DE GRUYTER OPEN

UDK: 338.23:336.74(560)
DOI: 10.2478/jcbtp-2018-0008

Journal of Central Banking Theory and Practice, 2018, 1, pp. 175-206
Received: 28 January 2017; accepted: 3 June 2017

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Divisia and Simple Sum Monetary Aggregates: Any Empirical Relevance for Turkey?

Abstract: In consideration of channels through which monetary policy affects economic activity, the monetary aggregates have been mostly ignored by the monetary authorities instead of which short-run interest rates have been given a priori role. These monetary aggregates are largely argued to fail in measuring the effectiveness of different monetary policy regimes in forecasting the macroeconomic fundamentals. Grounded on the "Barnett critique", the formation of traditional simple-sum monetary aggregates assuming for perfect substitution among the components of the money supply is blamed for such a failure of money in explaining the real activity. Given increasing varieties of financial assets which have completely different "moneyness", it is important to provide an alternative measure of the money supply. Hereby, the Divisia monetary aggregates which give different weights to different assets have arisen as an alternative approach. In this study, a Divisia index is constructed to test its predictive power on quantities and prices compared to its simple sum counterpart. Accordingly, a Divisia index is built-up for Turkish economy for the period 2006-2016 to see whether the utilization of the Divisia monetary aggregates in the conduct of monetary policy makes any difference compared to that of traditional simple sum money supply. Under different specifications, though the relative power of the Divisia aggregates in predicting quantity and price variables is found, still, it can be argued that theoretically well-rounded formation of the Divisia index is not that much empirically justified for the case of Turkey.

Keywords: Turkey; Monetary policy; Monetary aggregation; Divisia index; Simple sum index.

JEL Classification: E51, E52, E58.

1. Introduction

It is dramatically acknowledged among economists that the quantity theory of money holds in the long run, so that it is the money equilibrium which primarily determines the price level of an economy. In fact, almost a consensus has arisen among economists particularly in the post-1980 episode for inability of monetary aggregates i.e., simple-sum type, to serve as either information variable, an indicator of policy action or an instrument in a policy rule and thus to reflect the stance of monetary policy instead of which the interest-oriented monetary policy framework has been indigenized. Still, there is not so much agreement regarding what is the accurate measure of the aggregate quantity of money in the economy which can serve not only as an accounting identity, but also as an indicator of monetary stance. The simple-sum aggregates are used as the official aggregates in almost all economies and do not carry a further meaning other than being an accounting identity. Accordingly, the targeted growth rates of monetary aggregates have been advocated for being of *no avail* to have correlation with the variables, i.e. of output and prices. There remains, however, a dilemma whether the interest rate-oriented policy tools *per se* successfully predict the variations in quantity and price variables. Herein, the alternative method of Divisia type monetary aggregation is highly proposed compared to its simple-sum counterpart as a complementary instrument with short-term interest rates in the conduct of monetary policy, so as to both predicting the variations in targeted variables and providing the stability of the system. Though a simple sum monetary aggregation is only consistent with microeconomic theory in the cases where economic decision makers hold *only one* monetary asset, the Divisia index differentiates the monetary assets in between in accordance with their discounted spread, i.e. their user costs. Given the increasing varieties of financial assets and innovations, the arguments for utilization of Divisia aggregates in the monetary policy stance are more advocated.

In this study, a Divisia index is built-up for the Turkish economy being a good example for developing economies with liberalization and competition in the banking sector particularly in the post-1980 episode in distinguishing different formations of monetary aggregates, that is, between the *traditional* simple summation and *alternative* Divisia one for their predictive power for explaining the variations in certain macroeconomic variables. Besides, it is attempted to answer whether inclusion of the Divisia-type monetary aggregation compared to its simple-sum counterpart does make a difference in the conduct of monetary policy for Turkey. In order to answer those questions, the wavelet transformation and Structural VAR analyses are made. To our best, there is no any other study that constructs the Divisia aggregates for Turkey for the last decade which has witnessed a more interest-oriented inflation targeting policy regime. The wavelet analysis prevails for relatively high comovement between GDP growth rate and both Divisia and simple sum monetary aggregates at low frequencies. However, at the peak times of the crisis episode, there is no correlation at relatively high frequencies between GDP growth and changes in monetary aggregates that may in turn suggest the *underutilization* of the traditional simple sum monetary aggregates to serve as policy instrument in the conduct of monetary policy. Besides, the comovement between inflation rate and both types of monetary aggregates prevails but for some time. The wavelet analysis is followed up by certain specifications of SVAR model for Turkey through which the quantity-price variables on one side, and monetary policy instruments on the other side, are brought together in the attempt to answer whether the Divisia type monetary aggregation makes any difference compared to its simple-sum counterpart in provision of complementarity with short-term interest rates in the conduct of monetary policy. Under different specifications, though the relative power of Divisia aggregates in predicting quantity and price variables is to be found, still it can be argued that theoretically well-rounded formation of the Divisia index is not that much empirically justified for Turkey.

In the following chapter, theoretical formation of the Divisia index is provided. In chapter 3, the monetary aggregates are introduced for Turkey. Then, it is introduced the data and conceptual framework in chapter 4 so as to show how the Divisia index is constructed for Turkey. In chapter 5, the methodological underpinnings of wavelet-measure are introduced and then the corresponding results are reported to give some descriptive understanding. Then, in chapter 6, the SVAR methodology and the short-run and long-run models for Turkey is introduced and certain conclusions drawn regarding the estimation results. Section 7 concludes.

