP and Value added are in Billion Dollars, Employment in thousands and unemployment in percent. Table report the mean values of the economic activity measures, with the corresponding standard deviations presented in parentheses and the minimum and maximum values for each sector are enclosed in square brackets beneath their respective mean values.

- If $\rho(M_t, Y_t) < 0$, it implies that M_t is countercyclical, indicating an inverse relationship with economic activity.
- If $\rho(M_t, Y_t) = 0$, it suggests that M_t is acyclical, meaning there is no significant contemporaneous co-movement with economic activity.

Furthermore, to assess the sectorial phase shift of M_t, I examine the cross-correlation coefficient $\rho(M_t, Y_{t+j})$ for $j \neq 0$. The absolute value of $\rho(M_t, Y_{t+j})$ is used to determine the leading, synchronous, or lagging behavior of M_t with respect to the economic cycle:

- If the absolute value of $\rho(M_t, Y_{t+j})$ is maximum for a positive j, it indicates that M_t is leading the economic cycle by j periods.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table 3. Aggregate and sectorial real GDP contemporaneous correlation and phase shift

	Fed funds rate	Divisia M1	Divisia M4	Divisia M1A	Divisia M4A	Divisia M1AI	Divisia M4AI
A. Contemporaneous correlations							
Aggregate	0.15	−0.11	−0.38	0.10	−0.46	0.13	0.10
Agriculture	−0.19	0.03	−0.14	−0.10	0.17	−0.07	0.22
Construction	0.02	−0.09	0.23	−0.02	−0.11	0.00	0.13
Education	0.51	−0.60	−0.42	−0.50	−0.43	−0.51	−0.39
Finance	−0.10	0.21	−0.19	0.38	−0.18	0.41	0.36
Hospitality	0.24	−0.27	−0.35	−0.08	−0.32	−0.07	0.01
Information	0.26	−0.07	−0.22	0.22	−0.32	0.23	0.14
Manufacturing	0.44	−0.41	−0.10	−0.21	−0.39	−0.18	−0.07
Mining	−0.05	−0.25	−0.35	−0.22	−0.39	−0.19	−0.05
Professional and business service	0.17	−0.16	−0.14	0.14	−0.37	0.17	0.18
Retail trade	0.01	0.10	−0.43	0.16	−0.40	0.19	0.03
Transportation and warehousing	0.26	−0.20	−0.32	0.02	−0.43	0.05	0.07
Utilities	0.28	−0.28	0.05	−0.08	−0.33	−0.07	−0.13
Wholesale trade	0.02	0.17	−0.31	0.38	−0.42	0.41	0.10
B. Phase Shift							
Lagging	7	6	5	4	0	5	4
Leading	3	6	6	8	4	8	9
Synchronous	3	1	2	1	9	0	0

Notes: In panel A: Red = acyclical, purple = countercyclical, and orange = procyclical. Numbers in panel B indicate the number of sectors for which each policy variable was lagging, leading, or synchronous with the sectorial real GDP cycle.

- If the absolute value of $\rho(M_t, Y_{t+j})$ is maximum for $j = 0$, it suggests that M_t is synchronous with the economic cycle.
- If the absolute value of $\rho(M_t, Y_{t+j})$ is maximum for a negative j, it implies that M_t is lagging the economic cycle by j periods.

These assessments help us understand the timing and direction of the relationship between the monetary measures and sectorial economic activity across different sectors.

Tables 3 to 6 provide an overview of the cyclical correlations between sectorial real GDP (Table 3), value added (Table 4), unemployment (Table 5), and employment (Table 6) with both narrow and broad Divisia money measures, as well as with the Fed funds rate. For brevity, only the contemporaneous correlations ($j = 0$) and the phase shift information are reported in panels A and B, respectively. Detailed correlations are presented in Appendix Table A1 (sectorial economic activities) and Table 2 (sectorial labor market activities).

As shown in Panel A of Table 3, at the aggregate level, the Fed funds rate is weakly procyclical with real GDP, with a contemporaneous correlation of 0.15. At the sectorial level, it is procyclical in 8 sectors, with the strongest correlation in the education sector at 0.51. The positive correlations between sectorial GDP and the Fed funds rate are generally larger than the correlation between aggregate GDP and the Fed funds rate. Construction, Mining, Retail trade, and Wholesale trade are generally acyclical with the Fed funds rate, while Agriculture and Finance are weakly countercyclical with the Fed funds rate.

The remaining part of Panel A of Table 3 shows the contemporaneous correlations of various Divisia monetary aggregates with aggregate and sectorial real GDP. The correlations largely

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table 4. Aggregate and sectorial real value added contemporaneous correlation and phase shift

	Fed funds rate	Divisia M1	Divisia M4	Divisia M1A	Divisia M4A	Divisia M1AI	Divisia M4AI
A. Contemporaneous correlations							
Aggregate	0.26	−0.15	−0.01	0.19	−0.26	0.21	0.22
Agriculture	−0.01	0.45	−0.16	0.59	−0.06	0.59	0.24
Construction	0.20	−0.01	−0.35	0.09	−0.43	0.12	0.02
Education	0.43	−0.29	0.15	−0.22	0.06	−0.25	−0.25
Finance	0.10	−0.08	−0.38	0.04	−0.46	0.08	0.11
Hospitality	0.23	−0.26	−0.38	−0.07	−0.32	−0.05	0.01
Information	0.24	−0.23	0.42	0.07	0.09	0.09	0.35
Manufacturing	0.24	−0.09	−0.34	0.15	−0.46	0.17	0.05
Mining	−0.28	0.33	−0.19	0.49	−0.06	0.49	0.15
Professional and business service	0.34	−0.20	0.22	0.16	−0.16	0.18	0.23
Retail trade	−0.22	0.51	−0.28	0.65	−0.09	0.66	0.33
Transportation and warehousing	0.36	−0.34	−0.42	−0.11	−0.50	−0.09	−0.08
Utilities	0.26	0.20	0.02	0.24	−0.05	0.20	−0.26
Wholesale trade	0.00	0.26	0.02	0.53	−0.10	0.54	0.31
B. Phase Shift							
Lagging	8	9	2	9	6	8	7
Leading	1	3	6	3	2	4	6
Synchronous	4	1	5	1	5	1	0

Notes: In panel A: Red = acyclical, purple = countercyclical, and orange = procyclical. Numbers in panel B indicate the number of sectors for which each policy variable was lagging, leading, or synchronous with the sectorial real value-added cycle.

depict countercyclical patterns of both narrow and broad Divisia measures with both aggregate and sectorial real GDP. The largest negative correlation is between Divisia M1 and the education sector's real GDP (−0.60). Generally, the education sector has the highest absolute correlations for any Divisia money measure relative to all other sectors, which is also the case with the Fed funds rate. Notably, all the narrow Divisia money measures exhibit weakly procyclical relationships with Finance, Retail trade, and Wholesale trade, while being acyclical with Construction real GDP.

Panel B of Table 3 presents the phase shift information, showing the number of sectors for which each policy variable was lagging, leading, or synchronous with the sectorial economic cycle. Details of the specific sectors where each policy variable is a lagging, leading, or synchronous indicator are shown in Appendix Table A1. The Fed funds rate is generally a lagging indicator of sectorial real GDP (7 out of 13 sectors) and only a leading indicator in 3 out of 13 sectors. In contrast, both narrow and broad Divisia measures are generally leading indicators of sectorial real GDP more frequently than the Fed funds rate.

Additionally, the Fed funds rate demonstrates procyclical tendencies when using an alternative measure of economic activity (sectorial value added in Table 4) across most sectors, except for mining and retail trade. The correlation between the policy rate and value added in the agricultural sector is −0.01, indicating an acyclical relationship. With this alternative measure of economic activity, the Divisia money measures are generally countercyclical, particularly with Divisia M1, M4, and M4A, at both the sectorial and aggregate levels, albeit with notable exceptions. Divisia M4AI is procyclical with sectorial value added except in education and utilities. In 6 out of 13

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table 5. Aggregate and sectorial unemployment contemporaneous correlation and phase shift

	Fed funds rate	Divisia M1	Divisia M4	Divisia M1A	Divisia M4A	Divisia M1AI	Divisia M4AI
A. Contemporaneous correlations							
Aggregate	−0.52	0.43	0.16	0.22	0.35	0.20	0.04
Agriculture	−0.44	0.16	0.02	0.02	0.25	0.00	0.01
Construction	−0.44	0.28	0.31	0.12	0.44	0.10	0.04
Education	−0.54	0.47	0.08	0.24	0.30	0.22	0.05
Finance	−0.44	0.28	0.31	0.12	0.44	0.10	0.04
Hospitality	−0.53	0.55	0.25	0.36	0.39	0.35	0.17
Information	−0.48	0.42	0.10	0.21	0.35	0.18	0.02
Manufacturing	−0.41	0.28	0.23	0.08	0.40	0.05	0.00
Mining	−0.52	0.55	0.01	0.37	0.44	0.37	0.32
Professional and business service	−0.52	0.39	0.24	0.20	0.43	0.18	0.07
Retail trade	−0.54	0.44	0.15	0.22	0.34	0.20	0.06
Transportation and warehousing	−0.59	0.56	0.21	0.35	0.44	0.33	0.16
Utilities	−0.47	0.38	0.03	0.29	0.20	0.28	0.13
Wholesale trade	−0.57	0.39	0.14	0.19	0.33	0.17	0.03
B. Phase Shift							
Lagging	0	0	0	0	0	0	11
Leading	0	10	13	12	2	13	1
Synchronous	13	3	0	1	11	0	1

Notes: In panel A: Red = acyclical, purple = countercyclical, and orange = procyclical. Numbers in panel B indicate the number of sectors for which each policy variable was lagging, leading, or synchronous with the sectorial unemployment cycle.

sectors, Divisia M4A is effectively acyclical. All the narrow measures also have positive contemporaneous correlations with sectorial value added in agriculture, mining, retail trade, utilities, and wholesale trade. Phase shift information indicates most policy variables are lagging indicators for value added. However, monetary measures are still more frequently leading indicators than the Fed funds rate.

Table 5, Panel A shows that both aggregate and sectorial unemployment rates are significantly negatively related to the Fed funds rate, with correlations ranging from −0.41 to −0.59. Additionally, Divisia monetary aggregates are contemporaneously positively related to both aggregate and sectorial unemployment rates, indicating that with tight labor markets (decreasing unemployment rates), policymakers decrease the money supply. The positive correlations are higher for both aggregate and every sector with Divisia M1 and M4A, while Divisia M4AI is basically acyclical with all sectors except Hospitality, Mining, Transportation and Warehousing, and Utilities.

In Panel B, we observe the Fed funds rate to be synchronous with sectorial unemployment rates in all 13 sectors, while the Divisia aggregates are leading indicators of sectorial unemployment rates in almost all industries except for Divisia M4A and M4AI. While Divisia M4 outperforms M1 as a leading indicator of sectorial unemployment rates (13 vs. 10 sectors), Divisia M1A and M1AI also lead their broad counterparts in this regard.

Table 6 displays the cyclical correlations between employment, Divisia money, and the Fed funds rate. The table reveals that the different monetary measures largely exhibit negative relationships with the level of economic activity, as measured by sectorial employment levels. This indicates that a sectorial employment boom is accompanied by a reduction in money supply.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table 6. Aggregate and sectorial employment contemporaneous correlation and phase shift

	Fed funds rate	Divisia M1	Divisia M4	Divisia M1A	Divisia M4A	Divisia M1AI	Divisia M4AI
A. Contemporaneous correlations							
Aggregate	0.43	−0.43	−0.21	−0.21	−0.35	−0.18	0.04
Agriculture	−0.07	−0.15	−0.32	−0.03	−0.36	0.00	0.02
Construction	0.43	−0.17	−0.10	−0.01	−0.39	0.01	−0.09
Education	0.52	−0.77	−0.46	−0.66	−0.52	−0.65	−0.40
Finance	0.37	−0.14	−0.35	−0.06	−0.46	−0.03	−0.07
Hospitality	0.36	−0.51	−0.46	−0.35	−0.45	−0.33	−0.15
Information	0.57	−0.31	0.26	−0.06	−0.05	−0.05	0.07
Manufacturing	0.55	−0.45	0.11	−0.15	−0.42	−0.13	−0.08
Mining	−0.19	−0.18	−0.53	−0.09	−0.47	−0.07	−0.16
Professional and business service	0.20	−0.11	−0.31	0.10	−0.40	0.14	0.15
Retail trade	0.41	−0.32	−0.15	−0.09	−0.33	−0.06	0.04
Transportation and warehousing	0.20	−0.13	−0.28	0.08	−0.37	0.12	0.18
Utilities	0.27	−0.44	−0.33	−0.32	−0.51	−0.33	−0.39
Wholesale trade	0.58	−0.43	0.08	−0.17	−0.29	−0.15	−0.01
B. Phase Shift							
Lagging	5	7	2	6	1	6	1
Leading	1	3	7	7	3	7	3
Synchronous	7	3	4	0	9	0	9

Notes: In panel A: Red = acyclical, purple = countercyclical, and orange = procyclical. Numbers in panel B indicate the number of sectors for which each policy variable was lagging, leading, or synchronous with the sectorial employment cycle.

The table also shows a similar pattern of phase shifts, where Divisia monetary measures are more often leading indicators of sectorial economic and labor market activities than the Fed funds rate. Additionally, Divisia M4 outperforms M1 as a leading indicator, but the narrow measures Divisia M1A and M1AI tend to be more effective leading indicators than M4A and M4AI, respectively.

In summary, both narrow and broad Divisia money measures are generally more effective leading indicators of sectorial economic and labor market activities than the traditional Fed funds rate. In this regard, both narrow and broad money measures exhibit advantageous and desirable cyclical properties in relation to sectorial economic activities. Divisia M4 is generally favored as a leading indicator in more sectors than Divisia M1, while Divisia M1A and M1AI consistently outperform their broad counterparts in this regard.

4. The information content of money

After noting some desirable cyclical properties of both narrow and broad Divisia monetary aggregates, this section is dedicated to examining the predictive value of each monetary aggregate concerning sectorial economic indicators. I approach this assessment in two distinct ways: first, I employ Granger causality tests to gauge the ability of each aggregate to predict real economic activities in a Granger causal sense (Granger (1969)). Secondly, I employ forecasting regressions to evaluate how effectively the various monetary aggregates predict future sectorial economic activities. While the primary focus revolves around the information content of narrow and broad Divisia money measures for sector-level economic activity, I also assess the predictive capacity

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

of the federal funds rate and, in all cases, present the information content of these predictors for aggregate economic activity indicators as benchmark.

4.1. Granger Causality Analysis

In this subsection, I adopt a modified version of Granger (1969)'s methodology. This modified version of the methodology inspired by Bernanke and Blinder (1992), Belongia and Ireland (2015), and Dery and Serletis (2021b), utilize the following regression equation:

$$Y_t = \alpha + \sum_{i=1}^{p} \beta_i Y_{t-i} + \sum_{j=1}^{q} \theta_j X_{t-j} + \sum_{k=1}^{r} \lambda_k P_{t-k} + e_t \tag{1}$$

where Y_t is a measure of sectorial economic activity (Real GDP, Value added, employment, or unemployment), X_t is a predictor variable (either the Fed funds rate or a monetary aggregate), and P_t is the consumer price index which acts as an adjustment variable to remove the effects of general prices from the estimates. The optimal lag length for p, q, and r are flexibly determined based on the Akaike information criterion after letting each of p, q, and r take values from 1 to 12. Equation 1 is estimated separately for each predictor variable and for each measure of sectorial economic activity and then test for causality running from the predictor to the particular sectorial measure of economic activity. That is $\theta_j = 0, \forall\, j$. Intuitively, I am testing the null hypothesis that all lags of the predictor variable (the X variable in equation 1) can be excluded from the regression. In presenting the results, I report the marginal significance level. Therefore, smaller p-values indicate a stronger role for that predictor variable.

Table 7 presents the Granger causality test results for aggregate and sectorial real GDP for the Fed funds rate and the narrow and broad Divisia measures. Bold numbers indicate that the null hypothesis of no causality from the policy variable to sectorial real GDP is rejected at the 10% significance level. The table shows that at the aggregate level, there is no causality from the Fed funds rate to real GDP, as there is insufficient evidence to reject the null hypothesis at the 10% significance level. Generally, causality from the Fed funds rate to sectorial real GDP exists in only 6 out of the 13 sectors: Agriculture, Construction, Information, Manufacturing, Retail trade, and Utilities.

Conversely, the various narrow and broad Divisia money measures provide significant information content for predicting both aggregate and sectorial real GDP. Specifically, in a Granger sense, there is causality from each narrow and broad Divisia money measure to aggregate real GDP. At the sectorial level, these Divisia indices are highly informative for predicting sectorial real GDP, as indicated by the near-total rejection of the null hypothesis of no causality in almost all sectors. Notably, there is information content for predicting 12, 13, and 12 out of the 13 sectors for Divisia M1, M1A, and M1AI, respectively. The corresponding numbers for M4, M4A, and M4AI are 11, 10, and 9, respectively.

Virtually every Divisia money measure has more predictive capability in a Granger sense than the traditional Fed funds rate within this recent sample period. In other words, money measures appear to connect better with sectorial real GDP than interest rate measures in this contemporary period. Additionally, narrow money outperforms their broad counterparts within their respective categories: M1 vs. M4 (12 vs. 11), M1A vs. M4A (13 vs. 10), and M1AI vs. M4AI (12 vs. 9).

Table 8 summarizes, for each sectorial economic activity measure (GDP, value added, employment, and unemployment) and for each predictor (Fed funds rate, Divisia M1, M4, M1A, M4A, M1AI, and M4AI), the count of the number of sectors in which the null hypothesis of no causality was rejected at the 10% significance level. The higher the number, the more informative the policy variable. The total possible count is 13. Appendix Table A3 contains the detailed causality results for Table 8.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table 7. Causality from policy variables to aggregate and sectorial real GDP

	Fed funds rate	Divisia M1	Divisia M4	Divisia M1A	Divisia M4A	Divisia M1AI	Divisia M4AI
Aggregate Real GDP	0.692	**0.000**	**0.000**	**0.001**	**0.003**	**0.001**	**0.012**
Agriculture	**0.065**	**0.078**	0.197	**0.029**	0.172	**0.025**	0.618
Construction	**0.005**	**0.030**	**0.001**	**0.016**	**0.071**	**0.002**	**0.063**
Education	0.466	**0.002**	**0.013**	**0.002**	**0.012**	**0.001**	0.369
Finance	0.147	**0.000**	**0.050**	**0.000**	**0.012**	**0.000**	**0.001**
Hospitality	0.796	**0.006**	**0.016**	**0.079**	0.523	**0.065**	0.524
Information	**0.005**	**0.000**	**0.000**	**0.001**	**0.022**	**0.002**	**0.000**
Manufacturing	**0.020**	**0.000**	**0.001**	**0.000**	**0.000**	**0.001**	**0.036**
Mining	0.363	0.696	**0.018**	**0.004**	**0.006**	**0.002**	**0.026**
Professional and business service	0.810	**0.000**	**0.036**	**0.000**	**0.051**	**0.000**	**0.047**
Retail trade	**0.069**	**0.000**	**0.000**	**0.000**	**0.002**	**0.000**	**0.024**
Transportation and warehousing	0.795	**0.001**	**0.003**	**0.001**	**0.007**	**0.001**	**0.068**
Utilities	**0.002**	**0.051**	0.504	**0.022**	0.459	0.166	0.231
Wholesale trade	0.159	**0.000**	**0.000**	**0.000**	**0.012**	**0.000**	**0.002**

Notes: Numbers are marginal significance levels. Bold numbers indicate significance at 10%. Null hypothesis is no causality from policy variable to real GDP. Data is in logged levels.

Table 8. Count of number of sector in which policy variable is informative

	Fed funds rate	Divisia M1	Divisia M4	Divisia M1A	Divisia M4A	Divisia M1AI	Divisia M4AI
Aggregate variables	1	4	3	4	3	4	4
Sectorial real GDP	6	12	11	13	10	12	9
Sectorial Value added	5	13	12	13	10	13	9
Sectorial employment	5	10	9	11	8	12	10
Sectorial unemployment	6	12	7	12	5	12	5

Notes: The numbers in this table represent the count of sectors where the null hypothesis of no causality from the policy variable to the specific economic activity measure is rejected at the 10% significance level. Data is in logged levels.

At the aggregate level, out of the 4 economic activity measures, the Fed funds rate only provides information content for predicting one measure. In contrast, for the various Divisia measures, the null hypothesis of no causality is rejected in all 4 cases with narrow measures and in 3 out of 4 cases with broad measures. Table 8 also reveals that across all 4 sectorial activity measures, narrow money measures are more informative than broad measures. For example, with Divisia M1, M1A, and M1AI and sectorial unemployment, the count is 12 out of 13 for each of them, while the corresponding numbers for Divisia M4, M4A, and M4AI are 7, 5, and 5 respectively.[5]

Although the Divisia measures prove valuable in forecasting a range of sectorial economic indicators, it's worth considering the possibility that their predictive power might be entirely absorbed by the presence of short-term interest rates, such as the Fed funds rate. This scenario echoes arguments made regarding the redundancy of simple sum monetary aggregates in the 1980s by Sims (1980) and Litterman and Weiss (1985). Therefore, I proceed to reestimate a

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table 9. Count of number of sector in which policy variable is informative while controlling for fed funds rate

	Divisia M1	Divisia M4	Divisia M1A	Divisia M4A	Divisia M1AI	Divisia M4AI
A. Logged level and controlling for Fed funds rate						
Aggregate variables	4	3	2	2	2	1
Sectorial real GDP	10	11	7	7	8	4
Sectorial Value added	12	13	10	9	10	7
Sectorial employment	10	8	8	5	9	5
Sectorial unemployment	10	7	8	3	7	3
B. Quarterly growth rate and controlling for Fed funds rate						
Aggregate variables	4	4	3	3	2	0
Sectorial real GDP	10	9	8	4	9	5
Sectorial Value added	13	13	10	7	5	8
Sectorial employment	12	10	7	4	9	8
Sectorial unemployment	10	9	10	5	10	4

Notes: The numbers in this table represent the count of sectors where the null hypothesis of no causality from the policy variable to the specific economic activity measure is rejected at the 10% significance level. The regressions control for the Fed funds rate, with data presented in logged levels and quarterly growth rates.

modified version of Equation 1, explicitly accounting for the influence of the Fed funds rate as follows:

$$Y_t = \alpha + \sum_{i=1}^{p} \beta_i Y_{t-i} + \sum_{j=1}^{q} \theta_j M_{t-j} + \sum_{k=1}^{r} \lambda_k P_{t-k} + \sum_{\ell=1}^{s} \phi_\ell R_{t-\ell} + e_t. \tag{2}$$

Where R_t is the Fed funds rate and M_t represent a monetary aggregate, all other variables are as previously denoted in equation 1. This modified causality test evaluates whether the predictive abilities of Divisia money measures for sectorial economic activities are significantly impacted or diminished by the presence of a short-term interest rate.

In similar manner to Table 8, panel A of Table 9 present the sectorial predictive ability of narrow and broad Divisia accounting for the effect of the Fed funds rate.[6] In general, I find that the predictive capabilities of Divisia money measures for sectorial economic activity are not eroded in the presence of a short-term interest rate. The results also largely depict the informativeness of narrow over broad Divisia measures, except in the case of sectorial real GDP and value added, where Divisia M4 is more informative than Divisia M1.

I conducted an analysis to assess the predictive power of selected narrow and broad Divisia money measures for sector-specific economic and labor market activity indicators. Up to this point, the causality analysis has been based on data presented in logged levels. In Table 9 panel B, I address the sensitivity of the findings to alternative data transformations by examining causality using the quarterly growth rates of the relevant economic activity measures. This approach aligns with the suggestion made by Christiano and Ljungqvist (1988) that causality test results may vary depending on various data transformations. In this regard, I control variables for both short-term interest rate and the price level and present the results in Table 9 panel B directly comparable to panel A of the same table.[7]

The information content of the various Divisia measures for predicting sectorial economic and labor market activities remains largely consistent with the results presented in Table 9, Panel A. Narrow Divisia money measures continue to exhibit slightly greater information content for predicting sectorial economic activity. The only exception is the result for sectorial value added,

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

where Divisia M4AI is more informative than Divisia M1AI. In general, the informativeness of the various Divisia money measures for predicting sectorial economic activities, as assessed through Granger causality tests, appears to be unaffected by this alternative data transformation.

Delving beyond aggregate data and into sector-specific information is inherently enlightening, as it unveils the heterogeneity in the ability of these monetary measures to predict sectorial economic activities. For instance, when focusing on aggregate real GDP (Panel B of Table 9), both Divisia M1 and M4 are informative. However, these indices are not informative for predicting real GDP in every sector. In particular, Divisia M1 does not have information content for predicting construction, mining, and utilities real GDP. Similarly, Divisia M4 is uninformative for predicting agriculture, construction, mining, and utilities real GDP.

It is worth highlighting the significance of the findings, given that my sample period, spanning from 2005Q1 to 2022Q4, falls within the post-1980 era—a period during which Friedman and Kuttner (1992) raised doubts about the predictive power of money. The fact that I observe significant predictive and information content in Divisia money at such a disaggregate sectorial level is indeed noteworthy

The conclusion that narrow Divisia money exhibits greater information content for predicting sectorial economic activities during the period from 2005Q1 to 2022Q4 is consistent with the findings of Belongia and Ireland (2015) and Dery and Serletis (2021b), who established that narrow Divisia money at the aggregate level outperforms the Fed funds rate in terms of informativeness for the sample period from 2000 to 2018. This consistency underscores the robustness and contemporary relevance of this current research findings.

4.2. Forecasting regression analysis

To assess the connection between the various predictors and future levels of sectorial economic activities, I run a forecasting regression similar to the specification used in Caldara et al. (2016) and Dery and Serletis (2021a) as follows:

$$y^s_{t+h} = \alpha^s + \theta^s x_t + \sum_{i=1}^{h+1} \beta^s_i y^s_{t-i} + e^s_{t+h} \tag{3}$$

The variable y^s_{t+h} represents the forward difference in the growth rate of the relevant sectorial economic activity measure at a horizon of $h \geq 0$ quarters for sector s. In Equation (3), x_t is one of the predictor variables (Fed funds rate, Divisia M1, Divisia M4, Divisia M1A, Divisia M4A, Divisia M1AI, or Divisia M4AI). I run this regression separately for each sectorial economic activity measure and for each of the predictor variables at horizons within two years.

Table 10 presents the one-year-ahead ($h = 4$) forecasting regression results for real GDP (Panel A) and value added (Panel B). An increase in the Fed funds rate predicts an economically and statistically significant reduction in future real GDP and value added at both the aggregate and sectorial levels, except for mining and utilities real GDP, as well as education, mining, and utilities value added. A 1 percentage point increase in the Fed funds rate predicts the most significant decline in hospitality real GDP and value added, exceeding 2 percentage points.

Regarding the ability of narrow and broad Divisia money measures to predict future aggregate and sectorial real GDP, at the aggregate level, an increase in narrow money measures predicts a significant increase in real GDP, while broad money measures do not show an economically or statistically significant predictive relationship. At the sectorial level, changes in narrow money measures (M1, M1A, and M1AI) are clearly more effective in predicting future changes in sectorial real GDP than changes in their broad money counterparts (M4, M4A, and M4AI). For instance, an increase in M1 predicts a statistically significant increase in real GDP for education, finance, manufacturing, retail trade, transportation and warehousing, and wholesale trade, while a similar increase in M4 does not produce any statistically significant predictions for these industries.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table 10. One-year-ahead forecasting regression results for real GDP and value added

	Fed Funds rate	Divisia M1	Divisia M4	Divisia M1A	Divisia M4A	Divisia M1AI	Divisia M4AI
A. Aggregate and Sectorial real GDP							
Aggregate	−0.939***	0.270***	0.099	0.316***	0.087	0.279***	0.064
Agriculture	−0.617**	−0.107	−0.104	−0.139	−0.113	−0.118	0.064
Construction	−1.000**	−0.060	−0.368***	−0.148	−0.481***	−0.137	0.064
Education	−0.250	0.196**	0.107	0.178	0.082	0.170	0.018
Finance	−0.497***	0.137***	0.032	0.182***	0.031	0.166***	0.033
Hospitality	−2.468**	1.518***	0.756*	1.637***	0.674	1.442***	0.471
Information	−0.782***	0.354***	0.308***	0.453***	0.318***	0.410***	0.324***
Manufacturing	−1.647***	0.256**	−0.151	0.324**	−0.154	0.279***	0.064
Mining	0.035	0.066	−0.170	−0.001	−0.252	0.002	−0.370
Professional and business service	−0.673**	0.364***	0.354***	0.449***	0.355***	0.279***	0.064
Retail trade	−1.519***	0.175**	−0.091	0.171	−0.133	0.141	−0.288**
Transportation and warehousing	−1.748***	0.589***	0.190	0.663***	0.158	0.592***	0.135
Utilities	0.143	−0.029	−0.044	0.051	−0.054	0.034	−0.062
Wholesale trade	−2.007***	0.419***	−0.100	0.556***	−0.111	0.484***	−0.188
B. Aggregate and Sectorial real value added							
Aggregate	−0.472*	0.366***	0.350***	0.444***	0.346***	0.397***	0.358***
Agriculture	−2.376**	1.302***	0.839**	1.685***	0.945***	1.483***	0.358***
Construction	−2.108***	0.410***	0.183	0.517***	0.167	0.467***	0.358***
Education	0.277	0.124*	0.211***	0.123	0.210***	0.130	0.297***
Finance	−0.776***	0.148***	0.063	0.204***	0.074	0.182***	0.068
Hospitality	−2.454**	1.528***	0.740*	1.718***	0.684	1.499***	0.500
Information	−0.325	0.258***	0.301***	0.337***	0.329***	0.303***	0.416***
Manufacturing	−1.071***	0.510***	0.364***	0.620***	0.362***	0.397***	0.358***
Mining	2.285	1.724***	1.756***	1.976***	1.721***	1.703***	1.319**
Professional and business service	−0.127	0.295***	0.294***	0.414***	0.327***	0.397***	0.358***
Retail trade	−0.624**	0.377***	0.336***	0.418***	0.303***	0.378***	0.229*
Transportation and warehousing	−1.639***	0.721***	0.262	0.917***	0.288	0.812***	0.318
Utilities	0.558	0.204**	0.338***	0.310**	0.425***	0.274**	0.503***
Wholesale trade	−0.854**	0.507***	0.376***	0.660***	0.400***	0.599***	0.457***

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

In general, the parameter estimates are larger for narrow money measures than for broad money measures in their respective categories.

While both narrow and broad money measures generally have a significant predictive relationship with aggregate and sectorial value added, the pattern of narrow money being economically

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

and statistically more attuned to aggregate and sectorial economic activities is maintained. For example, except for education, information, and utilities, the parameter estimates for all other sectors are larger for narrow money than their respective broad counterparts, and in some cases more than double, as seen in hospitality and transportation and warehousing.

Although the absolute value of the parameter estimate of changes in the Fed funds rate on economic activities is generally larger than for monetary measures, the number of sectors with statistically significant relationships favors narrow money measures, particularly when considering sectorial value added.

Table 11 presents the one-year-ahead forecasting regression results for aggregate and sectorial labor market activities. As expected, an increase in the Fed funds rate predicts a decline in employment at both the aggregate and sectorial levels. This reduction in employment is predicted to occur in almost all sectors, except for mining and education, where the results are not statistically significant. An increase in narrow money also predicts an increase in employment across all sectors (except mining) and at the aggregate level. Besides having statistically significant relationships, the parameter estimates for changes in narrow money forecasting changes in sectorial employment are larger compared to broad money for every sector except mining and agriculture (for M4 and M4A).

Both narrow and broad money measures are significant predictors of future changes in aggregate and sectorial unemployment, with narrow money within each category being more statistically related to sectorial unemployment. Additionally, both narrow and broad money measures outperform the Fed funds rate in predicting future changes in sectorial unemployment across a wide range of sectors. Appendix Table A7 (GDP and Value Added) and Table 8 (Employment and Unemployment) show the results of both the one- and two-year-ahead forecasts. These supplementary results of the two-year-ahead forecast largely align with the conclusion that narrow money has a significant future predictive ability over broad money. The two-year forecast results particularly show a stronger predictive ability of narrow over broad money for sectorial unemployment rates. Appendix Figures A1 to A7 trace out the parameter estimates for each forecast horizon from $h = 0, 1, 2, \ldots 8$ with their respective 90% confidence intervals for each predictor variable for the aggregate and sectorial economic activity measures. These results affirms the conclusions drawn based on the one-year-ahead results.

Considering the contemporary sample period spanning from 2005 to 2022, both the Granger causality analysis and the forecasting regression results consistently favor narrow Divisia monetary aggregates as having relatively more information content for predicting aggregate and sectorial economic and labor market activities. Narrow money, in particular, appears to have more predictive power than the traditional Fed funds rate within this recent sample period. This finding is consistent with those of Belongia and Ireland (2015) and Dery and Serletis (2021b), who established that narrow Divisia money at the aggregate level outperforms the Fed funds rate in terms of informativeness for the sample period from 2000 to 2018.

5. Structural VAR analysis

In this section, I introduce a 4-variable VAR model to identify an aggregate monetary policy shock and analyze its impact on sectorial real GDP. The identification process sequentially incorporates each category of narrow and broad Divisia money measures to capture their role and importance in monetary policy identification and to assess the diverse sectorial responses to this aggregate shock.