2 Divisia index and its theoretical foundation

The simple sum monetary aggregates used as the official aggregates in almost all economies do not carry a further meaning other than being an accounting identity. Accordingly, simple summation would provide valid indices of the stock of nominal monetary wealth or indices of bank liability, but not valid structural economic variables (Barnett, 1980). In construction of those simple sum aggregates all assets are aggregated with equal weights which imply the imposition of perfect substitution between all monetary assets. Thus, all the assets are treated as if they have the same “moneyness”. Such an imposition implies linear indifference curves faced by asset holders which, however, necessitate the holding of either the monetary asset with the lowest opportunity cost or an indeterminate set of assets each sharing the same as well as the lowest opportunity cost in their utility maximization problem. Given the increasing varieties of financial assets and innovations in late 1970s, those critiques on accuracy of this method in measure of monetary aggregation have been more intensified. Stated by Chrystal and MacDonald (1994, p.74) that "in particular, liberalization and competition in banking have generated shifts in demand between components of money which have undermined earlier empirical regularities. Interest payments on transaction deposits have made it more difficult to distinguish money held for transaction from money held for savings". In order for dealing with the problems regarding traditional simple sum monetary aggregates, particularly for its deficiency to serve as objective or indicator of the stance of monetary policy, the first rigorous attempt was made by W. Barnett who firstly provided mathematical derivation of the user costs for alternative monetary assets (Barnett, 1978). Then, to estimate theoretically an accurate measure of monetary aggregation, that is, total quantity of "moneyness", Barnett (1980) brings the aggregation theory and the statistical index number theory together[1] for the construction of monetary quantity index numbers, and advocates "the use of the Tornqvist-Theil Divisia index to measure the quantity of money" (Barnett 1980, p.13). Those Divisia monetary aggregates have a micro-foundation being consistent with the underlying utility function and production function and are superior to simple sum and weighted-sum aggregates that take into account an arbitrary degree of moneyness (Ishida 1984, p.51). The reason for building-up the theory with micro-foundation is that allocating resources among rational agents for perfect substitutes goods necessitates corner solutions.

As stated by Anderson et al. (1997a, p.34) that the simple sum monetary aggregation is only consistent with microeconomic theory in the case where economic decision makers hold only one monetary asset. This presumption regarding the elasticities of substitution among monetary assets can be pointed out to be so

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[1] As pointed out by Barnett (1980), the index number theory permits us to dispense with the unknown parameters that exist in the aggregator functions. Ishida (1984, p.49) provides a clear distinction between aggregation theory and statistical index number theory stating that while the aggregation theory aims at deriving an economically meaningful aggregator function – that represents a specific utility function or production function – the statistical index number theory gives a priori place to the optimizing behavior of economic agents and tries to approximate the aggregator function using statistical indices based on information of prices – thus to provide parameter-free approximations to the functions. Since for statistical index numbers, there is no need to estimate unknown parameters they are suitable aggregates for official use by central banks. Besides, in the case of monetary aggregates, financial innovation has made it necessary to include new assets into these aggregates that require long times series, which in turn make it more convenient to use statistical index numbers.

unrealistic given the varieties of assets with different maturities and returns. The Divisia index[2], instead, does not require such a strong assumption on elasticities of substitution and differentiates the monetary assets in between in accordance with their discounted spread, i.e. their user costs. The user cost of a monetary asset can be defined as the discounted interest foregone by the household as a result of choosing to hold the asset (Anderson et al. 1997a, p.35). Equivalently, it shows the discounted spread between the rate of return on a benchmark asset and that on a particular monetary asset. Hereby, the benchmark asset corresponds to "a risk-free asset that can be used only for inter-temporal transfer of wealth and provides no more services" (Anderson et al., 1997c, p.55). Theoretically, the benchmark rate corresponds to the maximum return on assets. Then,

$$\pi_{it}^{nom} = p_t^*(R_t - r_{it})/(1 + R_t)$$

where π_{it}^{nom} denote the nominal user cost of monetary asset *i* in period *t*, p_t^* is the cost of living index, r_{it} show the nominal yield on monetary asset *i* in period *t* and R_t represent the nominal holding period yield on the benchmark asset – benchmark rate, in period *t*. Thus, the nominal user cost of asset *i* in period *t* equals the nominal value of interest income forgone by holding a unit of that asset for one period – $p_t^* (R_t - r_{it})$ –, discounted by $(1 + R_t)$ to represent the value of interest at the end of the period (Anderson et al. (1997c, p.55). Given that the consumers and producers are faced with different interest rates it should be pointed out that the corresponding user costs of assets differ as well. The real user cost of assets[3] can be defined as follows:

$$\pi_{it}^{real} = (\frac{\pi_{it}^{nom}}{p_t^*}).$$

3. Monetary aggregates for Turkey

Previously stated, the increasing varieties of financial assets that concurrently came along with instability of money demand in the late 1970s choked the life out of the money supply as information variable for and/or indicator of conduct of monetary policy. Accordingly, the targeted growth rates of monetary aggregates were advocated for being of *no avail* to have correlation with the policy variables, i.e. output, price, and interest rate, and monetary authorities set sight more on

[2] In defining the conceptual framework underlying the Divisia index, Anderson et al. (1997a, 1997b, 1997c) and Karaman (2009) are **strictly** followed.

[3] See Anderson et al. (1997a) for more detailed derivation of real user cost of assets.

alternative tools. Hence, almost a consensus has arisen among economists particularly in the post-1980 period for the inability of monetary aggregates to act as either information variable, indicator of policy action or instrument in a policy rule which, in turn, gave place to the interest-oriented policy framework in most of the economies. In this regard, the Central Bank of Turkey (CBT, henceforth) began to implement inflation targeting regime after gaining its independence in 2001. Then, in the early periods, the regime was named *implicit inflation targeting since* the inflation targeting was not the only policy objective because of the IMF-backed stabilization program laying constraints on the central bank balance sheet (Gürkaynak et al., 2015). Later, it became *inflation targeting* in 2006 after which monetary-targeting has become more out of sight. Thus, the argument that the stability of the aggregate price level acts as the driving force behind economic growth and prosperity (Çelik, 1999) has prevailed more in the past decade. In conduct of monetary policy for the sake of provision of price-output stability, *a priori* role is given to the interest rate-oriented policy stance grounded on theoretical formation of Taylor rule so that supply of money serves only as an accounting identity.

There exists relatively a simple set of monetary assets defined within the monetary system. That is, in the calculation of the monetary assets there are only currencies in circulation, sight (or demand) deposits, and time deposits with different maturities and in different units of currency. Going back to the end of 2005, all the definitions on money supply were revised so as to correspond to international standards in the monetary sector[4]. Accordingly, the definitions of different aggregates of money supply (M1, M2 and M3) are as follows:

$$M1 = \text{Currency in circulation} + \text{Sight deposits (TL, FX)}$$
$$M2 = M1 + \text{Time deposits (TL, FX)}$$
$$M3 = M2 + \text{Repo} + \text{Money market funds}$$

Divisia monetary aggregates have been constructed for many countries e.g., USA, Britain, Japan, Germany, Netherlands, Canada, Australia, Switzerland, Taiwan and Malaysia[5]. Among others, only in Britain the monetary authority announced

[4] The mentioned arrangement can be reached at: http://www.tcmb.gov.tr/wps/wcm/connect/86726b86-d2a5-413a-8c10 a8e9a3f18ab8/paraarz%C4%B1.pdf?MOD=AJPERES&CACHEID=ROOTWORKSPACE86726b86-d2a5-413a-8c10-a8e9a3f18ab8 (accessed 18/11/2016).