Consider a standard structural VAR model of the form

$$\boldsymbol{A}\boldsymbol{Z}_t' = \boldsymbol{\Gamma}_0 + \sum_{k=1}^{p} \boldsymbol{Z}_{t-k}'\boldsymbol{\Gamma}_k + \boldsymbol{\varepsilon}_t' \tag{4}$$

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table 11. One-year-ahead forecasting regression results for employment and unemployment rate

	Fed Funds rate	Divisia M1	Divisia M4	Divisia M1A	Divisia M4A	Divisia M1AI	Divisia M4AI
A. Aggregate and Sectorial employment							
Aggregate	−0.746***	0.300***	0.153*	0.370***	0.149*	0.329***	0.145*
Agriculture	−1.206***	0.140**	−0.184**	0.176*	−0.201**	0.156*	0.145*
Construction	−1.786***	0.399***	0.082	0.507***	0.073	0.459***	0.145*
Education	−0.237	0.139**	0.044	0.234**	0.041	0.195**	0.014
Finance	−0.619***	0.144***	0.051	0.202***	0.066	0.179***	0.068
Hospitality	−1.902***	0.957***	0.340	1.205***	0.318	1.035***	0.197
Information	−0.885***	0.433***	0.371***	0.592***	0.400***	0.530***	0.440***
Manufacturing	−1.160***	0.323***	0.057	0.436***	0.073	0.329***	0.145*
Mining	0.112	0.193	−0.211	0.244	−0.259	0.215	−0.383
Professional and business service	−1.145***	0.350***	0.149*	0.437***	0.149	0.329***	0.145*
Retail trade	−0.928***	0.246***	0.091	0.243***	0.071	0.243***	0.038
Transportation and warehousing	−0.972***	0.382***	0.289***	0.500***	0.298***	0.456***	0.332***
Utilities	−0.113**	0.037***	0.024	0.069***	0.035**	0.068***	0.067***
Wholesale trade	−0.723***	0.257***	0.155**	0.346***	0.164**	0.311***	0.181**
B. Aggregate and Sectorial unemployment							
Aggregate	0.272	−0.153***	−0.157***	−0.246***	−0.180***	−0.222***	−0.192***
Agriculture	0.201	−0.074	−0.019	−0.192***	−0.082	−0.171***	−0.192***
Construction	0.726***	−0.221***	−0.121	−0.388***	−0.190*	−0.351***	−0.192***
Education	0.043	−0.078***	−0.096***	−0.142***	−0.109***	−0.130***	−0.120***
Finance	0.726***	−0.221***	−0.121	−0.388***	−0.190*	−0.351***	−0.268**
Hospitality	0.009	−0.108	−0.132	−0.308*	−0.147	−0.271*	−0.161
Information	0.166	−0.124***	−0.119**	−0.230***	−0.150**	−0.208***	−0.181***
Manufacturing	0.385**	−0.160***	−0.108	−0.263***	−0.139*	−0.222***	−0.192***
Mining	−0.797***	0.082	−0.018	−0.012	−0.045	0.002	−0.053
Professional and business service	0.358**	−0.143***	−0.105*	−0.240***	−0.145**	−0.222***	−0.192***
Retail trade	0.203	−0.127***	−0.127**	−0.228***	−0.152***	−0.207***	−0.175***
Transportation and warehousing	0.119	−0.131**	−0.114*	−0.261***	−0.137**	−0.232***	−0.149**
Utilities	−0.006	−0.019	−0.016	−0.075**	−0.044	−0.064**	−0.064
Wholesale trade	0.240**	−0.120***	−0.121***	−0.196***	−0.142***	−0.174***	−0.149***

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

where $\boldsymbol{Z}_t'$ is a $n \times 1$ vector of the relevant variables, $\boldsymbol{A}$ is a $n \times n$ matrix of contemporaneous coefficients, $\boldsymbol{\Gamma}_0$ is a $n \times 1$ vector of constants, $\boldsymbol{\Gamma}_k$, $k = 1, \ldots, p$, are $n \times n$ matrices of slope coefficients, and $\boldsymbol{\varepsilon}_t'$ is a $n \times 1$ vector of structural disturbances with variance-covariance matrix $\boldsymbol{D}$. Express equation (4) compactly as

$$\boldsymbol{A}\boldsymbol{Z}_t' = \boldsymbol{X}_t'\boldsymbol{B} + \boldsymbol{\varepsilon}_t' \tag{5}$$

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

with $\boldsymbol{B} = \left[\boldsymbol{B}_1^{'}, \ldots, \boldsymbol{B}_p^{'}, \boldsymbol{\Gamma}_0^{'}\right]$ and $\boldsymbol{X}_t^{'} = \left[\boldsymbol{Z}_{t-1}^{'}, \ldots, \boldsymbol{Z}_{t-p}^{'}, \mathbf{1}\right]$, such that the reduced-form VAR is

$$\boldsymbol{Z}_t^{'} = \boldsymbol{X}_t^{'}\boldsymbol{\Phi} + \boldsymbol{u}_t^{'} \tag{6}$$

where $\boldsymbol{\Phi} = \boldsymbol{B}\boldsymbol{A}^{-1}$, $\boldsymbol{u}_t^{'} = \boldsymbol{\varepsilon}_t^{'}\boldsymbol{A}^{-1}$, and $E\left[\boldsymbol{u}_t\boldsymbol{u}_t^{'}\right] = \boldsymbol{\Omega}$.

The model as succinctly presented in equation 4 to 6 is identified using a penalty function approach similar to Caldara et al. (2016) and Dery and Serletis (2023) among others. With this approach, the structural parameters in $\boldsymbol{A}, \boldsymbol{B}$, and $\boldsymbol{D}$ are identified by maximizing a criterion function subject to inequality constraint(s). The criterion function comprises the summation of impulse responses for target variables, while the inequality constraints specify predefined sign restrictions on these responses within a specific period. Specifically, with a 4-variable VAR comprising of real GDP growth rate, inflation, Divisia money growth rate, and interest rate, a contractionary monetary policy shock is identified as an innovation that leads to the largest increase in the interest rate with a simultaneous decrease in real GDP growth, inflation, and money growth for three consecutive quarters. The penalty function that identifies shock is

$$\boldsymbol{\Psi}\left(\boldsymbol{s}_1\right) = \sum_{\gamma=1}^{3}\sum_{h=0}^{3}\left(\frac{-\boldsymbol{e}_\gamma^{'}\boldsymbol{L}_h\left(\boldsymbol{T}^{-1}, \boldsymbol{\Phi}\boldsymbol{T}^{-1}\right)\boldsymbol{s}_1}{\omega_\gamma}\right) + \sum_{h=0}^{3}\left(\frac{\boldsymbol{e}_4^{'}\boldsymbol{L}_h\left(\boldsymbol{T}^{-1}, \boldsymbol{\Phi}\boldsymbol{T}^{-1}\right)\boldsymbol{s}_1}{\omega_4}\right) \tag{7}$$

with

$$\begin{aligned}
&\boldsymbol{e}_1^{'}\boldsymbol{L}_h\left(\boldsymbol{T}^{-1}, \boldsymbol{\Phi}\boldsymbol{T}^{-1}\right)\boldsymbol{s}_1 < 0, \text{ for } h = 0, 1, 2, 3\\
&\boldsymbol{e}_2^{'}\boldsymbol{L}_h\left(\boldsymbol{T}^{-1}, \boldsymbol{\Phi}\boldsymbol{T}^{-1}\right)\boldsymbol{s}_1 < 0, \text{ for } h = 0, 1, 2, 3\\
&\boldsymbol{e}_3^{'}\boldsymbol{L}_h\left(\boldsymbol{T}^{-1}, \boldsymbol{\Phi}\boldsymbol{T}^{-1}\right)\boldsymbol{s}_1 < 0, \text{ for } h = 0, 1, 2, 3\\
&\boldsymbol{e}_4^{'}\boldsymbol{L}_h\left(\boldsymbol{T}^{-1}, \boldsymbol{\Phi}\boldsymbol{T}^{-1}\right)\boldsymbol{s}_1 > 0, \text{ for } h = 0, 1, 2, 3
\end{aligned}$$

representing the constraints on real GDP growth, inflation, Divisia money growth, and interest rates. The model is estimated using Bayesian methods, with each estimation conducted separately using a different Divisia money measure to capture the role of alternative Divisia money measures in the identification of monetary policy shock.

Figures 7 and 8 present the impulse responses to a contractionary monetary policy shock using Divisia M1 (Figure 7) and M4 (Figure 8) in the identification of the shock. The responses of these macroeconomic variables are consistent with empirical evidence on the effects of a contractionary monetary policy shock, thus validating the identified shock. Appendix Figures A8 to A11 show similar results for both narrow and broad credit card-augmented and credit card-augmented inside money measures.

Figures 9 and 10 present the responses of real GDP in the largest sector (manufacturing - Figure 9) and the smallest sector (utilities - Figure 10) to the identified monetary policy shock.[8] For the manufacturing sector, the monetary policy shock generates a statistically significant reduction in real GDP growth rate when the policy identification includes a narrow Divisia measure. In the utilities sector, the results are relatively similar, except with Divisia M4.

Lastly, Figure 11 compares the responses of the largest sector (manufacturing), the smallest sector (utilities), and the aggregate economy to the monetary policy shock for each category of Divisia money. The results show that the effects of the monetary policy shock are more pronounced and persistent in the manufacturing sector when the policy identification includes narrow Divisia money. In the utilities sector, the responses are generally more pronounced than the aggregate responses and are relatively larger in magnitude compared to the manufacturing sector.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

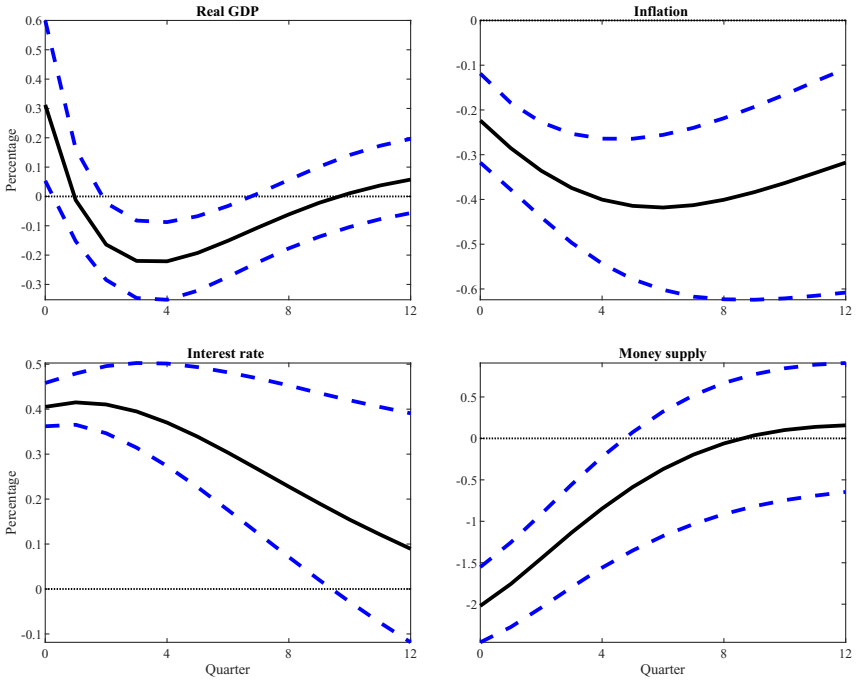

Figure 7. Responses of macroeconomic variables to contractionary monetary policy shock with Divisia M1 in identification. Black solid line is the median response while blue dashed lines are 68% credibility region.

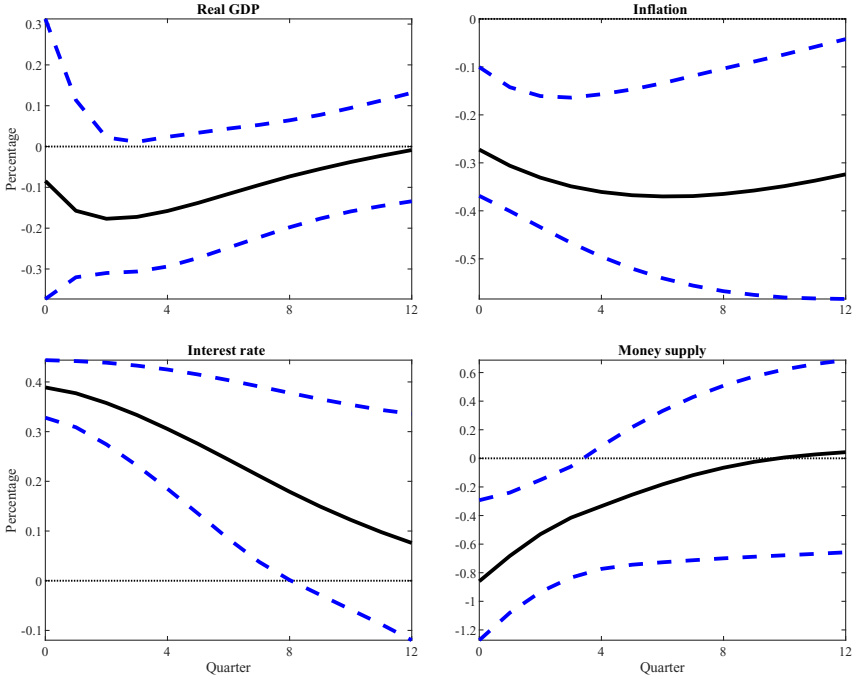

Figure 8. Responses of macroeconomic variables to contractionary monetary policy shock with Divisia M4 in identification. Black solid line is the median response while blue dashed lines are 68% credibility region.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

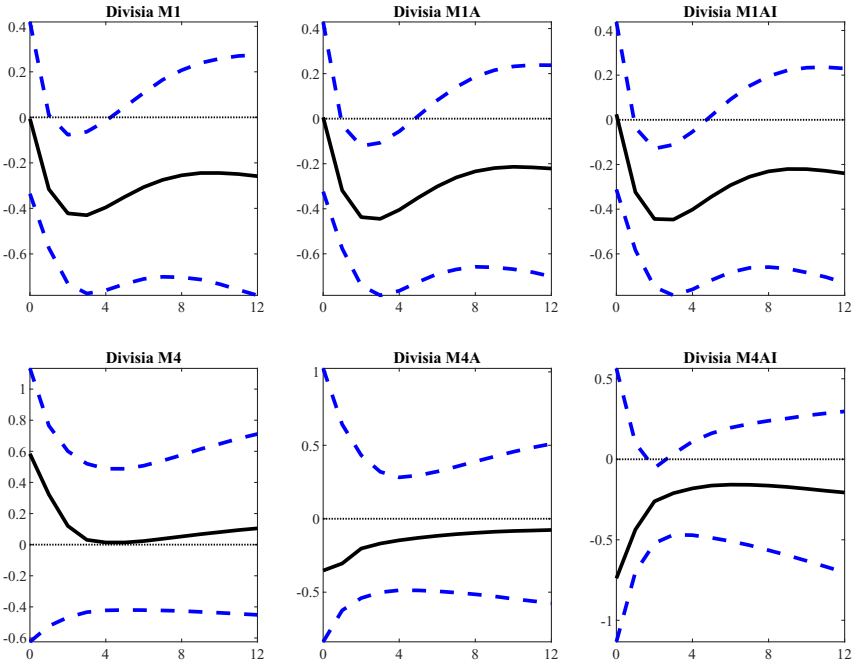

Figure 9. Responses of manufacturing sector real GDP to contractionary monetary policy shock with narrow and broad Divisia in identification. Black solid line is the median response while blue dashed lines are 68% credibility region.

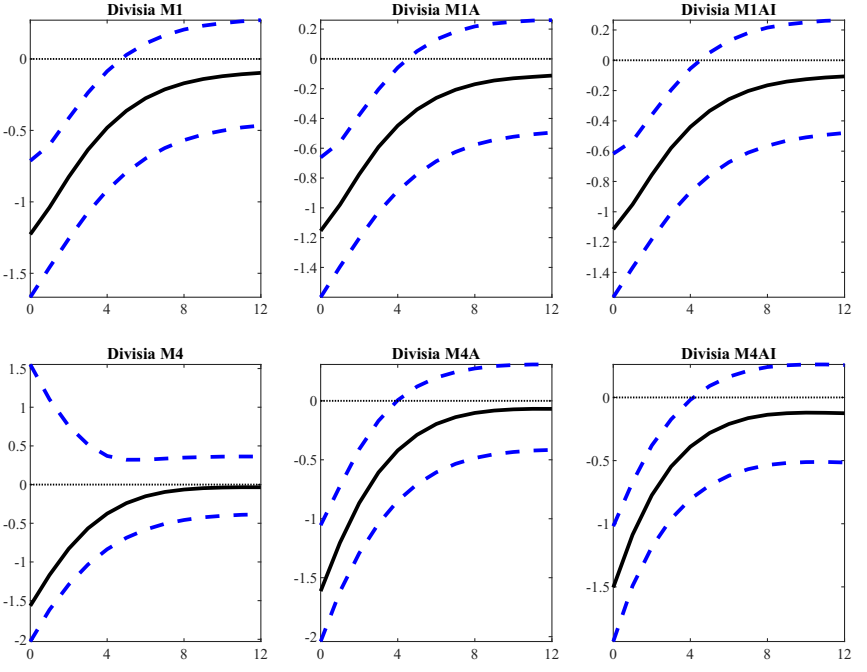

Figure 10. Responses of utilities sector real GDP to contractionary monetary policy shock with narrow and broad Divisia in identification. Black solid line is the median response while blue dashed lines are 68% credibility region.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

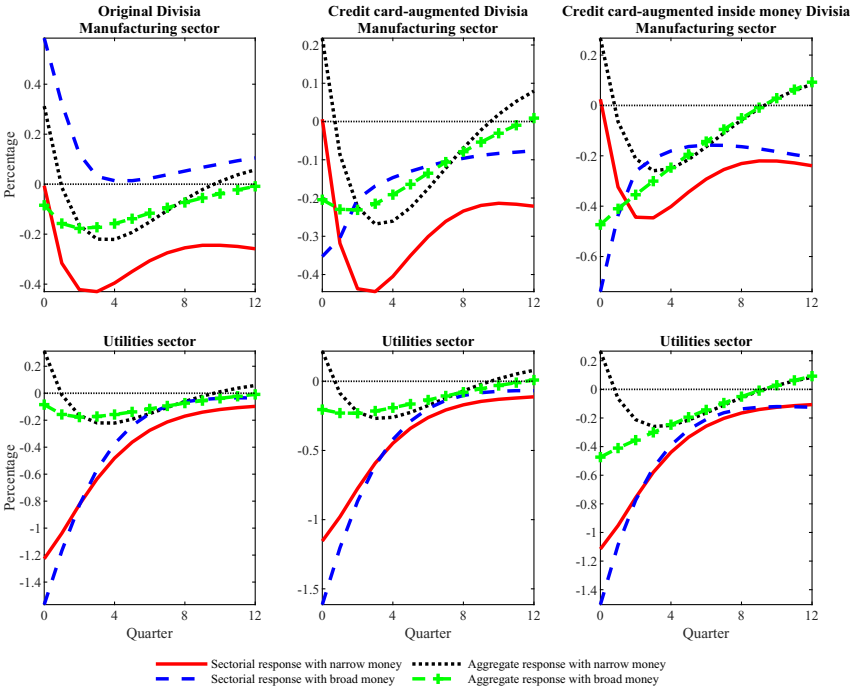

Figure 11. Comparison of largest sector (manufacturing) and smallest sector (utilities) real GDP responses aggregate responses with narrow and broad Divisia in identification.

6. Conclusion

This study explores the behavior and predictive capabilities of narrow and broad Divisia monetary aggregates in relation to sectorial economic and labor market indicators. To accomplish this, I employ quarterly data spanning from 2005Q1 to 2022Q4 to scrutinize the information content and predictive performance of seven policy-related variables across thirteen sectors/industries within the United States (US). This exploration proceeds in four sequential steps.

Firstly, the study investigates the cyclical dynamics of Divisia money aggregates and their correlations with sectorial economic activity indicators. In this pursuit, I adopt the approach laid out by Kydland and Prescott (1990) and apply a regression-based filter as proposed by Hamilton (2018) to isolate the cyclical components of these monetary aggregates and sectorial economic activity indicators. I then assess the cyclical correlation and co-movement of money measures with those sectorial economic indicators. I make comparisons between and within three categories of narrow and broad Divisia monetary aggregates; the original Divisia aggregates (Divisia M1 and M4), credit cards augmented Divisia (Divisia M1A and M4A), and credit cards augmented inside money Divisia (Divisia M1AI and M4AI), as well as the traditional Federal funds rate, in order to discern their cyclical characteristics. The analysis shows that both narrow and broad Divisia money measures are more effective leading indicators of sectorial economic and labor market activities than the traditional Fed funds rate. Divisia M4 is favored in more sectors than Divisia M1, while Divisia M1A and M1AI consistently outperform their broad counterparts.

Secondly, following the approach inspired by Bernanke and Blinder (1992), Belongia and Ireland (2015), and Dery and Serletis (2021b), I employ the concept of Granger causality, as outlined by Granger (1969), to evaluate the information content of the Federal funds rate, narrow, and broad Divisia monetary aggregates in terms of their ability to predict sectorial economic and labor market indicators. The findings here reveal that Divisia money measures exhibit relatively

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

higher levels of informativeness compared to the Federal funds rate when it comes to predicting sectorial real GDP, value added, employment, and unemployment rates. Specifically, the Fed funds rate has predictive information for these economic and labor market indicators in at most 6 out of 13 sectors. In contrast, narrow Divisia money (M1, M1A, and M1AI) predicts at least 10 out of 13 sectors, up to a maximum of 13. Broad Divisia measures (M4, M4A, and M4AI) predict at least 5 out of 13 sectors, up to a maximum of 12. Furthermore, the presence of a short-term interest rate does not absorb the information content of both narrow and broad Divisia money when predicting sectorial economic activity.

Thirdly, within the framework of a forecasting regression analysis, similar to the methodology employed by Caldara et al. (2016) and Dery and Serletis (2021a), I evaluate the ability of changes in the growth rate of narrow and broad money measures to predict changes in the growth rate of specific sectorial economic activity indicators up to two years in advance. This analysis leads to the conclusion that narrow Divisia money measures exhibit greater effectiveness in forecasting sectorial economic activity indicators when compared to their broad money counterparts. The statistical and economic significance of the forecasted results are more pronounced and persistent, as well as mostly in line with economic theory and expectations when using narrow measures.

Lastly, a 4-variable structural VAR model is used to identify the monetary policy shock, with each narrow and broad Divisia money measure entering the identification sequentially. The sectorial real GDP responses to the identified monetary policy shock for the largest sector (manufacturing) and the smallest sector (utilities) are presented, demonstrating heterogeneous responses across sectors. In the largest sector, the monetary policy shock produces more pronounced and persistent effects when identified with narrow Divisia money compared to broad money. In the smallest sector, the responses to the shock are relatively similar regardless of whether narrow or broad Divisia money is used in the identification.

The results indicate that Divisia money measures, particularly narrow ones, are strong predictors of sectorial real GDP, value added, employment, and unemployment rates across various sectors. They often outperform the traditional Fed funds rate in terms of informativeness. The analysis remains robust when considering alternative data transformations, reinforcing the reliability of Divisia money measures in forecasting economic activities. Overall, the study highlights the contemporary relevance of narrow Divisia monetary aggregates in forecasting sectorial economic and labor market indicators across various sectors. These findings emphasize the significance of incorporating these measures in economic analysis and policy-making.

Notes

1 Some examples of studies demonstrating the significant information content and superiority of these Divisia money measures over simple sum as well as studies showing the strong connection of money with economic activity are Barnett and Chauvet (2011), Hendrickson (2014), Serletis and Gogas (2014), Belongia and Ireland (2014, 2015, 2016), Ellington (2018), Dai and Serletis (2019), Serletis and Xu (2020, 2021), Dery and Serletis (2021b), and Xu and Serletis (2022). In this paper, I generally use the terms "information content" and "predictive ability or power" interchangeably. Although these terms are used variably in the literature, in this context, "information content" refers to either indicating a Granger causal relationship or the capability to forecast another variable in a regression context. When used in the context of SVAR, it generally denotes the information that a particular policy variable provides for a structural interpretation of the transmission mechanism of monetary policy.

2 The sample period is truncated to 2006Q3 for all variables when credit card-augmented Divisia and credit card-augmented inside money Divisia measures are used in the analysis, as these measures are only available from 2006Q3.

3 https://centerforfinancialstability.org/

4 see Barnett and Chauvet (2011), Hendrickson (2014), Serletis and Gogas (2014), Belongia and Ireland (2014, 2015, 2016), Ellington (2018), Dai and Serletis (2019), Serletis and Xu (2020, 2021), and Xu and Serletis (2022) among others where there is general consensus on the superiority of Divisia money over simple sum money measures.

5 Conducting the Granger causality test on filtered data obtained using the Hamilton (2018) filter does not significantly alter the conclusions made based on analysis with level data. The results of the causality on cyclical data generally shows that narrow money have more predictive power at both the aggregate and sectorial level than Fed funds rate. Also, within

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

each category of Divisia, narrow money generally have more predictive ability than their broad counterparts. See Appendix Table A4 for these additional results.

6 Appendix Table A5 contains the detailed causality results for Table 9 panel A.

7 Appendix Table A6 contains the detailed causality test results for Table 9 panel B.

8 Although it is possible to estimate and present the results for each of the 13 sectors' responses to the aggregate shock, only the responses of the largest and smallest sectors are presented for brevity.

References

Barnett, W. (1980) Economic monetary aggregates: An application of index number and aggregation theory. *Journal of Econometrics* 14(1), 11–48.

Barnett, W. (2016) Friedman and divisia monetary measures. In: Barnett, W. (eds.), *Milton Friedman: Contributions to Economics and Public Policy*, pp. 265–291. Oxford University Press.

Barnett, W. A. and L. Su. (2017) Data sources for the credit-card augmented divisia monetary aggregates. *Research in International Business and Finance* 39, 899–910.

Barnett, W. A. and L. Su. (2020) Financial firm production of inside monetary and credit card services: An aggregation theoretic approach. *Macroeconomic Dynamics* 24(1), 130–160.

Barnett, W. A., J. Liu, R. S. Mattson and J. Van Den Noort. (2013) The new cfs divisia monetary aggregates: Design, construction, and data sources. *Open Economies Review* 24(1), 101–124.

Barnett, W. A. and M. Chauvet. (2011) How better monetary statistics could have signaled the financial crisis. *Journal of Econometrics* 161(1), 6–23.

Belongia, M. T. and P. N. Ireland. (2014) The barnett critique after three decades: A new keynesian analysis. *Journal of Econometrics* 183(1), 5–21.

Belongia, M. T. and P. N. Ireland. (2015) Interest rates and money in the measurement of monetary policy. *Journal of Business and Economic Statistics* 33(2), 255–269.

Belongia, M. T. and P. N. Ireland. (2016) Money and output: Friedman and schwartz revisited. *Journal of Money, Credit and Banking* 48(6), 1223–1266.

Belongia, M. and P. Ireland. (2018) Targeting constant money growth at the zero lower bound. *International Journal of Central Banking* 14, 159–204.

Bernanke, B. and A. Blinder. (1992) The federal funds rate and the channels of monetary transmission. *American Economic Review* 82, 901–921.

Caldara, D., C. Fuentes-Albero, S. Gilchrist and E. Zakrajšek. (2016) The macroeconomic impact of financial and uncertainty shocks. *European Economic Review* 88, 185–207.

Christiano, L. and L. Ljungqvist. (1988) Money does granger-cause output in the bivariate money-output relation. *Journal of Monetary Economics* 22, 217–235.

Dai, W. and A. Serletis. (2019) On the markov switching welfare cost of inflation. *Journal of Economic Dynamics and Control* 108, 103748.

Dery, C. and A. Serletis. (2021a). Disentangling the effects of uncertainty, monetary policy and leverage shocks on the economy. *Oxford Bulletin of Economics and Statistics* 83(5), 1029–1065.

Dery, C. and A. Serletis. (2021b). Interest rates, money, and economic activity. *Macroeconomic Dynamics* 25(7), 1842–1891.

Dery, C. and A. Serletis. (2023) Macroeconomic fluctuations in the United States: The role of monetary and fiscal policy shocks. *Open Economies Review* 34(5), 961–977.

Ellington, M. (2018) The case for divisia monetary statistics: A bayesian time-varying approach. *Journal of Economic Dynamics and Control* 96, 26–41.

Friedman, B. and K. Kuttner. (1992) Money, income, prices, and interest rates. *American Economic Review* 82, 472–492.

Granger, C. W. J. (1969) Investigating causal relations by econometric models and cross-spectral methods. *Econometrica* 37(3), 424–443.

Hamilton, J. D. (2018) Why you should never use the hodrick-prescott filter. *The Review of Economics and Statistics* 100(5), 831–843.

Hendrickson, J. (2014) Redundancy or mismeasurement? A reappraisal of money. *Macroeconomic Dynamics* 18(7), 1437–1465.

Jadidzadeh, A. and A. Serletis. (2019) The demand for assets and optimal monetary aggregation. *Journal of Money, Credit and Banking* 51(4), 929–952.

Keating, J., L. Kelly, A. Smith and V. Valcarcel. (2019) A model of monetary policy shocks for financial crises and normal conditions. *Journal of Money, Credit and Banking* 51(1), 227–259.

Kydland, F. and E. Prescott. (1990) Business cycles: Real facts and a monetary myth. *Federal Reserve Bank of Minneapolis Quarterly Review* 14, 383–398.

Leeper, E. M. and J. E. Roush. (2003) Putting "m" back in monetary policy. *Journal of Money, Credit, and Banking* 35(6), 1217–1256.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Litterman, R. and L. Weiss. (1985) Money, real interest rates and output: A reinterpretation of postwar us data. *Econometrica* 53(1), 129–156.
Liu, J., C. Dery and A. Serletis. (2020) Recent monetary policy and the credit card-augmented divisia monetary aggregates. *Journal of Macroeconomics* 64, 103203.
Serletis, A. and L. Xu. (2020) Functional monetary aggregates, monetary policy, and business cycles. *Journal of Economic Dynamics and Control* 121, 103994.
Serletis, A. and L. Xu. (2021) The welfare cost of inflation. *Journal of Economic Dynamics and Control* 128, 104144.
Serletis, A. and P. Gogas. (2014) Divisia monetary aggregates, the great ratios, and classical money demand functions. *Journal of Money, Credit and Banking* 46(1), 229–241.
Sims, C. (1980) Comparison of interwar and postwar business cycles. *American Economic Review* 70, 250–257.
Taylor, J. (1993) Discretion versus policy rules in practice. *Carnegie-Rochester Conference Series on Public Policy* 39, 195–214.
Wu, J. C. and F. D. Xia. (2016) Measuring the macroeconomic impact of monetary policy at the zero lower bound. *Journal of Money, Credit and Banking* 48(2-3), 253–291.
Xu, L. and A. Serletis. (2022) The demand for assets: Evidence from the markov switching normalized quadratic model. *Journal of Money, Credit and Banking* 54(4), 989–1025.

Appendix

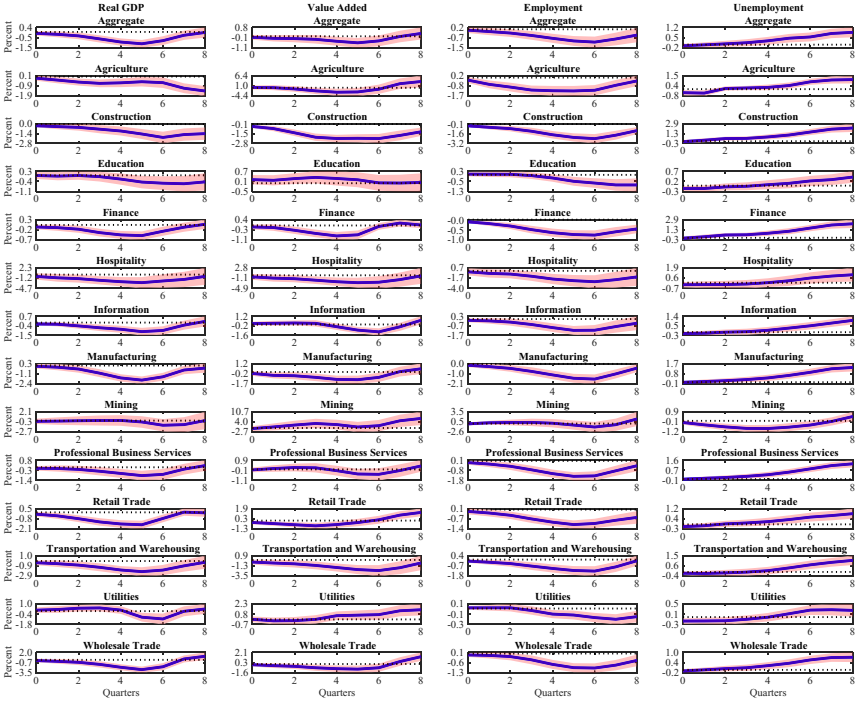

Figure A1. Forecasting regression with fed funds rate.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

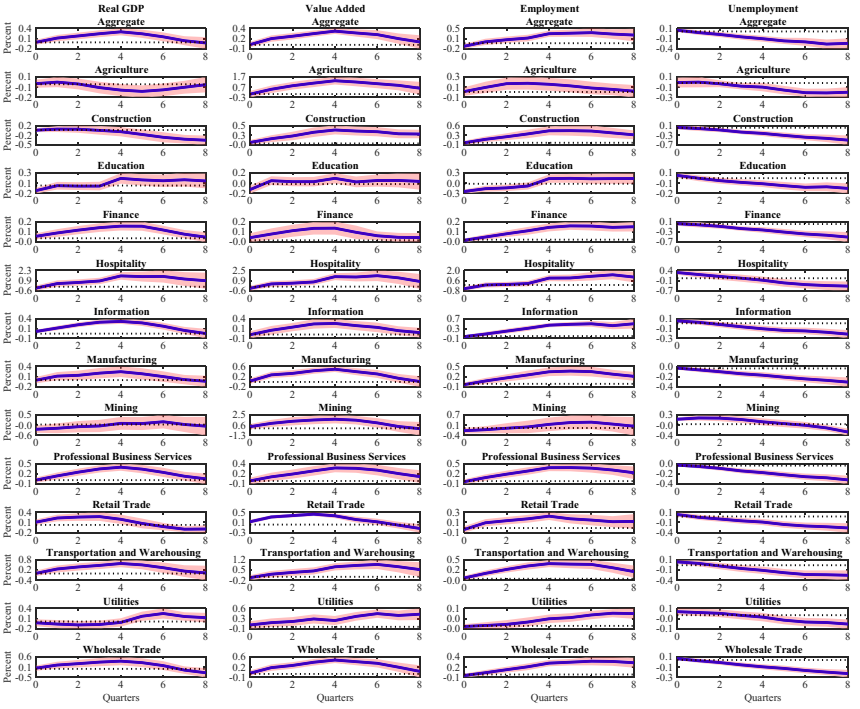

Figure A2. Forecasting regression results with Divisia M1.

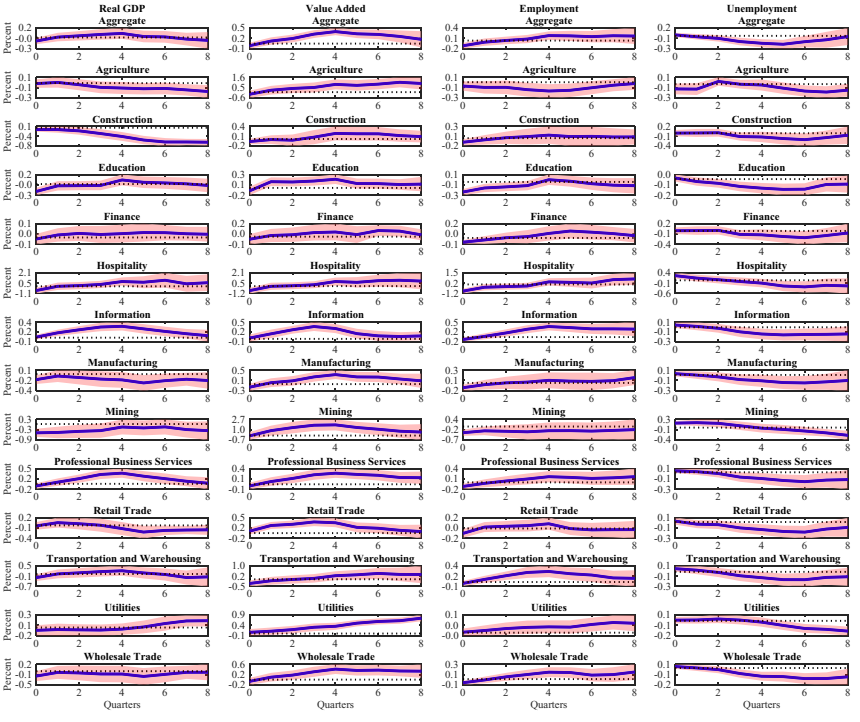

Figure A3. Forecasting regression results with Divisia M4.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table A1. Cyclical correlations between predictors and sectorial economic activity