[5] Barnett and Chauvet (2008) make a review of the studies that attempted to build Divisia monetary aggregates and bring together the history of the problems produced by the use of simple sum monetary aggregates and disappearance of those problems by utilization of Divisia indices.

periodically the Divisia aggregates together with the Simple sum counterparts[6]. There exists a few of studies in the literature that constructs Divisia aggregates for Turkish economy. The first study is due to Kunter (1993) who developed Divisia index – M1, M2 and M2Y – and compared it with the simple-sum counterparts through their annual growth rates for the period 1986–1993 leaving the possible effects on other macroeconomic variables for other studies. An important contribution to the literature was made by Çelik (1999) who constructed the Divisia aggregates for Turkey for the period 1986–1999 to test the empirical validity of the micro-foundations approach for Turkey beside to four of the G-7 countries. In Çelik (1999), main finding is that Divisia M1 appears to be the "best" monetary aggregate in the specification of a money demand function as well as in the causality analysis. Accordingly, Divisia M1 as a monetary target for the short-run is recommended. A well-rounded study was also provided by Karaman (2009) who applied certain models and methods to compare the performances of simple sum and Divisia aggregates in predicting Turkish inflation and output growth for the period 1986 – 2006 both in-and out-of-sample and found that money can be utilized for providing significant information in predicting inflation and output in Turkey and that the Divisia aggregates give superior information in predicting output and inflation. To our best knowledge, there is no any other study subsequent to Karaman (2009) that construct the Divisia aggregates for their implications on the fluctuations in the economic activity itself. Given i) the arrangements for all the definitions on money supply for 2005 and later on, ii) the outstanding changed nature of monetary structure within which a more interest-oriented inflation targeting regime after 2006 has been determined witnessed for the last decade and iii) the critiques on the existence of *redundant* fluctuations in output and prices, it seems to us that there emerged a need for considering alternative approaches of monetary aggregation theories and thus of monetary theories for Turkey so as to take into account what would be the consequences on the output, prices and returns on assets of changes in the money supply.

4. Data and conceptual framework in construction of Divisia index

To construct the Divisia monetary aggregates the official definitions of the monetary assets determined by CBT are followed. In this regard, deposits in banks are separated between those in Turkish lira and foreign exchange by their ma-

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6 The data set of and related information on the Divisia aggregates computed by Bank of England can be reached from: *http://www.bankofengland.co.uk/statistics/Pages/iadb/notesiadb/divisia.aspx* (accessed 18/11/2016).

turities[7] such that both Turkish lira and foreign currency deposits are expressed as the sum of currencies, sight deposits, time deposits up to 1-month, 3-month, 6-month and 1-year and more. The period is between 2005M12 – 2016M4. In determination of the rate of return data used in the computation of the assets' user costs in Turkish lira, the weighted average interest rates of banks for deposits in Turkish lira are used. Besides, for USD and Euro, the weighted average interest rates for deposits are expressed in domestic currency after taking average of those two currencies. As in definitions of monetary aggregates, the interest rates are differentiated in terms of their maturities, so that the returns on time deposits are divided among 1-month, 3-month, 6-month and 1-year and more ones. All those variables are expressed monthly. Besides, in order to assign weights to deposits in foreign currencies, in this study it is accepted that the interest rates on FX deposits represent the actual rate of return of those assets for the sake of simplicity. Thus, the expected rate of depreciation/appreciation is not considered as determinant of the true value of deposits.[8] In this study we confine ourselves to construct the Divisia indices of the definitions M1 and M2 leaving M3 for the future research. For representing the real income, GDP in constant prices in 1998 – seasonally and calendar adjusted – is used. It is redefined in the form of natural logarithm. The inflation data is monthly CPI over which the quarterly change is obtained. The overnight interest rate and 1-week repo rates are used to obtain quarterly interest rate data. At this stage, before introducing the methodologies and results of wavelet transformations and structural VAR it may beneficial to define the conceptual framework of formulations used to obtain the Divisia index. To do this, Karaman (2009) and Anderson et al. (1997b; 1997c) are strictly followed[9]:

π_{it}^{nom} is the nominal stock of monetary asset i for period t such that $m_t^{nom} = (m_{1t}^{nom} \dots m_{nt}^{nom})\, \pi_{it}^{nom}$ is the nominal and π_{it}^{real} is the real user cost of the monetary asset *i* for period *t* such that

$$\pi_{it}^{real} = \frac{\pi_{it}^{nom}}{P_{it}^{*}} = \frac{R_t - r_{it}}{1 + R_t}$$

The total expenditure on monetary assets is given by:

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7 The related data is taken from: *http://evds.tcmb.gov.tr/index_en.html. (accessed 18/11/2016).*

8 In Karaman (2009), the expectations on whether the FX deposits may depreciate or appreciate in the next month are taken into consideration through backward and forward calculations so as to calculate more accurately true rates of return on those groups of deposits.