$\rho(x_t,\ y_{t+j})$, j = -8, -4, 0, 4, 8										
	A. Sectorial Ral GDP					B. Sectorial real Value added				
	$j=$-8	$j=-4$	$j=0$	$j=4$	$j=8$	$j=-8$	$j=-4$	$j=0$	$j=4$	$j=8$
Fed funds rate										
Aggregate	−0.37	−0.31	0.15	0.10	−0.03	−0.20	−0.29	0.26	0.07	−0.16
Agriculture	−0.22	−0.11	−0.19	0.27	0.55	−0.09	−0.44	−0.01	−0.04	−0.09
Construction	0.02	0.30	0.02	0.04	0.23	−0.19	−0.19	0.20	0.10	0.10
Education	−0.29	0.02	0.51	0.44	−0.08	0.15	0.16	0.43	0.36	−0.02
Finance	−0.33	−0.36	−0.10	−0.23	−0.05	−0.32	−0.33	0.10	−0.09	−0.10
Hospitality	−0.32	−0.23	0.24	0.43	−0.15	−0.38	−0.27	0.23	0.37	−0.14
Information	−0.42	−0.42	0.26	0.29	0.03	−0.21	−0.06	0.24	0.30	0.38
Manufacturing	−0.19	−0.06	0.44	0.23	0.19	−0.20	−0.33	0.24	0.01	−0.26
Mining	0.00	−0.03	−0.05	−0.09	−0.27	−0.17	−0.44	−0.28	−0.22	−0.32
Professional and business service	−0.28	−0.21	0.17	0.13	−0.09	−0.11	−0.10	0.34	0.10	−0.13
Retail trade	−0.29	−0.29	0.01	0.13	0.16	−0.26	−0.53	−0.22	−0.06	−0.11
Transportation and warehousing	−0.28	−0.23	0.26	0.23	−0.10	−0.41	−0.30	0.36	0.22	−0.13
Utilities	−0.04	−0.13	0.28	0.18	0.13	0.19	−0.16	0.26	0.13	−0.13
Wholesale trade	−0.16	−0.31	0.02	−0.02	−0.14	−0.11	−0.41	0.00	−0.14	−0.24
Divisia M1										
Aggregate	0.37	0.44	−0.11	−0.28	−0.16	0.28	0.47	−0.15	−0.26	−0.01
Agriculture	0.12	−0.03	0.03	−0.30	−0.54	0.12	0.71	0.45	0.08	−0.02
Construction	−0.10	−0.28	−0.09	0.22	0.09	0.18	0.32	−0.01	−0.09	−0.11
Education	0.21	−0.01	−0.60	−0.61	−0.11	−0.21	−0.12	−0.29	−0.23	0.09
Finance	0.33	0.51	0.21	0.09	−0.06	0.32	0.34	−0.08	−0.12	−0.03
Hospitality	0.25	0.37	−0.27	−0.60	−0.15	0.32	0.41	−0.26	−0.59	−0.19
Information	0.39	0.58	−0.07	−0.48	−0.41	0.21	0.19	−0.23	−0.34	−0.36
Manufacturing	0.14	0.13	−0.41	−0.46	−0.15	0.28	0.50	−0.09	−0.17	0.08
Mining	0.15	0.06	−0.25	−0.06	0.33	0.22	0.68	0.33	0.04	0.11
Professional and business service	0.34	0.38	−0.16	−0.27	−0.11	0.20	0.32	−0.20	−0.22	−0.01
Retail trade	0.15	0.30	0.10	−0.17	−0.22	0.20	0.66	0.51	0.11	−0.12
Transportation and warehousing	0.29	0.37	−0.20	−0.39	−0.10	0.41	0.45	−0.34	−0.49	−0.15
Utilities	0.09	0.18	−0.28	−0.27	−0.02	−0.15	0.32	0.20	0.13	0.18
Wholesale trade	0.15	0.48	0.17	−0.03	−0.02	0.20	0.63	0.26	0.13	0.13
Divisia M4										
Aggregate	−0.31	−0.44	−0.38	0.15	0.42	−0.22	−0.08	−0.01	0.24	0.28
Agriculture	−0.24	−0.13	−0.14	−0.19	0.03	0.00	0.14	−0.16	−0.04	0.15
Construction	−0.23	−0.27	0.23	0.52	0.31	−0.14	−0.30	−0.35	0.21	0.44
Education	0.15	0.00	−0.42	−0.20	0.27	0.39	0.58	0.15	−0.09	0.03
Finance	−0.38	−0.39	−0.19	0.21	0.24	−0.30	−0.58	−0.38	0.19	0.38

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table A1. Continued

$\rho(x_t, y_{t+j})$, j = -8, -4, 0, 4, 8										
	A. Sectorial Ral GDP					B. Sectorial real Value added				
	j=-8	$j=-4$	$j=0$	$j=4$	$j=8$	$j=-8$	$j=-4$	$j=0$	$j=4$	$j=8$
Hospitality	−0.18	−0.06	−0.35	−0.18	0.40	−0.17	−0.08	−0.38	−0.21	0.32
Information	−0.12	−0.13	−0.22	−0.06	0.13	−0.06	0.25	0.42	0.23	−0.06
Manufacturing	−0.18	−0.26	−0.10	0.29	0.51	−0.18	−0.29	−0.34	0.18	0.42
Mining	−0.31	−0.36	−0.35	0.21	0.56	−0.01	0.12	−0.19	−0.27	−0.04
Professional and business service	−0.34	−0.35	−0.14	0.25	0.33	−0.19	0.03	0.22	0.35	0.19
Retail trade	−0.16	−0.45	−0.43	−0.01	0.38	−0.15	−0.17	−0.28	−0.13	0.10
Transportation and warehousing	−0.30	−0.34	−0.32	0.13	0.49	−0.12	−0.21	−0.42	0.00	0.36
Utilities	0.09	0.06	0.05	0.21	0.27	0.64	0.65	0.02	−0.13	−0.08
Wholesale trade	−0.23	−0.42	−0.31	0.12	0.36	−0.12	0.01	0.02	0.19	0.14
Divisia M1A										
Aggregate	0.18	0.35	0.10	−0.23	−0.20	0.10	0.52	0.19	−0.24	−0.06
Agriculture	0.29	−0.07	−0.10	−0.29	−0.62	−0.07	0.61	0.59	0.16	−0.02
Construction	−0.23	−0.35	−0.02	0.31	0.12	0.01	0.22	0.09	−0.04	−0.11
Education	0.24	0.04	−0.50	−0.67	−0.17	−0.12	−0.03	−0.22	−0.29	0.04
Finance	0.13	0.43	0.38	0.17	−0.05	0.24	0.27	0.04	−0.09	−0.06
Hospitality	0.20	0.35	−0.08	−0.62	−0.22	0.26	0.41	−0.07	−0.60	−0.26
Information	0.23	0.54	0.22	−0.42	−0.49	0.16	0.32	0.07	−0.34	−0.47
Manufacturing	0.10	0.05	−0.21	−0.43	−0.22	0.08	0.44	0.15	−0.15	0.06
Mining	0.07	0.05	−0.22	−0.13	0.32	0.15	0.61	0.49	0.06	0.09
Professional and business service	0.11	0.34	0.14	−0.22	−0.16	−0.02	0.43	0.16	−0.23	−0.06
Retail trade	0.09	0.11	0.16	−0.07	−0.29	0.04	0.51	0.65	0.23	−0.12
Transportation and warehousing	0.12	0.31	0.02	−0.36	−0.16	0.30	0.43	−0.11	−0.49	−0.18
Utilities	0.06	0.14	−0.08	−0.27	−0.07	−0.18	0.30	0.24	0.13	0.16
Wholesale trade	−0.06	0.30	0.38	0.08	−0.03	−0.03	0.57	0.53	0.20	0.14
Divisia M4A										
Aggregate	0.06	−0.10	−0.46	0.10	0.36	−0.04	0.06	−0.26	0.09	0.35
Agriculture	−0.19	0.10	0.17	−0.14	−0.33	0.01	0.32	−0.06	0.07	0.16
Construction	−0.01	−0.29	−0.11	0.43	0.32	0.14	−0.04	−0.43	0.25	0.32
Education	0.27	0.09	−0.43	−0.34	0.12	0.12	0.35	0.06	−0.27	−0.03
Finance	−0.16	−0.09	−0.18	0.31	0.29	0.02	−0.26	−0.46	0.19	0.39
Hospitality	0.03	0.14	−0.32	−0.27	0.27	0.05	0.15	−0.32	−0.27	0.22
Information	0.17	0.16	−0.32	−0.17	0.07	0.06	0.29	0.09	−0.05	−0.09
Manufacturing	−0.04	0.04	−0.39	−0.04	0.36	0.04	−0.04	−0.46	0.12	0.44
Mining	−0.10	−0.20	−0.39	0.23	0.57	−0.08	0.36	−0.06	−0.18	0.16

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table A1. Continued

	$\rho(x_t, y_{t+j})$, j = -8, -4, 0, 4, 8									
	A. Sectorial Ral GDP					B. Sectorial real Value added				
	j = -8	$j=-4$	$j=0$	$j=4$	$j=8$	$j=-8$	$j=-4$	$j=0$	$j=4$	$j=8$
Professional and business service	0.03	−0.16	−0.37	0.15	0.36	−0.06	0.00	−0.16	0.17	0.33
Retail trade	0.06	0.00	−0.40	−0.02	0.26	0.00	0.14	−0.09	0.06	0.13
Transportation and warehousing	0.03	−0.07	−0.43	0.03	0.40	0.12	0.10	−0.50	−0.11	0.30
Utilities	0.12	0.29	−0.33	−0.07	0.31	0.35	0.56	−0.05	−0.18	−0.01
Wholesale trade	0.00	−0.08	−0.42	0.12	0.39	−0.03	0.15	−0.10	0.20	0.30
Divisia M1AI										
Aggregate	0.18	0.37	0.13	−0.19	−0.18	0.10	0.53	0.21	−0.22	−0.05
Agriculture	0.32	−0.04	−0.07	−0.28	−0.62	−0.09	0.61	0.59	0.18	−0.01
Construction	−0.22	−0.35	0.00	0.32	0.11	0.02	0.23	0.12	−0.01	−0.09
Education	0.26	0.05	−0.51	−0.66	−0.18	−0.10	−0.04	−0.25	−0.31	0.02
Finance	0.12	0.44	0.41	0.20	−0.04	0.23	0.28	0.08	−0.05	−0.04
Hospitality	0.21	0.37	−0.07	−0.59	−0.22	0.28	0.43	−0.05	−0.58	−0.25
Information	0.23	0.55	0.23	−0.39	−0.47	0.19	0.35	0.09	−0.32	−0.48
Manufacturing	0.12	0.08	−0.18	−0.40	−0.21	0.08	0.44	0.17	−0.12	0.07
Mining	0.07	0.07	−0.19	−0.11	0.33	0.14	0.60	0.49	0.07	0.10
Professional and business service	0.11	0.36	0.17	−0.19	−0.14	−0.01	0.45	0.18	−0.21	−0.06
Retail trade	0.09	0.12	0.19	−0.04	−0.26	0.02	0.50	0.66	0.26	−0.10
Transportation and warehousing	0.12	0.33	0.05	−0.33	−0.15	0.31	0.44	−0.09	−0.46	−0.16
Utilities	0.08	0.16	−0.07	−0.26	−0.06	−0.18	0.27	0.20	0.11	0.15
Wholesale trade	−0.08	0.30	0.41	0.11	−0.01	−0.04	0.56	0.54	0.22	0.16
Divisia M4AI										
Aggregate	0.06	0.14	0.10	0.32	0.24	−0.07	0.30	0.22	0.18	0.24
Agriculture	0.31	0.37	0.22	−0.13	−0.40	−0.15	0.34	0.24	0.24	0.17
Construction	−0.08	−0.27	0.13	0.48	0.17	0.07	0.12	0.02	0.42	0.17
Education	0.39	0.10	−0.39	−0.45	0.00	0.18	0.19	−0.25	−0.52	−0.11
Finance	−0.17	0.14	0.36	0.55	0.26	0.00	−0.03	0.11	0.43	0.32
Hospitality	0.19	0.31	0.01	−0.25	0.15	0.20	0.33	0.01	−0.24	0.12
Information	0.20	0.35	0.14	−0.04	−0.05	0.34	0.54	0.35	−0.13	−0.29
Manufacturing	0.23	0.23	−0.07	0.06	0.13	−0.09	0.11	0.05	0.31	0.37
Mining	−0.08	−0.05	−0.05	0.33	0.49	−0.15	0.35	0.15	0.05	0.30
Professional and business service	−0.01	0.08	0.18	0.31	0.23	−0.11	0.25	0.23	0.18	0.16
Retail trade	0.15	0.05	0.03	0.30	0.14	−0.16	0.20	0.33	0.35	0.17
Transportation and warehousing	0.04	0.16	0.07	0.18	0.24	0.20	0.30	−0.08	0.00	0.18
Utilities	0.23	0.36	−0.13	0.00	0.11	0.11	0.28	−0.26	−0.23	0.02
Wholesale trade	−0.19	−0.03	0.10	0.44	0.34	−0.23	0.23	0.31	0.40	0.29

Yellow = lagging, blue = Synchronous, Green = leading the cycle

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table A2. Cyclical correlations between predictors and sectorial labor market activity

$\rho(x_t, y_{t+j}), j = -8, -4, 0, 4, 8$										
	A. Sectorial Employment					B. Sectorial Unemployment				
	$j=$-8	$j=$-4	$j=0$	$j=4$	$j=8$	$j=$-8	$j=$-4	$j=0$	$j=4$	$j=8$
Fed funds rate										
Aggregate	−0.32	−0.11	0.43	0.31	0.09	0.21	0.07	−0.52	−0.41	−0.12
Agriculture	−0.44	−0.25	−0.07	−0.26	−0.14	0.11	0.00	−0.44	−0.12	−0.26
Construction	−0.06	0.02	0.43	0.24	0.09	0.27	0.18	−0.44	−0.30	−0.10
Education	−0.32	0.11	0.52	0.29	−0.06	0.19	0.03	−0.54	−0.44	−0.12
Finance	−0.23	−0.11	0.37	0.14	0.12	0.27	0.18	−0.44	−0.30	−0.10
Hospitality	−0.38	−0.13	0.36	0.32	−0.07	0.22	0.01	−0.53	−0.46	0.05
Information	−0.04	−0.02	0.57	0.37	0.15	0.20	0.07	−0.48	−0.31	−0.11
Manufacturing	−0.13	0.05	0.55	0.20	0.06	0.21	0.15	−0.41	−0.34	−0.12
Mining	−0.30	−0.21	−0.19	−0.26	−0.38	0.05	−0.19	−0.52	0.01	0.11
Professional and business service	−0.39	−0.30	0.20	0.08	0.03	0.25	0.12	−0.52	−0.35	−0.13
Retail trade	−0.32	−0.15	0.41	0.41	0.25	0.22	0.06	−0.54	−0.37	−0.13
Transportation and warehousing	−0.38	−0.30	0.20	0.14	0.05	0.24	0.04	−0.59	−0.42	−0.06
Utilities	−0.34	−0.11	0.27	0.08	−0.26	−0.05	0.06	−0.47	−0.27	−0.17
Wholesale trade	−0.15	0.00	0.58	0.32	0.17	0.21	0.13	−0.57	−0.36	−0.15
Divisia M1										
Aggregate	0.32	0.24	−0.43	−0.52	−0.22	−0.19	−0.22	0.43	0.52	0.16
Agriculture	0.48	0.24	−0.15	−0.15	−0.07	−0.04	−0.16	0.16	0.14	0.16
Construction	0.04	0.20	−0.17	−0.13	0.05	−0.25	−0.33	0.28	0.37	0.13
Education	0.30	−0.09	−0.77	−0.63	−0.11	−0.15	−0.17	0.47	0.54	0.13
Finance	0.21	0.28	−0.14	−0.15	−0.10	−0.25	−0.33	0.28	0.37	0.13
Hospitality	0.35	0.23	−0.51	−0.62	−0.15	−0.17	−0.16	0.55	0.63	0.07
Information	0.04	0.24	−0.31	−0.39	−0.11	−0.19	−0.21	0.42	0.39	0.06
Manufacturing	0.16	0.17	−0.45	−0.33	0.01	−0.19	−0.30	0.28	0.41	0.16
Mining	0.47	0.30	−0.18	−0.16	0.11	−0.08	−0.08	0.55	0.30	−0.20
Professional and business service	0.41	0.47	−0.11	−0.28	−0.22	−0.24	−0.27	0.39	0.47	0.16
Retail trade	0.27	0.29	−0.32	−0.51	−0.32	−0.21	−0.22	0.44	0.48	0.14
Transportation and warehousing	0.40	0.42	−0.13	−0.28	−0.23	−0.20	−0.17	0.56	0.60	0.12
Utilities	0.46	0.15	−0.44	−0.45	−0.14	−0.06	−0.07	0.38	0.28	0.01
Wholesale trade	0.17	0.21	−0.43	−0.41	−0.12	−0.20	−0.29	0.39	0.49	0.15
Divisia M4										
Aggregate	−0.26	−0.17	−0.21	0.20	0.46	0.13	0.03	0.16	−0.23	−0.53
Agriculture	−0.28	−0.50	−0.32	−0.01	0.07	0.04	0.06	0.02	−0.40	−0.38
Construction	0.03	−0.03	−0.10	0.36	0.51	0.12	0.15	0.31	−0.23	−0.54
Education	−0.02	−0.17	−0.46	−0.06	0.35	0.07	−0.09	0.08	−0.21	−0.48