9 More detailed derivations of the following concepts can be reached from Anderson et al. (1997c).

$$Y_t = \sum_{i=1}^{n} \pi_{it}^{nom} m_{it}^{real} = \sum_{i=1}^{n} \pi_{it}^{real} m_{it}^{nom} .$$

The share of asset *i* in period *t* in total expenditures on monetary assets is given by:

$$w_{it} = \left(\frac{\pi_{it}^{real} m_{it}^{nom}}{y_t} \right) = (R_s - r_{is}) m_{is}^{nom} / \sum_{i=1}^{n} (R_s - r_{js}) m_{js}^{nom}.$$

The above formulations reveal that the Divisia indices can be measured from the stocks of nominal monetary assets and interest rates. Accordingly, the nominal Divisia index of monetary services[10] DM_t^{nom} is measured as:

$$DM_t^{nom} = DM_{t-1}^{nom} \prod_{i=1}^{n} \left(\frac{m_{it}^{nom}}{m_{it-1}^{nom}} \right)^{\overline{w_{\iota t}}}$$

where $\overline{w_{\iota t}} = (w_{it} + w_{it-1})/2$. The real Divisia index can be obtained by taking the logarithms of the formula such that

$$logDM_t^{nom} - logDM_{t-1}^{nom} = \sum_{i=1}^{n} \overline{w_{\iota t}} (logm_{it}^{nom} - logm_{it-1}^{nom}).$$

It is given the graphs of Divisia and simple-sum M1 and M2 indices Figure 1 and 2, respectively. In Table 1 in the Appendix, given that there are no missing values in any of the series in the group, the descriptive statistics of all the variables for group statistics are provided. The correlation matrix for the sample period is given in Table 2. The latter reveals that the correlation between output and money supply is higher when the M1 indices are used and between inflation and money supply is higher when M2 used for both Divisia and simple sum. As expected, the correlation between broad money simple sum and Divisia aggregates (M2S and M2D) is relatively small compared to narrow ones. Lastly, historical series for Turkey between 2005Q4-2016Q1 are given in Figure 8 in the Appendix.

[10] The use of the Tornqvist-Theil Divisia index to measure the quantity of money is highly advocated. In Anderson et al. (1997c, p. 55) stated that "the Törnqvist-Theil index number is the only one known among superlative index numbers to retain its second-order tracking properties when some common aggregation theoretic assumptions are violated." That is, the Törnqvist-Theil index numbers provide well-rounded statistical approximations of the unknown aggregates.

Figure 1: Graph of Divisia and simple-sum M1 indices

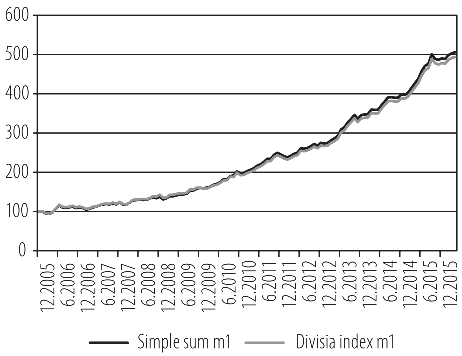
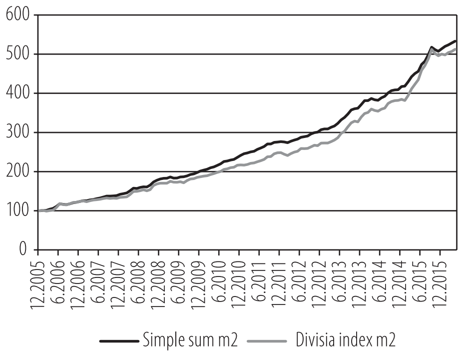


Figure 2: Graph of Divisia and simple-sum M2 indices



5. Wavelet analysis

The correlation coefficients in Table 2 give the extent of the comovement between variables for only a **single** value for a given of time period. Acknowledging that the degree of comovement can change over time, it is largely argued in the literature that the measure of the correlation coefficient hides certain information across the series. In this regard, to obtain some frequency domain beside to the time domain i.e., given by the measure of correlation, the wavelet approach is preferred. As stated by Rua (2010), essentially, the wavelet-based measure allows one to quantify the comovement in the time–frequency space and evaluate over which periods of time as well as of frequencies is the comovement higher. Hence, it gives correlation coefficients around each moment in time and for each frequency. Given that the strength of the comovement may vary over time, this feature is of great importance (Rua 2010, p. 686-687).

The comovements in the time–frequency space are represented by the contour plot on which the strength and the direction of the comovement between two time series over a sample period can be obtained. Through this way, the varying features of the comovement are thought to be described better. In the figures below, the horizontal axis shows the time interval whereas the vertical axis corresponds to the frequency. The frequency is expressed in the form of years. The time interval is around ten years which determines a short frequency domain. In accordance with different color tones one can define various levels of comovements between series. In the counter plot, the increasing darkness corresponds to increasing values i.e., the high degrees of comovement between two series whereas increasing light colours to low degrees. The degree of signals is given by the bar located on the right hand side of the figures on which the darker layers correspond to strong comovements whereas as the layers turn whiter the comovement becomes weaker. Hence, one can reach a two-fold analysis which is on the one side where the series move together or not and on the other side whether the strength of the relationship varies at different frequencies over time. Sample period is from Q4 2005 up to Q12016. The results are obtained using Matlab.

From the figures below one can figure out certain outstanding results. In those figures, the existence of the comovements among GDP growth, output gap, inflation and changes in monetary aggregates are questioned. The time series of m1s, m2s, m1d and m2d refer to simple sum aggregates and Divisia aggregates for M1 and M2, respectively. Besides, GDP stands for – first difference of – log of GDP, gap captures the cyclical components around the trend, inf stand for inflation and int for - first difference of – interest rate. Figures 3.1 and 3.2 demonstrate the wavelet results of the comovement between total output and Divisia and simple sum narrow monetary aggregates i.e. M1, respectively. The frequency is higher as the time relation becomes less than one year whereas it becomes lower as the time interval goes beyond one year. From the figure, there seems to be a high degree of comovement between GDP and both Divisia and Simple sum M1 at relatively low frequencies during the whole sample period. At high frequency domain, there seems not to be an outstanding comovement between either forms of money supply changes and GDP growth.

Figure 3.1: Comovement between GDP and M1D

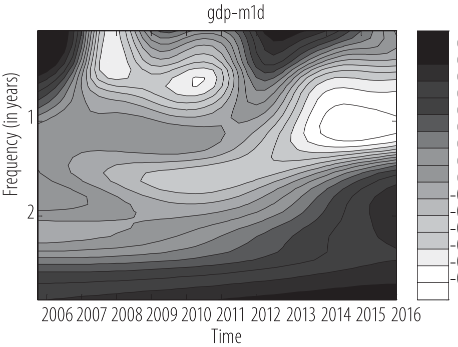
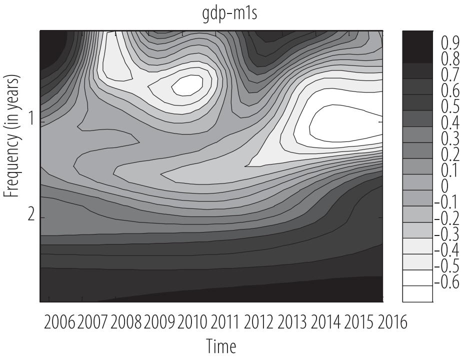


Figure 3.2: Comovement between GDP and M1S



Note: For the Figures 3 to 7, the horizontal axis shows the time interval i.e., between period 2006-2016 and the vertical axis corresponds to the frequency. The frequency is expressed in the form of years.