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table A2. Continued

$\rho(x_t, y_{t+j}), j = -8, -4, 0, 4, 8$										
	A. Sectorial Employment					B. Sectorial Unemployment				
	$j=$-8	$j=$-4	$j=0$	$j=4$	$j=8$	$j=$-8	$j=$-4	$j=0$	$j=4$	$j=8$
Finance	−0.07	−0.22	−0.35	0.25	0.46	0.12	0.15	0.31	−0.23	−0.54
Hospitality	−0.15	−0.16	−0.46	−0.09	0.41	0.05	−0.06	0.25	−0.04	−0.50
Information	0.07	0.44	0.26	0.27	0.25	0.11	0.03	0.10	−0.31	−0.51
Manufacturing	−0.02	0.02	0.11	0.44	0.38	0.15	0.13	0.23	−0.24	−0.54
Mining	−0.14	−0.41	−0.53	−0.18	0.08	−0.04	−0.06	0.01	−0.30	−0.37
Professional and business service	−0.30	−0.35	−0.31	0.18	0.36	0.11	0.11	0.24	−0.24	−0.53
Retail trade	−0.13	−0.08	−0.15	0.17	0.40	0.08	0.00	0.15	−0.24	−0.49
Transportation and warehousing	−0.31	−0.35	−0.28	0.21	0.37	0.07	0.04	0.21	−0.17	−0.51
Utilities	0.18	−0.08	−0.33	−0.26	−0.18	−0.10	−0.12	0.03	−0.29	−0.37
Wholesale trade	−0.03	0.14	0.08	0.38	0.40	0.06	−0.03	0.14	−0.24	−0.50
Divisia M1A										
Aggregate	0.20	0.28	−0.21	−0.51	−0.26	−0.08	−0.23	0.22	0.51	0.20
Agriculture	0.38	0.24	−0.03	−0.10	−0.09	0.09	−0.09	0.02	0.06	0.17
Construction	−0.18	0.12	−0.01	−0.07	0.03	−0.09	−0.30	0.12	0.36	0.15
Education	0.32	0.02	−0.66	−0.70	−0.16	−0.07	−0.20	0.24	0.54	0.19
Finance	0.00	0.24	−0.06	−0.12	−0.10	−0.09	−0.30	0.12	0.36	0.15
Hospitality	0.31	0.27	−0.35	−0.66	−0.20	−0.12	−0.20	0.36	0.67	0.14
Information	−0.06	0.34	−0.06	−0.40	−0.14	−0.09	−0.22	0.21	0.39	0.06
Manufacturing	−0.04	0.21	−0.15	−0.33	−0.04	−0.05	−0.26	0.08	0.38	0.20
Mining	0.35	0.31	−0.09	−0.21	0.06	−0.04	−0.13	0.37	0.40	−0.19
Professional and Business Service	0.19	0.43	0.10	−0.22	−0.24	−0.11	−0.26	0.20	0.46	0.20
Retail trade	0.14	0.27	−0.09	−0.45	−0.37	−0.11	−0.24	0.22	0.47	0.19
Transportation and warehousing	0.17	0.39	0.08	−0.23	−0.24	−0.12	−0.19	0.35	0.62	0.18
Utilities	0.43	0.30	−0.32	−0.56	−0.24	−0.07	−0.08	0.29	0.28	0.01
Wholesale trade	0.01	0.27	−0.17	−0.41	−0.15	−0.09	−0.30	0.19	0.49	0.19
Divisia M4A										
Aggregate	0.01	−0.02	−0.35	0.04	0.28	−0.05	−0.11	0.35	−0.01	−0.32
Agriculture	0.06	−0.20	−0.36	0.01	0.20	−0.05	−0.11	0.25	−0.22	−0.22
Construction	0.23	0.05	−0.39	0.20	0.41	−0.13	−0.07	0.44	−0.10	−0.37
Education	0.18	−0.09	−0.52	−0.20	0.19	−0.06	−0.17	0.30	0.05	−0.30
Finance	0.21	−0.05	−0.46	0.24	0.33	−0.13	−0.07	0.44	−0.10	−0.37
Hospitality	0.09	0.04	−0.45	−0.19	0.26	−0.09	−0.15	0.39	0.18	−0.32
Information	0.03	0.36	−0.05	−0.02	0.16	−0.07	−0.08	0.35	−0.09	−0.37
Manufacturing	0.17	0.08	−0.42	0.11	0.43	−0.06	−0.09	0.40	−0.06	−0.35
Mining	0.15	−0.13	−0.47	−0.10	0.26	−0.03	−0.14	0.44	0.03	−0.45

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table A2. Continued

$\rho(x_t, y_{t+j})$, j = −8, −4, 0, 4, 8										
	A. Sectorial Employment					B. Sectorial Unemployment				
	j = -8	j = -4	j = 0	j = 4	j = 8	j = -8	j = -4	j = 0	j = 4	j = 8
Professional and business service	0.05	−0.06	−0.40	0.15	0.29	−0.12	−0.07	0.43	−0.05	−0.34
Retail trade	0.12	0.12	−0.33	−0.03	0.21	−0.08	−0.12	0.34	−0.01	−0.31
Transportation and warehousing	0.09	−0.10	−0.37	0.18	0.29	−0.11	−0.11	0.44	0.10	−0.33
Utilities	0.48	−0.02	−0.51	−0.36	−0.05	−0.09	−0.22	0.20	−0.03	−0.20
Wholesale trade	0.10	0.16	−0.29	0.09	0.29	−0.10	−0.19	0.33	−0.01	−0.30
Divisia M1AI										
Aggregate	0.22	0.30	−0.18	−0.48	−0.26	−0.11	−0.25	0.20	0.50	0.20
Agriculture	0.37	0.25	0.00	−0.07	−0.07	0.07	−0.10	0.00	0.05	0.17
Construction	−0.17	0.13	0.01	−0.06	0.03	−0.11	−0.32	0.10	0.33	0.15
Education	0.34	0.03	−0.65	−0.68	−0.16	−0.10	−0.23	0.22	0.52	0.19
Finance	0.02	0.24	−0.03	−0.09	−0.09	−0.11	−0.32	0.10	0.33	0.15
Hospitality	0.33	0.29	−0.33	−0.63	−0.20	−0.15	−0.22	0.35	0.66	0.14
Information	−0.03	0.36	−0.05	−0.40	−0.16	−0.12	−0.24	0.18	0.37	0.06
Manufacturing	−0.02	0.23	−0.13	−0.32	−0.05	−0.08	−0.28	0.05	0.36	0.19
Mining	0.33	0.30	−0.07	−0.18	0.09	−0.05	−0.13	0.37	0.39	−0.18
Professional and business service	0.20	0.45	0.14	−0.19	−0.22	−0.14	−0.29	0.18	0.44	0.20
Retail trade	0.17	0.29	−0.06	−0.43	−0.37	−0.14	−0.26	0.20	0.46	0.19
Transportation and warehousing	0.18	0.41	0.12	−0.19	−0.23	−0.15	−0.21	0.33	0.60	0.18
Utilities	0.42	0.29	−0.33	−0.54	−0.22	−0.10	−0.09	0.28	0.28	0.01
Wholesale trade	0.04	0.29	−0.15	−0.40	−0.15	−0.12	−0.32	0.17	0.47	0.19
Divisia M4AI										
Aggregate	0.21	0.31	0.04	0.03	0.08	−0.25	−0.33	0.04	0.04	−0.08
Agriculture	0.07	0.01	0.02	0.27	0.24	−0.14	−0.23	0.01	−0.25	0.00
Construction	0.11	0.06	−0.09	0.24	0.20	−0.21	−0.29	0.04	−0.15	−0.15
Education	0.35	0.09	−0.40	−0.33	0.07	−0.27	−0.35	0.05	0.14	−0.06
Finance	0.14	0.12	−0.07	0.32	0.14	−0.21	−0.29	0.04	−0.15	−0.15
Hospitality	0.29	0.27	−0.15	−0.21	0.14	−0.28	−0.30	0.17	0.29	−0.12
Information	0.19	0.51	0.07	−0.19	−0.06	−0.25	−0.30	0.02	−0.05	−0.16
Manufacturing	0.20	0.20	−0.08	0.11	0.18	−0.19	−0.31	0.00	−0.12	−0.13
Mining	0.05	−0.06	−0.16	0.12	0.35	−0.11	−0.18	0.32	0.10	−0.31
Professional and business service	0.08	0.23	0.15	0.32	0.16	−0.27	−0.30	0.07	−0.06	−0.10
Retail trade	0.31	0.35	0.04	0.00	−0.02	−0.27	−0.34	0.06	0.03	−0.08
Transportation and warehousing	0.10	0.21	0.18	0.33	0.12	−0.30	−0.29	0.16	0.16	−0.10
Utilities	0.38	0.01	−0.39	−0.36	−0.01	−0.29	−0.35	0.13	0.01	−0.01
Wholesale trade	0.24	0.36	−0.01	0.01	0.04	−0.27	−0.41	0.03	0.04	−0.05

Yellow = lagging, blue = Synchronous, Green = leading the cycle

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table A3. Granger causality test results with data in logged levels

A. Aggregate Variables				
	GDP	Value Added	Employment	Unemployment
Fed funds rate	0.692	0.820	**0.089**	0.357
Divisia M1	**0.000**	**0.000**	**0.005**	**0.003**
Divisia M4	**0.000**	**0.001**	0.116	**0.067**
Divisia M1A	**0.001**	**0.001**	**0.011**	**0.011**
Divisia M4A	**0.003**	**0.007**	**0.093**	0.108
Divisia M1AI	**0.001**	**0.001**	**0.007**	**0.007**
Divisia M4AI	**0.012**	**0.005**	**0.072**	**0.065**

	Agriculture	Construction	Education	Finance	Hospitality	Information	Manufacturing	Mining	Professional and Business Service	Retail Trade	Transportation and Warehousing	Utilities	Wholesale Trade
B. Sectorial real GDP													
Fed funds rate	**0.065**	**0.005**	0.466	0.147	0.796	**0.005**	**0.020**	0.363	0.810	**0.069**	0.795	**0.002**	0.159
Divisia M1	**0.078**	**0.030**	**0.002**	**0.000**	**0.006**	**0.000**	**0.000**	0.696	**0.000**	**0.000**	**0.001**	**0.051**	**0.000**
Divisia M4	0.197	**0.001**	**0.013**	**0.050**	**0.016**	**0.000**	**0.001**	**0.018**	**0.036**	**0.000**	**0.003**	0.504	**0.000**
Divisia M1A	**0.029**	**0.016**	**0.002**	**0.000**	**0.079**	**0.001**	**0.000**	**0.004**	**0.000**	**0.000**	**0.001**	**0.022**	**0.000**
Divisia M4A	0.172	**0.071**	**0.012**	**0.012**	0.523	**0.022**	**0.000**	**0.006**	**0.051**	**0.002**	**0.007**	0.459	**0.012**
Divisia M1AI	**0.025**	**0.002**	**0.001**	**0.000**	**0.065**	**0.002**	**0.001**	**0.002**	**0.000**	**0.000**	**0.001**	0.166	**0.000**
Divisia M4AI	0.618	**0.063**	0.369	**0.001**	0.524	**0.000**	**0.036**	**0.026**	**0.047**	**0.024**	**0.068**	0.231	**0.002**
C. Sectorial Value added													
Fed funds rate	**0.081**	**0.005**	0.817	**0.007**	0.826	0.215	0.653	0.236	0.776	**0.072**	0.762	0.007	0.828
Divisia M1	**0.002**	**0.003**	**0.000**	**0.000**	**0.005**	**0.004**	**0.000**	**0.000**	**0.000**	**0.000**	**0.001**	**0.001**	**0.000**
Divisia M4	**0.055**	**0.018**	**0.001**	**0.041**	**0.035**	**0.026**	**0.003**	**0.003**	**0.002**	**0.000**	0.230	**0.000**	**0.002**
Divisia M1A	**0.000**	**0.002**	**0.000**	**0.067**	**0.025**	**0.001**	**0.001**	**0.000**	**0.000**	**0.000**	**0.005**	**0.003**	**0.001**
Divisia M4A	**0.006**	**0.014**	**0.001**	**0.078**	0.610	0.197	**0.074**	**0.006**	**0.046**	**0.000**	0.424	**0.000**	**0.010**
Divisia M1AI	**0.001**	**0.001**	**0.000**	**0.097**	**0.020**	**0.001**	**0.001**	**0.000**	**0.000**	**0.000**	**0.004**	**0.003**	**0.000**
Divisia M4AI	**0.007**	**0.012**	**0.027**	0.247	0.649	0.102	**0.013**	**0.019**	**0.001**	**0.000**	0.417	**0.003**	**0.003**

Table A3. Continued

	Agriculture	Construction	Education	Finance	Hospitality	Information	Manufacturing	Mining	Professional and Business Service	Retail Trade	Transportation and Warehousing	Utilities	Wholesale Trade
D. Sectorial employment													
Fed funds rate	**0.024**	**0.002**	0.910	**0.001**	0.955	0.590	**0.049**	**0.058**	0.106	0.312	0.198	0.417	0.123
Divisia M1	0.124	**0.000**	0.229	**0.000**	0.282	**0.002**	**0.000**	**0.058**	**0.000**	**0.002**	**0.000**	**0.086**	**0.000**
Divisia M4	**0.004**	**0.000**	0.988	**0.002**	0.375	**0.087**	**0.001**	0.541	**0.009**	**0.010**	**0.001**	0.784	**0.005**
Divisia M1A	**0.002**	**0.000**	0.102	**0.000**	0.192	**0.000**	**0.003**	**0.001**	**0.000**	**0.002**	**0.000**	**0.018**	**0.001**
Divisia M4A	0.265	**0.001**	0.930	**0.011**	0.448	**0.076**	**0.003**	0.128	**0.009**	**0.007**	**0.001**	0.367	**0.013**
Divisia M1AI	**0.007**	**0.000**	**0.091**	**0.000**	0.165	**0.000**	**0.002**	**0.001**	**0.000**	**0.001**	**0.000**	**0.012**	**0.000**
Divisia M4AI	**0.008**	**0.001**	0.962	**0.005**	0.571	**0.039**	**0.005**	**0.025**	**0.009**	**0.008**	**0.000**	0.532	**0.020**
E. Sectorial unemployment													
Fed funds rate	**0.049**	0.188	**0.037**	0.188	0.170	0.130	0.305	0.938	0.150	0.041	**0.038**	**0.016**	**0.047**
Divisia M1	**0.072**	**0.000**	**0.018**	**0.000**	0.121	**0.019**	**0.004**	**0.050**	**0.001**	**0.009**	**0.021**	**0.011**	**0.003**
Divisia M4	**0.017**	**0.008**	0.218	**0.008**	0.748	0.922	**0.010**	**0.005**	0.175	**0.025**	0.753	**0.004**	0.730
Divisia M1A	**0.014**	**0.006**	**0.033**	**0.006**	**0.001**	**0.050**	**0.008**	**0.102**	**0.000**	**0.032**	**0.035**	**0.002**	**0.005**
Divisia M4A	**0.003**	0.190	0.212	0.190	0.805	0.253	**0.013**	**0.012**	0.190	**0.030**	0.948	**0.004**	0.826
Divisia M1AI	**0.008**	**0.004**	**0.022**	**0.004**	**0.000**	**0.017**	**0.001**	0.712	**0.000**	**0.022**	**0.028**	**0.002**	**0.045**
Divisia M4AI	**0.031**	0.101	0.185	0.101	0.673	0.135	**0.003**	**0.028**	0.129	**0.065**	0.779	**0.005**	0.804

Notes: Numbers are marginal significance levels. Bold numbers indicate significance at 10%.

Table A4. Count of number of sector in which policy variable is informative when causality is conducted on filtered data

	Fed funds rate	Divisia M1	Divisia M4	Divisia M1A	Divisia M4A	Divisia M1AI	Divisia M4AI
Aggregate variables	2	4	2	3	3	4	2
Sectorial real GDP	8	12	7	7	9	8	6
Sectorial value added	9	12	7	10	8	11	9
Sectorial employment	8	11	8	8	5	9	6
Sectorial unemployment	5	11	7	6	5	3	5

The numbers in this table represent the count of sectors where the null hypothesis of no causality from the policy variable to the specific economic activity measure is rejected at the 10% significance level. Data is filtered using Hamilton (2018) filter.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table A5. Granger causality test results with data in logged levels and controlling for interest rate

A. Aggregate Variables				
	GDP	**Value Added**	**Employment**	**Unemployment**
Divisia M1	**0.000**	**0.002**	**0.008**	**0.056**
Divisia M4	**0.000**	**0.000**	0.102	**0.021**
Divisia M1A	**0.004**	**0.022**	0.305	0.200
Divisia M4A	**0.071**	0.291	**0.101**	**0.007**
Divisia M1AI	**0.055**	**0.012**	0.104	0.252
Divisia M4AI	**0.070**	0.160	0.484	0.230

	Agriculture	Construction	Education	Finance	Hospitality	Information	Manufacturing	Mining	Professional and Business Service	Retail Trade	Transportation and Warehousing	Utilities	Wholesale Trade
B. Sectorial real GDP													
Divisia M1	0.132	0.154	**0.003**	**0.000**	**0.002**	**0.049**	**0.000**	**0.048**	**0.000**	**0.000**	**0.001**	0.731	**0.001**
Divisia M4	0.268	**0.046**	**0.002**	**0.066**	**0.003**	**0.029**	**0.006**	**0.024**	**0.001**	**0.000**	**0.001**	0.192	**0.000**
Divisia M1A	**0.043**	0.505	**0.085**	0.458	0.170	0.228	**0.003**	0.203	**0.017**	**0.067**	**0.059**	0.588	**0.000**
Divisia M4A	**0.097**	0.271	**0.004**	**0.074**	**0.052**	**0.001**	**0.016**	0.165	0.233	**0.044**	0.364	0.115	0.136
Divisia M1AI	**0.056**	0.669	**0.093**	0.430	**0.075**	0.305	**0.000**	0.185	**0.094**	**0.009**	**0.071**	0.607	**0.000**
Divisia M4AI	0.234	0.247	0.371	0.037	0.181	0.244	0.262	**0.041**	0.119	0.393	**0.003**	0.559	**0.006**
C. Sectorial Value added													
Divisia M1	**0.000**	**0.004**	**0.000**	**0.000**	**0.003**	**0.000**	0.152	**0.008**	**0.000**	**0.001**	**0.001**	**0.035**	**0.000**
Divisia M4	**0.055**	**0.021**	**0.000**	**0.031**	**0.009**	**0.070**	**0.020**	**0.000**	**0.001**	**0.001**	**0.017**	**0.000**	**0.000**
Divisia M1A	**0.012**	**0.080**	**0.096**	0.183	**0.034**	**0.021**	0.274	**0.009**	**0.048**	0.162	**0.014**	**0.060**	**0.019**
Divisia M4A	0.407	**0.041**	**0.062**	0.805	**0.083**	**0.001**	**0.051**	**0.027**	0.158	**0.000**	**0.024**	**0.027**	0.152
Divisia M1AI	0.008	0.137	0.133	**0.092**	**0.057**	**0.035**	0.202	**0.006**	**0.031**	**0.081**	**0.030**	**0.010**	**0.015**
Divisia M4AI	0.220	**0.017**	0.167	**0.011**	**0.019**	**0.028**	**0.072**	0.175	**0.029**	0.532	0.372	**0.000**	0.339