In consideration of the exploration of strength of comovement between GDP and Divisia and Simple sum monetary aggregates at M2, from the Figures 4.1 and 4.2, it is seen that the degree of comovement between GDP and M2 is getting intensified at lower frequencies being valid for both Divisia and Simple sum aggregates and for all the sample period. Contrary to the descriptive statistics that determines no significant correlation between GDP growth and change in M2 money supply, the Wavelet-based measure proposes a gradual increment in the comovement between the series over time at lower frequencies i.e. for two or more years. A robust comovement is to be found at very high frequencies at certain specific years. It should be pointed out that at the peak time of the crisis episode, there is no correlation at relatively high frequencies i.e. around one year, between GDP growth and changes in broad money supply both for Divisia and simple sum aggregates. This finding may pave the way for certain implications for further studies regarding the stance of monetary policy during the crisis episode e.g. *underutilization* of the conventional simple sum monetary aggregates in this period. One can attribute this to a formation of policy stance built on the short term interest rates rather than bolstering broad money supply in the monetary accelerator mechanism. Besides this, when the variable of GDP growth is replaced with that of output gap, there is a significant comovement between output gap and M2 monetary aggregate as seen in Figure 7. Also, there seems to be a break date in the sample period (around the year of 2010) after which the comovement gets intensified for both types of money supply. Herein, when the money supply is specified as Divisia M2 aggregate, the comovement becomes even higher at both low and high frequencies.

Figure 4.1: Comovement between GDP and M2S

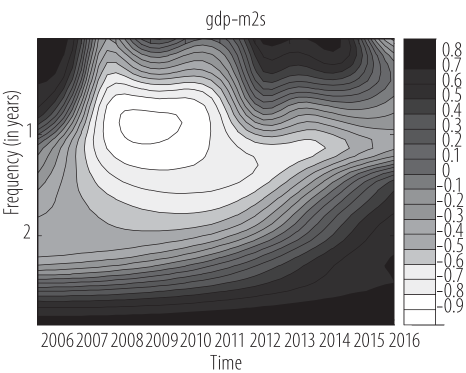
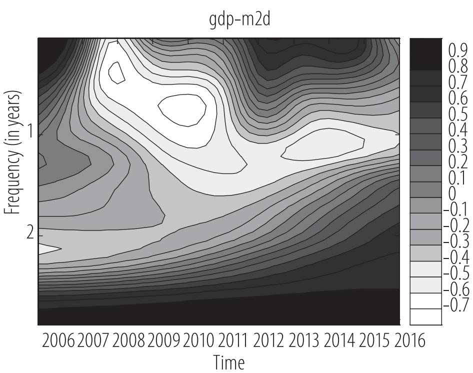


Figure 4.2: Comovement between GDP and M2D



Regarding the very abstract of comovement between inflation and money supply within time-frequency domain, for both conventional simple sum and Divisia aggregates there is clearly a breakpoint for M1 and M2 after which the strength of comovement between inflation growth and change in money supply dies away at both low and high frequencies. It is the case for both narrow and broad money supply. This can be a signal for the existence of breakpoint in the series, before delving into the estimated SVAR analysis, the breakpoint test is to be made in accordance with the restrictions on model structures. As seen from Figures 5 and 6 that the comovement correlation between inflation and money supply changes prevails particularly in lower frequencies until some period of time i.e. until 2011. One outstanding conclusion is that there arises a moderate correlation between inflation and money supply changes particularly for Divisia and simple sum M2 at very high frequencies which in turn may imply for relatively high price stickiness in Turkey[11].

Figure 5.1: Comovement between INF and M1S

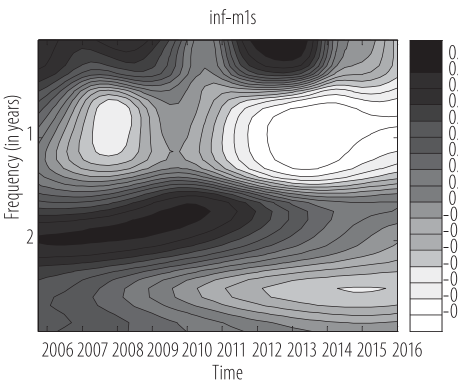
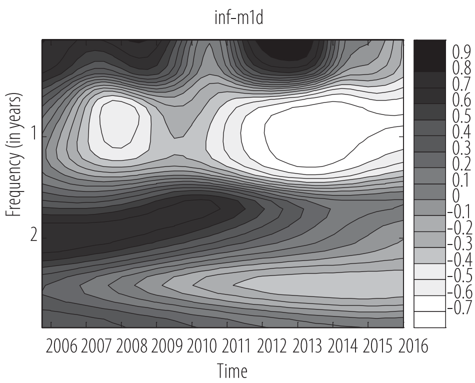


Figure 5.2: Comovement between INF and M1D



[11] This conclusion is consistent with the conclusion obtained by Özmen and Sevinç (2011) who found stickiness in the prices of consumption goods in Turkey.