Table A5. Continued

	Agriculture	Construction	Education	Finance	Hospitality	Information	Manufacturing	Mining	Professional and Business Service	Retail Trade	Transportation and Warehousing	Utilities	Wholesale Trade
D. Sectorial employment													
Divisia M1	**0.083**	**0.000**	0.220	**0.061**	0.280	**0.002**	**0.030**	0.162	**0.000**	**0.000**	**0.000**	**0.008**	**0.031**
Divisia M4	**0.038**	0.145	0.979	**0.001**	0.247	**0.006**	**0.000**	0.150	**0.001**	**0.000**	**0.000**	0.319	**0.003**
Divisia M1A	**0.040**	**0.037**	**0.033**	0.124	0.164	0.170	0.101	**0.072**	**0.002**	0.143	0.165	**0.005**	0.105
Divisia M4A	**0.024**	0.341	**0.033**	0.282	0.280	**0.005**	0.301	**0.067**	0.278	**0.072**	0.222	0.684	0.118
Divisia M1AI	0.121	**0.009**	**0.040**	0.155	0.359	**0.065**	**0.087**	**0.044**	0.103	0.138	0.066	**0.001**	**0.056**
Divisia M4AI	**0.026**	0.153	**0.063**	0.407	0.934	0.182	0.214	**0.063**	**0.000**	0.195	0.395	**0.008**	0.173
E. Sectorial unemployment													
Divisia M1	0.243	**0.000**	**0.030**	**0.000**	**0.077**	0.186	**0.001**	**0.022**	**0.001**	**0.013**	**0.081**	0.129	**0.048**
Divisia M4	**0.010**	0.129	0.728	0.129	0.805	**0.027**	**0.001**	**0.000**	**0.030**	**0.021**	0.763	**0.001**	0.268
Divisia M1A	0.331	**0.091**	**0.048**	**0.091**	**0.039**	0.212	**0.000**	**0.002**	**0.037**	0.321	0.331	**0.016**	0.271
Divisia M4A	**0.025**	0.204	0.187	0.204	0.664	0.151	0.366	**0.080**	**0.020**	0.222	0.726	0.249	0.316
Divisia M1AI	0.639	**0.005**	**0.023**	**0.005**	**0.004**	0.209	**0.023**	**0.001**	0.336	0.168	0.372	**0.035**	0.138
Divisia M4AI	**0.034**	0.394	0.344	0.394	0.528	0.491	**0.000**	0.347	0.705	0.119	0.168	**0.000**	0.499

Notes: Numbers are marginal significance levels. Bold numbers indicate significance at 10%.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table A6. Granger causality test results data with in quarterly growth rates and controlling for interest rate

A. Aggregate Variables				
	GDP	GDP ue Added	Employment	Unemployment
Divisia M1	**0.000**	**0.000**	**0.005**	**0.002**
Divisia M4	**0.000**	**0.001**	**0.034**	**0.033**
Divisia M1A	**0.031**	0.176	**0.000**	**0.000**
Divisia M4A	**0.000**	**0.002**	**0.014**	0.359
Divisia M1AI	0.271	0.101	**0.000**	**0.000**
Divisia M4AI	0.462	0.196	0.154	0.481

	Agriculture	Construction	Education	Finance	Hospitality	Information	Manufacturing	Mining	Professional and Business Service	Retail Trade	Transportation and Warehousing	Utilities	Wholesale Trade
B. Sectorial real GDP													
GDP visia M1	**0.062**	0.119	**0.003**	**0.030**	**0.000**	**0.000**	**0.000**	0.560	**0.001**	**0.001**	**0.000**	0.279	**0.001**
Divisia M4	0.246	0.201	**0.011**	**0.019**	**0.005**	**0.038**	**0.000**	0.996	**0.006**	**0.000**	**0.003**	0.237	**0.000**
Divisia M1A	**0.049**	0.485	0.097	**0.049**	**0.099**	**0.008**	0.266	0.351	0.198	**0.008**	**0.000**	0.106	**0.004**
Divisia M4A	0.337	0.421	0.145	0.393	0.237	**0.002**	**0.064**	0.446	**0.078**	0.363	0.235	0.407	**0.040**
Divisia M1AI	**0.032**	0.621	**0.091**	**0.053**	0.270	**0.004**	**0.011**	0.343	0.403	**0.000**	**0.000**	**0.053**	**0.000**
Divisia M4AI	0.514	0.276	0.654	**0.052**	0.288	0.175	**0.000**	0.148	**0.066**	0.155	0.019	0.499	**0.055**
C. Sectorial Value added													
Divisia M1	**0.038**	**0.000**	**0.001**	**0.000**	**0.000**	**0.098**	**0.000**	**0.000**	**0.000**	**0.000**	**0.001**	**0.021**	**0.000**
Divisia M4	**0.011**	**0.000**	**0.000**	**0.003**	**0.061**	**0.042**	**0.089**	**0.000**	**0.002**	**0.000**	**0.046**	**0.005**	**0.004**
Divisia M1A	**0.026**	**0.062**	**0.080**	0.199	0.188	**0.071**	0.373	**0.005**	**0.068**	**0.012**	**0.057**	**0.079**	**0.032**
Divisia M4A	**0.004**	0.511	**0.080**	0.109	**0.015**	**0.012**	0.585	0.103	**0.000**	0.426	**0.038**	**0.013**	0.417
Divisia M1AI	**0.010**	**0.008**	0.247	0.221	0.111	0.109	0.264	**0.046**	0.182	**0.090**	0.209	0.299	**0.067**
Divisia M4AI	**0.013**	0.653	**0.050**	0.173	**0.018**	**0.035**	0.160	**0.007**	**0.090**	0.626	**0.081**	**0.043**	0.267

Table A6. Continued

	Agriculture	Construction	Education	Finance	Hospitality	Information	Manufacturing	Mining	Professional and Business Service	Retail Trade	Transportation and Warehousing	Utilities	Wholesale Trade
D. Sectorial employment													
Divisia M1	**0.051**	**0.000**	0.531	0.036	**0.067**	**0.002**	**0.000**	**0.051**	**0.000**	**0.000**	**0.000**	**0.071**	**0.000**
Divisia M4	**0.022**	**0.000**	0.523	0.001	0.249	**0.031**	**0.000**	0.397	**0.011**	**0.007**	**0.000**	**0.051**	**0.008**
Divisia M1A	0.205	0.116	**0.006**	**0.009**	0.390	**0.000**	0.425	**0.086**	**0.014**	0.183	**0.032**	0.114	**0.000**
Divisia M4A	0.550	**0.000**	0.287	0.708	0.714	**0.007**	**0.000**	0.331	0.472	0.364	**0.000**	0.273	0.329
Divisia M1AI	0.183	**0.049**	**0.003**	**0.014**	0.213	0.142	**0.000**	**0.008**	**0.053**	**0.000**	**0.086**	**0.038**	0.443
Divisia M4AI	0.147	**0.000**	**0.078**	0.524	**0.016**	**0.007**	**0.002**	0.311	**0.008**	0.005	**0.000**	0.195	0.201
E. Sectorial unemployment													
Divisia M1	0.111	**0.004**	**0.034**	**0.004**	**0.069**	0.570	**0.000**	**0.024**	**0.019**	**0.001**	**0.021**	**0.074**	0.108
Divisia M4	0.049	**0.031**	0.149	**0.031**	**0.048**	0.855	**0.007**	**0.007**	**0.073**	**0.008**	0.658	**0.018**	0.255
Divisia M1A	0.239	**0.015**	**0.003**	0.015	0.120	**0.076**	**0.000**	**0.074**	**0.013**	**0.000**	**0.003**	0.125	**0.005**
Divisia M4A	**0.075**	0.597	**0.063**	0.597	0.594	0.547	0.547	**0.010**	**0.050**	0.455	0.218	**0.056**	0.487
Divisia M1AI	0.325	**0.011**	**0.002**	**0.011**	**0.100**	**0.070**	**0.000**	**0.037**	**0.009**	0.750	**0.002**	**0.060**	0.416
Divisia M4AI	0.193	0.163	**0.085**	0.163	0.434	0.422	**0.003**	0.287	**0.054**	0.497	0.136	**0.068**	0.176

Notes: Numbers are marginal significance levels. Bold numbers indicate significance at 10%.

Table A7. One and two year ahead forecasting regression results for real GDP value added

	Fed Funds rate		Divisia M1		Divisia M4		Divisia M1A		Divisia M4A		Divisia M1AI		Divisia M4AI	
	$j=4$	$j=8$	$j=4$	$j=8$	$j=4$	$j=8$	$j=4$	$j=8$	$j=4$	j=8	$j=4$	$j=8$	j=4	j=8
Aggregate and Sectorial real GDP														
Aggregate	−0.939***	−0.049	0.270***	−0.015	0.099	−0.071	0.316***	−0.054	0.087	−0.111	0.279***	−0.014	0.064	−0.047
Agriculture	−0.617**	−1.424***	−0.107	−0.008	−0.104	−0.177**	−0.139	0.072	−0.113	−0.191**	−0.118	0.082	0.064	−0.047
Construction	−1.000**	−1.380**	−0.060	−0.366***	−0.368***	−0.611***	−0.148	−0.420**	−0.481***	−0.693***	−0.137	−0.352**	0.064	−0.047
Education	−0.250	−0.434	0.196**	0.126	0.107	−0.036	0.178	0.217	0.082	−0.049	0.170	0.265	0.018	0.025
Finance	−0.497***	0.032	0.137***	0.013	0.032	0.027	0.182***	0.010	0.031	0.028	0.166***	0.011	0.033	0.021
Hospitality	−2.468**	−0.617	1.518***	0.848	0.756*	0.574	1.637***	0.803	0.674	0.560	1.442***	0.833	0.471	1.145
Information	−0.782***	0.141	0.354***	0.005	0.308***	0.054	0.453***	−0.033	0.318***	0.049	0.410***	−0.010	0.324***	0.114
Manufacturing	−1.647***	−0.334	0.256**	−0.036	−0.151	−0.167	0.324**	−0.085	−0.154	−0.207	0.279***	−0.014	0.064	−0.047
Mining	0.035	0.009	0.066	−0.091	−0.170	−0.377	−0.001	−0.339	−0.252	−0.494	0.002	−0.275	−0.370	−0.689*
Professional and business service	−0.673**	0.188	0.364***	0.037	0.354***	0.021	0.449***	0.012	0.355***	0.002	0.279***	−0.014	0.064	−0.047
Retail trade	−1.519***	−0.067	0.175**	−0.127*	−0.091	−0.126	0.171	−0.180	−0.133	−0.136	0.141	−0.145	−0.288**	−0.107
Transportation and warehousing	−1.748***	−0.240	0.589***	0.035	0.190	−0.169	0.663***	−0.120	0.158	−0.306	0.592***	−0.038	0.135	−0.207
Utilities	0.143	0.291	−0.029	0.130	−0.044	0.187*	0.051	0.195	−0.054	0.209*	0.034	0.209	−0.062	0.298**
Wholesale trade	−2.007***	0.972	0.419***	−0.211	−0.100	−0.037	0.556***	−0.513**	−0.111	−0.070	0.484***	−0.421**	−0.188	−0.143

Table A7. Continued

	Fed Funds rate		Divisia M1		Divisia M4		Divisia M1A		Divisia M4A		Divisia M1AI		Divisia M4AI	
	$j=4$	$j=8$	$j=4$	$j=8$	$j=4$	$j=8$	$j=4$	$j=8$	$j=4$	j=8	$j=4$	$j=8$	j=4	j=8
Aggregate and Sectorial real value added														
Aggregate	−0.472*	0.271	0.366***	0.077	0.350***	0.125	0.444***	0.056	0.346***	0.117	0.397***	0.079	0.358***	0.238
Agriculture	−2.376**	3.339*	1.302***	0.573	0.839**	0.940**	1.685***	0.330	0.945***	0.974**	1.483***	0.189	0.358***	0.238
Construction	−2.108***	−1.128***	0.410***	0.287***	0.183	0.079	0.517***	0.495***	0.167	0.084	0.467***	0.468***	0.358***	0.238
Education	0.277	0.045	0.124*	0.059	0.211***	0.092	0.123	0.058	0.210***	0.102	0.130	0.099	0.297***	0.195
Finance	−0.776***	0.036	0.148***	0.033	0.063	0.025	0.204***	0.041	0.074	0.022	0.182***	0.043	0.068	0.039
Hospitality	−2.454**	−0.231	1.528***	0.799	0.740*	0.816	1.718***	0.792	0.684	0.925	1.499***	0.923	0.500	1.529
Information	−0.325	0.609*	0.258***	0.045	0.301***	0.086	0.337***	0.092	0.329***	0.105	0.303***	0.082	0.416***	0.178*
Manufacturing	−1.071***	0.463	0.510***	0.019	0.364***	0.126	0.620***	−0.055	0.362***	0.110	0.397***	0.079	0.358***	0.238
Mining	2.285	6.356**	1.724***	−0.071	1.756***	0.577	1.976***	−0.732	1.721***	0.540	1.703***	−0.505	1.319**	0.696
Professional and business service	−0.127	0.347	0.295***	0.100	0.294***	0.174*	0.414***	0.098	0.327***	0.182	0.397***	0.079	0.358***	0.238
Retail trade	−0.624**	1.291***	0.377***	−0.165	0.336***	0.051	0.418***	−0.354**	0.303***	0.063	0.378***	−0.310*	0.229*	0.164
Transportation and warehousing	−1.639***	−0.655	0.721***	0.520	0.262	0.351	0.917***	0.407	0.288	0.284	0.812***	0.440	0.318	0.345
Utilities	0.558	1.455***	0.204**	0.409***	0.338***	0.716***	0.310**	0.478**	0.425***	0.793***	0.274**	0.407**	0.503***	0.913***
Wholesale trade	−0.854**	1.341***	0.507***	0.094	0.376***	0.302**	0.660***	−0.012	0.400***	0.311*	0.599***	0.009	0.457***	0.311

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

Table A8. One and two year ahead forecasting regression results for employment and unemployment

	Fed Funds rate		Divisia M1		Divisia M4		Divisia M1A		Divisia M4A		Divisia M1AI		Divisia M4AI	
	j = 4	*j* = 8	*j* = 4	*j* = 8	*j* = 4	*j* = 8	*j* = 4	*j* = 8	j = 4	j = 8	j = 4	j = 8	j = 4	j = 8
Aggregate and Sectorial Employment														
Aggregate	−0.746***	−0.478	0.300***	0.258**	0.153*	0.140	0.370***	0.391**	0.149*	0.151	0.329***	0.369**	0.145*	0.245
Agriculture	−1.206***	−0.302	0.140**	0.015	−0.184**	−0.028	0.176*	0.065	−0.201**	−0.022	0.156*	0.092	0.145*	0.245
Construction	−1.786***	−1.098***	0.399***	0.265***	0.082	0.033	0.507***	0.475***	0.073	0.027	0.459***	0.408***	0.145*	0.245
Education	−0.237	−0.764**	0.139**	0.141	0.044	−0.076	0.234**	0.253	0.041	−0.109	0.195**	0.259*	0.014	−0.137
Finance	−0.619***	−0.441***	0.144***	0.151***	0.051	0.026	0.202***	0.283***	0.066	0.021	0.179***	0.241***	0.068	0.033
Hospitality	−1.902***	−1.416	0.957***	1.100**	0.340	0.731	1.205***	1.732**	0.318	0.836	1.035***	1.660**	0.197	1.087
Information	−0.885***	−0.431	0.433***	0.490***	0.371***	0.281*	0.592***	0.729***	0.400***	0.311*	0.530***	0.632***	0.440***	0.495**
Manufacturing	−1.160***	−0.446*	0.323***	0.202***	0.057	0.117	0.436***	0.283**	0.073	0.118	0.329***	0.369**	0.145*	0.245
Mining	0.112	1.381	0.193	0.095	−0.211	−0.157	0.244	−0.158	−0.259	−0.253	0.215	−0.166	−0.383	−0.629*
Professional and business service	−1.145***	−0.436	0.350***	0.218**	0.149*	0.149	0.437***	0.270*	0.149	0.150	0.329***	0.369**	0.145*	0.245
Retail trade	−0.928***	−0.577**	0.246***	0.138	0.091	−0.022	0.243***	0.185	0.071	−0.047	0.243***	0.185	0.038	−0.016
Transportation and Warehousing	−0.972***	−0.127	0.382***	0.181*	0.289***	0.101	0.500***	0.215	0.298***	0.078	0.456***	0.193	0.332***	0.144
Utilities	−0.113**	−0.165**	0.037***	0.064***	0.024	0.039*	0.069***	0.088***	0.035**	0.040*	0.068***	0.080***	0.067***	0.039
Wholesale trade	−0.723***	−0.460*	0.257***	0.266***	0.155**	0.159	0.346***	0.365***	0.164**	0.156	0.311***	0.323***	0.181**	0.171