Figure 6.1: Comovement between INF and M2S

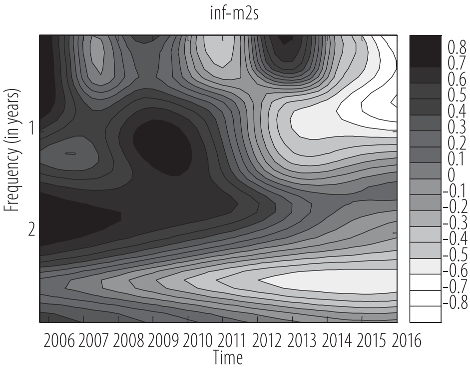


Figure 6.2: Comovement between INF and M2D

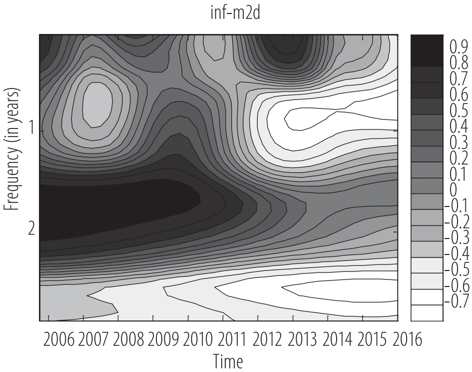


Figure 7.1: Comovement between GAP and M2S

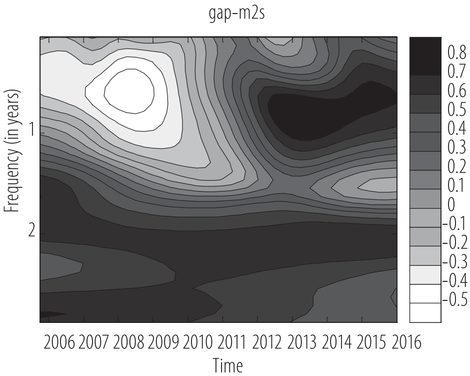
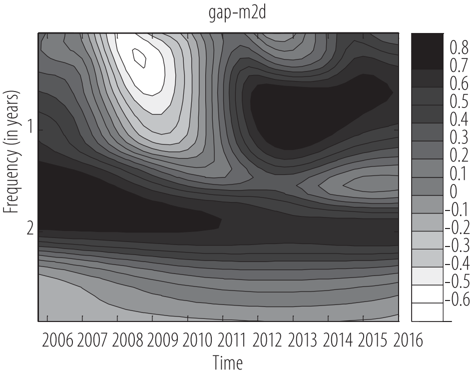


Figure 7.2: Comovement between GAP and M2D



The abovementioned results obtained from Wavelet-based measures imply at the end for small distinctions between Divisia and simple sum monetary aggregates for their corresponding comovements with income and prices. In the following section, to get better sight of whether there arises some note-worthy *contradistinction* between alternative measures of monetary aggregations, t*rue to form*, when considered within a structural VAR model with certain short-run and long-run restrictions, and once i) the stationarity is provided, ii) the optimal lag-length is determined and iii) the existence of break-point is controlled. Subsequent to this, question on the significance of Divisia index as alternative to the conventional one in predicting the variations in price and income for the case of Turkey can be better answered.

6. Structural VAR analysis

The standard vector autoregression (VAR) models due to Sims (1980) have been widely used in empirical macroeconomics so as to forecasting for policy analysis. VAR models provide *identificaton* by determining a link between the reduced-form time series and the structure, so that in order for obtaining the structural parameters, the estimates of those reduced-form parameters are used. Thus, historically observed variation in the data is interpreted to predict the consequences of an action not yet undertaken (Sims, 1986). By using VARs, it is attempted to reveal important dynamic characteristics of the economy without imposing structural restrictions from a particular economic theory (Keating, 1992). Hereby, the VARs method is argued to be *atheoretical*, that is, it uses a mechanical technique grounded to considerable extent on empirical sphere that is difficult to strike a balance with the economic theory. The need for a theoretical formation resulted in the development of the technique of **structural VAR** (SVAR) model contributed by Blanchard and Watson (1986), Bernanke (1986) and Sims (1986)[12]. This technique of SVAR allows one to use economic theory to incorporate the reduced-form VAR model into a system of structural equations (Keating, 1992). Accordingly, one can obtain the dynamic effects in a multivariate system grounded on the theoretical sphere. Besides, all variables in the system are treated as endogenous which in turn endogenizes the monetary policy instruments as well. In estimation of the parameters, certain structural restrictions are determined through which the impulse response functions and variance decomposition analyses can give structural information on the macroeconomic fundamentals.

6.1. Methodology

A vectoral form of structural VAR system is as follows[13]

$$Ax_t = C(L)x_{t-1} + Dz_t$$

[12] See Kilian (2013) for a review of how the literature on SVAR has evolved over time.

[13] Keating (1992) is followed to introduce the methodology for SVAR model.

where x_t is a vector of endogenous variables whereas z_t is of (unobservable) exogenous variables. The latter correspond to errors to structural equations. The square matrix of A shows the structural parameters on the contemporaneous endogenous variables. The polynomials in lag operator is denoted by the term $C(L)$ such that $C(L) = C_0 + C_1L + C_2L^2 + ... + C_kL^k$ where k is the kth degree matrix polynomial. The term D denotes the response of endogenous variables to the exogenous shocks. The reduced-form for the system is as follow

$$x_t = A^{-1}C(L)x_{t-1} + A^{-1}Dz_t.$$

When it is assumed that the (exogenous) shocks have temporary effects, then the error term z_t is equal to ε_t, a serially uncorrelated vector (white noise vector). In this case, the above equation can be rewritten as

$$x_t = B(L)x_{t-1} + e_t$$

where $B(L) = A^{-1}C(L)$ and $e_t = A^{-1}D\varepsilon_t$. The system here is a VAR model where the term e_t stands for the residuals and for the linear combinations of serially uncorrelated shocks. Besides, each variable is a function of lagged values of other variables. The term VAR coefficient matrix $B(L)$ is a nonlinear function of the structural parameters. If all shocks are stationary, then this above equation must be used. If it is assumed that the shocks have permanent effects, the reduced-form equation can be expressed in the form of first difference.

$$\Delta x_t = B(L)\Delta x_{t-1} + e_t$$

Putting differently, through this equation, the shocks to the term z_t are permanent. The z_t is to be modeled as a unit root process: $z_t - z_{t-1} = \varepsilon_t$, so that z is equal to the sum of all past and present values of residuals which in turn generates permanent shocks. If all shocks have unit root, the above equation must be estimated. If the parameters in A and D were known, the dynamic structure of the model and the structural shocks could be calculated from the coefficients of estimated SVAR and from the estimated residuals, respectively. Since the coefficients on A and D are unknown, the identification of the structural parameters is to be achieved by dint of imposing theoretical restrictions, so that the number of unknown parameters is reduced. The number of theoretical restrictions is set as $n(n-1)/2$ where n shows the number of variables in the model.

6.2. SVAR model

In this section, a SVAR model is estimated in order to capture the outstanding relationships between alternative monetary aggregates and quantity-price series. In this regard, two structural VAR models, i.e. one with short-run restrictions and the other with long-run restrictions are built up. Via those so-called identifying restrictions, it is doable to draw certain conclusions regarding the structural parameters of the 'true' model from the data without which different structural models give rise to the same reduced form generating inconsistency (Gottshalk, 2001). In determination of both types of restrictions previous studies and certain facts are utilized. Following Keating (1992) and Keating et al. (2014), both measures of interest rate and money are included besides the output and prices in the model setting so as to see the responses to different policy instruments when interest rates and money supply are simultaneously represented within SVAR system. Given a relatively **short** sample period, a 4-variable SVAR model is preferred. Specifically, for representing the real income, the GDP in constant prices in 1998 – seasonally and calendar adjusted – is used. The inflation data is monthly CPI over which the quarterly change is obtained. The overnight interest rate and 1-week repo rates are used to obtain quarterly interest rate data. Sample period is from Q1 2006 up to Q1 2016 to reflect a stable monetary policy regime that is *explicit* inflation targeting and to have the revised definitions of monetary aggregates.

The SVAR **model 1** comprises the quarterly change in CPI (e_t^p), the first difference of logarithm of GDP (e_t^y), the first difference of interest rate (e_t^r) and the quarterly change in money supply indices, M2D and M2S (e_t^m). The SVAR **model 2** incorporate the output gap – measured via Hodrick-Prescott filter (e_t^{gap}) instead of logarithm of GDP into the model. Four structural shocks are defined in the model. The shocks which are of primary interest in this study are shocks to monetary policy i.e. money supply and interest rate.

Considering the ordering of the variables, the first equation that stands for inflation (e_t^p) provides three restrictions, so that the inflation is predetermined. Hence, in the short run, the producers only respond to supply shocks i.e., cost-push inflation that can generates changes in the price level. Regarding the equation for interest rate (e_t^r) the assumption is that given the inflation-targeting policy regime in Turkey for the sample period, the adjustment of the short-term interest rates are due to the expected changes in the price level. The third equation of money supply (e_t^m) provides the last restriction on the model where the shocks to the money supply equation can be considered as the discretionary deviations from the rule. The last equation for output (e_t^y) is a reduced IS-equation where the total output is explained by all other variables – being fully endogenous.

In the Model 2 for the short run SVAR model, the changes in the logarithm of GDP are replaced by output gap which captures the cyclical components around the trend, so that it is aimed to see whether inclusion of (alternative) monetary aggregates – M2D and M2S – within the monetary policy contributes to a Taylor-type formation of the policy stance. Regarding the ordering of the variables, the output gap is taken as most pre-determined variable providing three restrictions to the model. Inflation is assumed to be set only in accordance with the output gap. Lastly, the adjustment of the short-term interest rates is due to the expected changes in the price level and output gap being relevant with the benchmark Taylor-type policy rule. The Model 1 and Model 2 are defined below as follows.

Model 1 for short run SVAR (GDP, INF, INT, M) Model 2 for short run SVAR (GAP, INF, INT, M):

$$\begin{bmatrix} e_t^p \\ e_t^r \\ e_t^m \\ e_t^y \end{bmatrix} = \begin{bmatrix} C(1) & 0 & 0 & 0 \\ C(2) & C(3) & 0 & 0 \\ C(4) & C(5) & C(6) & 0 \\ C(7) & C(8) & C(9) & C(10) \end{bmatrix} \cdot \begin{bmatrix} \varepsilon_t^p \\ \varepsilon_t^r \\ \varepsilon_t^m \\ \varepsilon_t^y \end{bmatrix} \qquad \begin{bmatrix} e_t^{GAP} \\ e_t^p \\ e_t^r \\ e_t^m \end{bmatrix} = \begin{bmatrix} C(1) & 0 & 0 & 0 \\ C(2) & C(3) & 0 & 0 \\ C(4) & C(5) & C(6) & 0 \\ C(7) & C(8) & C(9) & C(10) \end{bmatrix} \cdot \begin{bmatrix} \varepsilon_t^{gap} \\ \varepsilon_t^p \\ \varepsilon_t^r \\ \varepsilon_t^m \end{bmatrix}$$

In the Model 3 below, the identifying restrictions on long-run multipliers for structural shocks are imposed. Due to the lack of space, only the results for long-run model which includes the variable of output gap are reported. Accordingly, in determination of ordering of the variables, three restrictions come from the equation for output gap (e_t^{GAP}) which specifies that the aggregate supply shocks are the only source of permanent movements in output gap. Two additional restrictions are obtained from equation for inflation (e_t^p) which depends only on output gap and (cost-push) inflation shocks in the long run. The effects due to changes in M2 monetary aggregates are not included in the equation since it is found that there is no causality from money supply to inflation. The equation that stands for the interest rate (e_t^r) denotes an extended long run IS equation which specifies the interest rates as a function of output gap and inflation as well as shocks to interest rates given the theoretical foundation of Taylor-rule.

Model 3 for Long run SVAR (GAP, INF, INT, M):

$$\begin{bmatrix} e_t^{GAP} \\ e_t^p \\ e_t^r \\ e_t^m \end{bmatrix} = \begin{bmatrix} C(1) & 0 & 0 & 0 \\ C(2) & C(5) & 0 & 0 \\ C(3) & C(6) & C(8) & 0 \\ C(4) & C(7) & C(9) & C(10) \end{bmatrix} \cdot \begin{bmatrix} \varepsilon_t^{gap} \\ \varepsilon_t^p \\ \varepsilon_t^r \\ \varepsilon_t^m \end{bmatrix}$$

6.3. Results

In estimation of structural VAR model i) the tests for stationarity are provided, ii) the optimal lag-length is determined, and iii) the existence of break-point is controlled. As stated above, the time series of m1s, m2s, m1d and m2d refer to simple sum aggregates and Divisia aggregates for M1 and M2, respectively.