Table A8. Continued

	Fed Funds rate		Divisia M1		Divisia M4		Divisia M1A		Divisia M4A		Divisia M1AI		Divisia M4AI	
	j = 4	*j* = 8	*j* = 4	*j* = 8	*j* = 4	*j* = 8	*j* = 4	*j* = 8	j = 4	j = 8	j = 4	j = 8	j = 4	j = 8
Aggregate and sectorial Unemployment														
Aggregate	0.272	0.871***	−0.153***	−0.251***	−0.157***	−0.015	−0.246***	−0.498***	−0.180***	−0.001	−0.222***	−0.417***	−0.192***	−0.020
Agriculture	0.201	1.088***	−0.074	−0.167***	−0.019	−0.129	−0.192***	−0.276***	−0.082	−0.129	−0.171***	−0.230***	−0.192***	−0.020
Construction	0.726***	2.259***	−0.221***	−0.488***	−0.121	−0.064	−0.388***	−0.865***	−0.190*	−0.103	−0.351***	−0.726***	−0.192***	−0.020
Education	0.043	0.390**	−0.078***	−0.143***	−0.096***	−0.053	−0.142***	−0.287***	−0.109***	−0.059	−0.130***	−0.255***	−0.120***	−0.068
Finance	0.726***	2.259***	−0.221***	−0.488***	−0.121	−0.064	−0.388***	−0.865***	−0.190*	−0.103	−0.351***	−0.726***	−0.268**	−0.065
Hospitality	0.009	1.004*	−0.108	−0.429***	−0.132	−0.265	−0.308*	−0.808***	−0.147	−0.303	−0.271*	−0.770***	−0.161	−0.314
Information	0.166	1.023***	−0.124***	−0.245***	−0.119**	−0.118	−0.230***	−0.435***	−0.150**	−0.136	−0.208***	−0.383***	−0.181***	−0.147
Manufacturing	0.385**	1.332***	−0.160***	−0.324***	−0.108	−0.102	−0.263***	−0.528***	−0.139*	−0.108	−0.222***	−0.417***	−0.192***	−0.020
Mining	−0.797***	0.452	0.082	−0.274***	−0.018	−0.249***	−0.012	−0.382***	−0.045	−0.257**	0.002	−0.336***	−0.053	−0.210*
Professional and business service	0.358**	1.261***	−0.143***	−0.292***	−0.105*	−0.123	−0.240***	−0.473***	−0.145**	−0.139	−0.222***	−0.417***	−0.192***	−0.020
Retail trade	0.203	0.802***	−0.127***	−0.261***	−0.127**	−0.091	−0.228***	−0.492***	−0.152***	−0.105	−0.207***	−0.421***	−0.175***	−0.120
Transportation and warehousing	0.119	1.075***	−0.131**	−0.257***	−0.114*	−0.096	−0.261***	−0.491***	−0.137**	−0.111	−0.232***	−0.441***	−0.149**	−0.151
Utilities	−0.006	0.278*	−0.019	−0.087***	−0.016	−0.128***	−0.075**	−0.150***	−0.044	−0.147***	−0.064**	−0.136***	−0.064	−0.174***
Wholesale trade	0.240**	0.720***	−0.120***	−0.239***	−0.121***	−0.129*	−0.196***	−0.405***	−0.142***	−0.149*	−0.174***	−0.341***	−0.149***	−0.145*

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

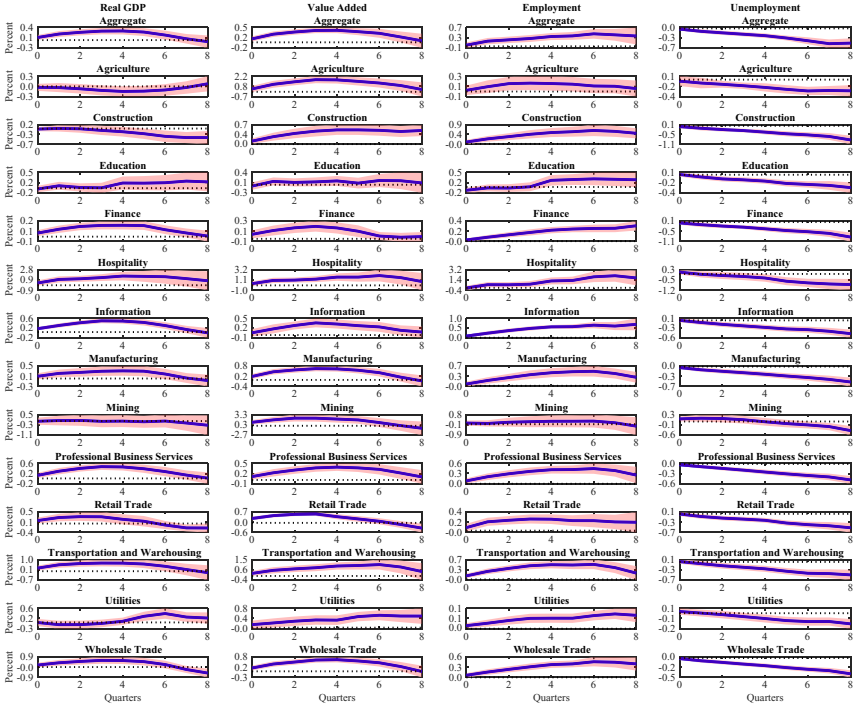

Figure A4. Forecasting regression results with Divisia M1A.

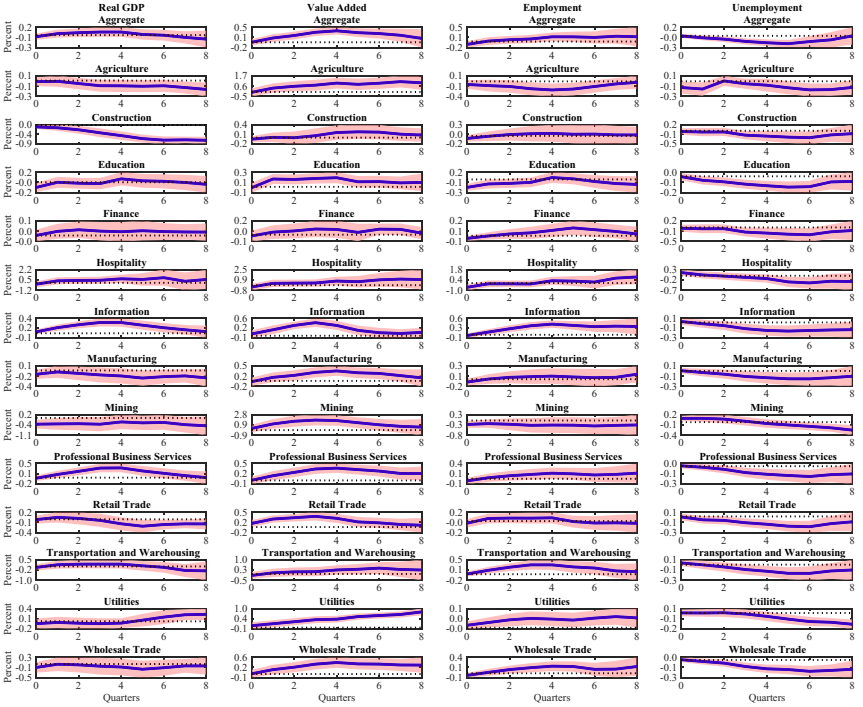

Figure A5. Forecasting regression results with Divisia M4A.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

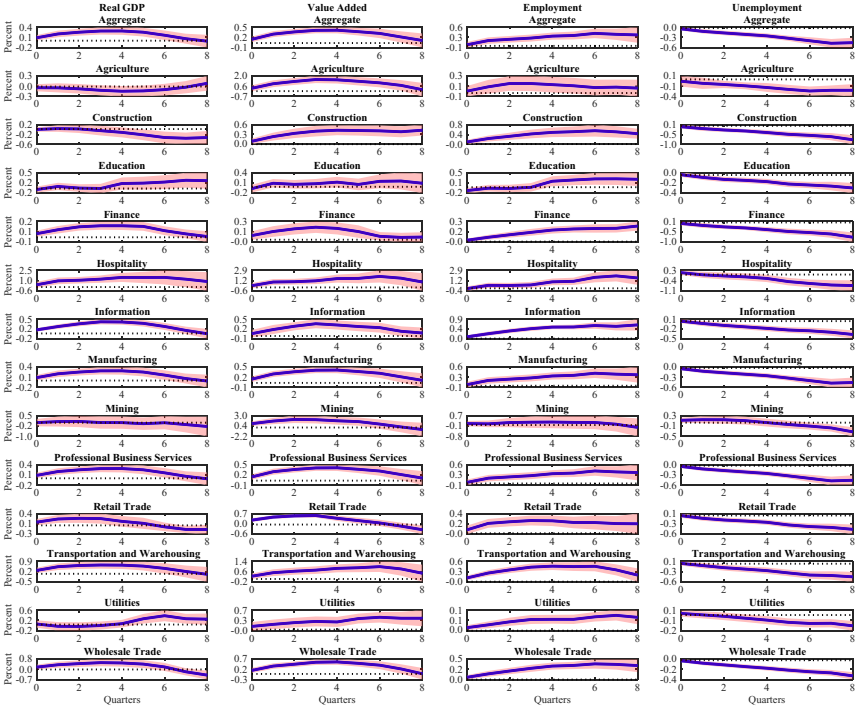

Figure A6. Forecasting regression results with Divisia M1AI.

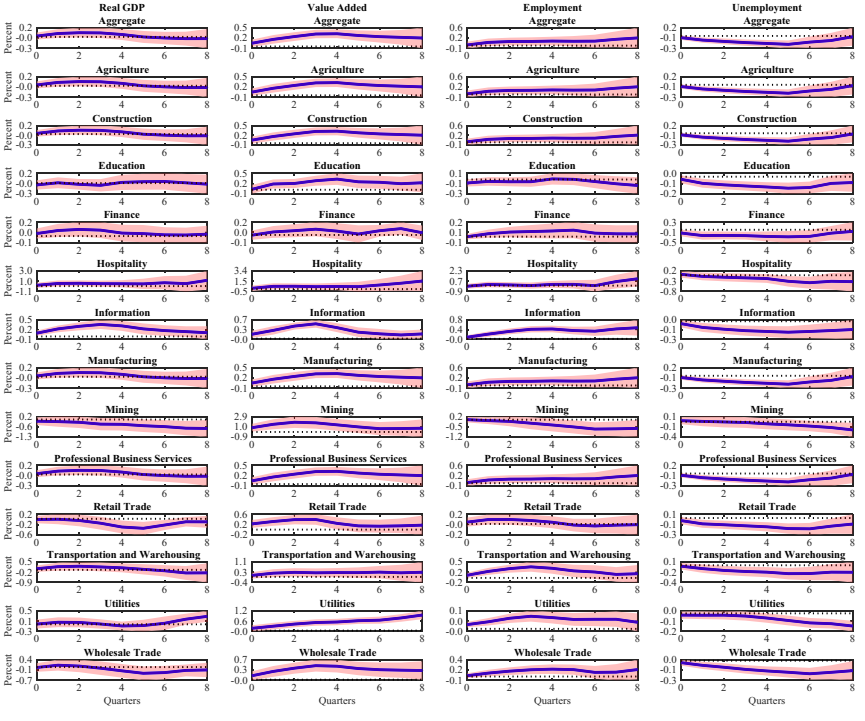

Figure A7. Forecasting regression results with Divisia M4AI.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

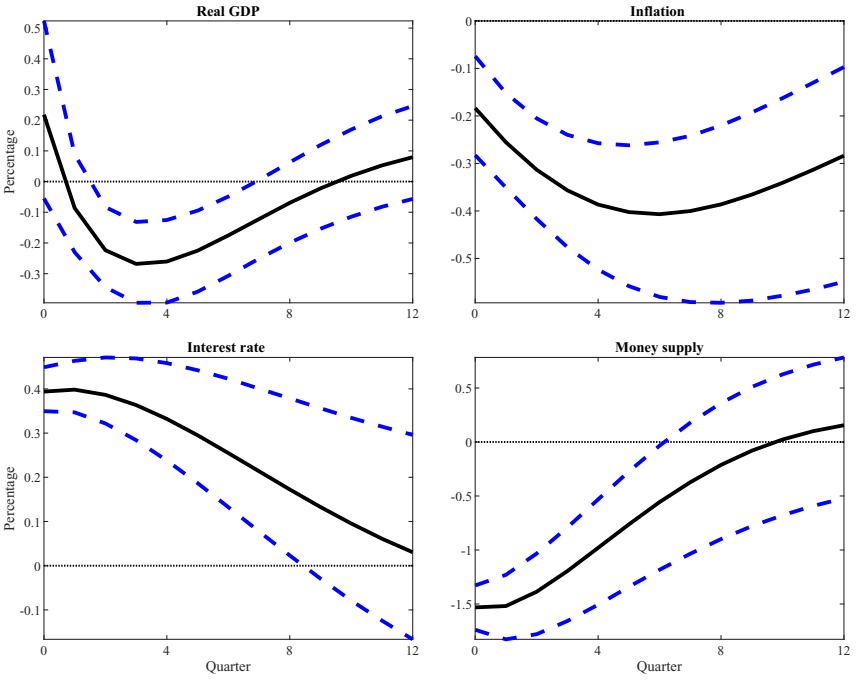

Figure A8. Responses of macroeconomic variables to contractionary monetary policy shock with Divisia M1A in identification. Black solid line is the median response while blue dashed lines are 68% credibility region.

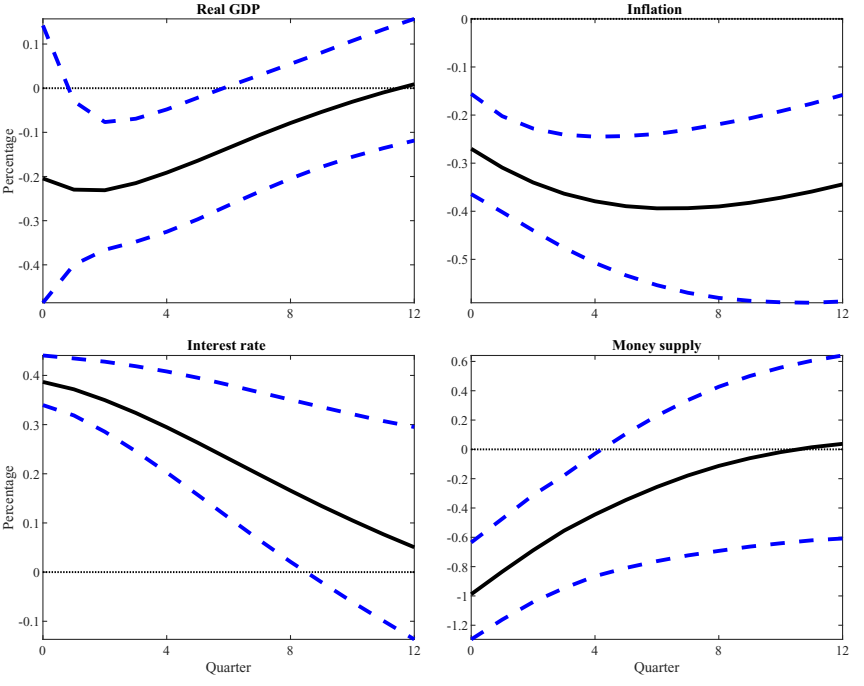

Figure A9. Responses of macroeconomic variables to contractionary monetary policy shock with Divisia M4A in identification. Black solid line is the median response while blue dashed lines are 68% credibility region.

https://doi.org/10.1017/S1365100524000452 Published online by Cambridge University Press

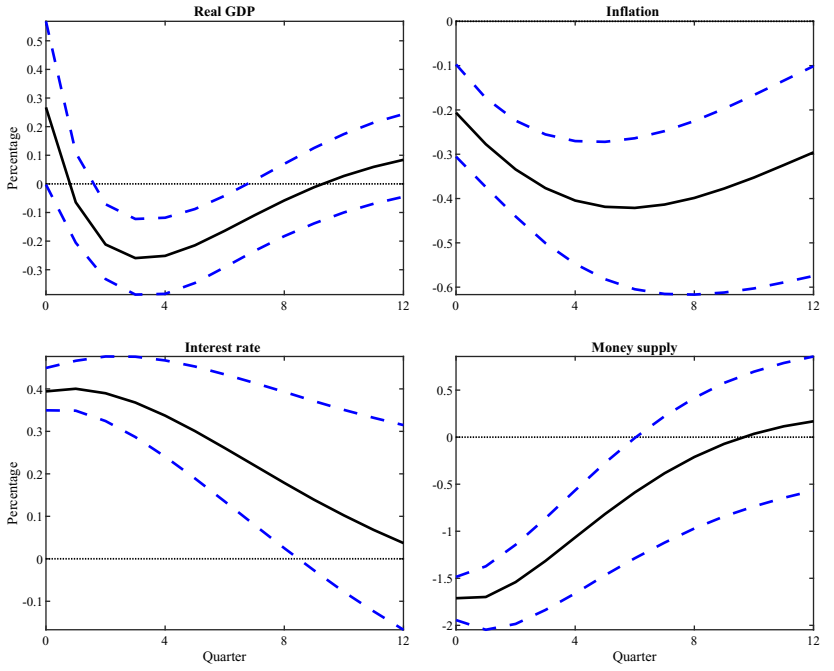

Figure A10. Responses of macroeconomic variables to contractionary monetary policy shock with Divisia M1AI in identification. Black solid line is the median response while blue dashed lines are 68% credibility region.

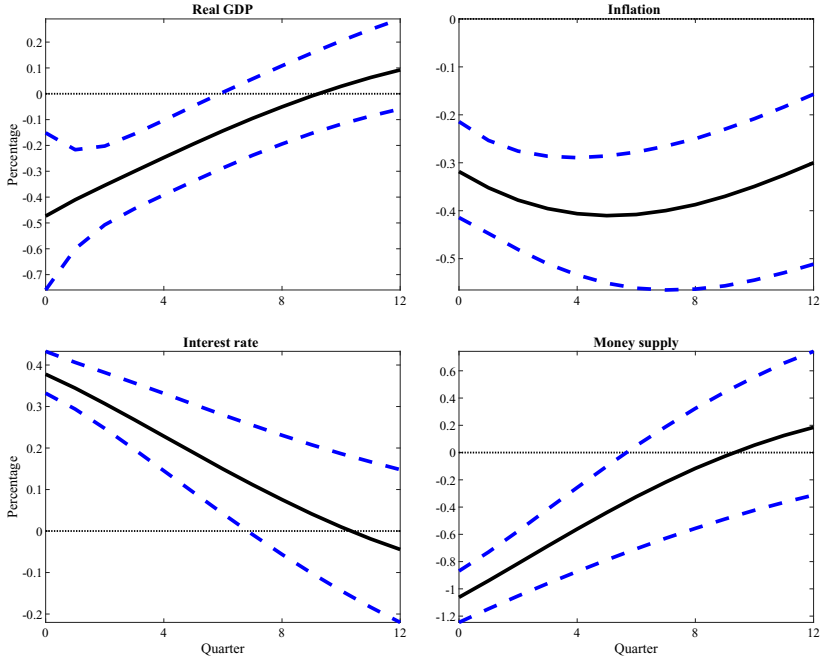

Figure A11. Responses of macroeconomic variables to contractionary monetary policy shock with Divisia M4AI in identification. Black solid line is the median response while blue dashed lines are 68% credibility region.

Cite this article: Dery C (2024). "Sectorial economic activity and Divisia monetary aggregates." *Macroeconomic Dynamics*. https://doi.org/10.1017/S1365100524000452