In the first instance, before moving to SVAR model, the stationarity of variables is tested using unit root test procedures of Augmented-Dickey-fuller (ADF) and of Phillips-Perron (PP). The argument is that the system, i.e., the estimated VAR, is stable (stationary) if all the modulus belonging to the roots of the system are less than one and lie inside the unit circle. None of the variables has the unit root except the interest rate and GDP for which the first differences are taken, thus it becomes I(1). The INF variable has unit root for only intercept when ADF is used. The optimal lag-length is determined as 1 in accordance with Schwarz information criterion. The structural break analysis for the regression model is made grounded on Bai and Perron (2003) multiple breakpoints tests. For both the variables of interest of M2S and M2D, Bai-Perron tests of *1 to M globally determined breaks* suggest 2010Q1 as the break dates whereas tests of *L+1 vs. L sequentially determined breaks* find no break-date. The estimated models are reported as there is break-date for the sample period. Due to the lack of space, however, the model with no break-date is not reported in this study.

The results for the short run SVAR model for Model 1 are given in Tables 3-4 and Figures 9-10.Table 3 reveals the estimated coefficients of the SVAR model when the money supply is specified as the Divisia aggregate type. Accordingly, from the model it is seen that changes in inflation and interest rate have a significant effect on the – first difference of – log GDP where the former negatively influences the GDP whereas the latter one has a positive effect. The model also shows that the interest rate has a positive and significant effect on the changes on money supply when Divisia M2 aggregate is used. It is as expected since the changes in interest rates are assumed to impinge upon the user costs of alternative monetary assets and thus on the Divisia sum monetary aggregates. As a crucial point, the estimated SVAR model reveals no important effect of the Divisia M2 aggregate on the variations in GDP which is very contrary to the conclusions drawn in existing literature. Figure 9 below demonstrates responses of model variables to the structural shock on – the change in – Divisia type money supply index. The standard deviation of the shocks is expressed as one along with confidence intervals (+/- 2 standard errors). In this regard, as a result of one time expansionary monetary policy shock through an increase in Divisia type money supply index M2D, as expected, the variable of GDP increases but the effect essentially dies out after three quarters. The interest rate rises with one lag as a response to discretionary deviation from the rule. Besides, the figure demonstrates no worth-mentioning response of inflation justifying the sticky prices for the constructed short-run SVAR model.

Table 4 shows the estimated coefficients of the SVAR model when the money supply is specified as the traditional simple-sum M2 aggregate. The results imply that in the short run, only inflation and interest rate changes matter for variations in the variable of GDP. However, the estimated coefficients on these variables have different signs compared to those in the model 1 which includes the Divisia M2 aggregate. Besides, since there is no channel through which the interest rate directly affects the money supply, i.e. all monetary assets are perfect substitutes, the interest rate does not have a significant effect on the changes in money supply. In consideration of the responses of model variables to the structural shock on simple sum type money supply, it is revealed from Figure 10 that the only difference worth mentioning comes from the response of the variable of GDP being contrary to the model above that includes M2D decreases for a certain period of time as a result of one-time expansionary monetary policy shock.

In the Model 2 for the short run SVAR model, as previously stated, the changes in the logarithm of GDP are replaced by the output gap. Hereby, it is aimed to see whether inclusion of alternative Divisia M2 within the stance of monetary policy beside to the short term interest rate contributes to prediction of quantity and prices when considered within the formation of Taylor-type conduct of policy rule. The results for the short run SVAR model for Model 2 are given in Tables 5-6 and Figures 11-12. The estimated coefficients of the SVAR model are provided when the money supply is specified as the Divisia type in Table 5. The table reveals that inflation is explained by the variations in output gap. Besides, changes in inflation and output gap are of importance for the interest rate, so the theoretical relevance of the benchmark Taylor-type formation of short-term interest rates for Turkish economy is justified. As expected, the changes in interest rates are significantly dependent on Divisia money supply changes. However, being a crucial point, the estimated SVAR model reveals no important effect of the Divisia monetary aggregates on the variations in inflation. The impulse response functions provide that one-time expansionary monetary policy shock through an increase in Divisia type money supply makes the variable of output gap increase while for simple-sum type the effect is the exact opposite. Besides, the effects on interest rates of the M2D are higher compared to that of M2S.

From Tables 7-8 and Figures 13-14, the long run behaviours of the estimated SVAR model can be obtained. Table 7 reveals the estimated coefficients of the

Model 3 when the money supply is specified as M2D. Accordingly, in explanation of interest rate, the variations in output gap and inflation do have a positive and significant effect in the long run, being in rapport with the theoretical articulation of the Taylor-type monetary policy rule. Besides, under the specification of Divisia type money supply, that the changes in money supply are significantly influenced by changes in prices and interest rates and that the discretionary changes in money supply generates note-worthy fluctuations in inflation may pave the way for the arguments that the quantity theory of money holds in the long run, so that it is the money equilibrium which primarily determines the price level of an economy. However, as denoted in Table 8, when the money supply is specified as traditional M2 aggregates, then no significant effects of prices and interest rates on the changes on money supply arise in the long run. Still, the theoretical formation of the Taylor-type monetary policy rule is justified. Figures 13 and 14 reveal that variations in the variables of output gap and interest rates are relatively higher when the money supply is specified as Divisia M2 aggregate. As a result of one time expansionary monetary policy shock, the response of interest rate is higher when money supply is specified as the simple sum one. In addition to this, in the presence of money supply shocks – shocks to both Divisia and simple-sum M2 aggregates, the response of output gap is so small in the long run model.

To summarize, when the **quantity** is expressed as the logarithm of the total output, then in the short run SVAR model, interest rate arises as the primary instrument for the monetary policy stance whereas the discretionary changes in the monetary aggregates have a minor place. Still, short run models above reveal that the explanatory power of the Divisia type money supply is higher compared to the simple one in explaining the variations in output – this may imply a complementary role. However, in explanation of the **price** variable, that is, the quarterly change in CPI, there is no primary role for both types of monetary aggregates in the short run. When the logarithm of GDP is replaced by output gap, inclusion of Divisia monetary aggregates improves the predictive power of money supply as the policy instrument in explaining variations the output gap compared to traditional simple sum aggregations. In the long run SVAR model where the quantity is specified as the output gap and money supply is specified as the Divisia type, the Taylor type response function as well as quantity theory of money seem to hold.

7. Conclusion

Given the relatively increased varieties of financial innovations in the last decade on the one side and the relatively high inflation rates as well as enduring deviation of the output from its potential on the other side, a Divisia index is constructed for Turkish economy to test the arguments favouring the relative predictive power of alternative monetary aggregates on quantity-price variables compared to its simple-sum counterparts and to visualize whether the utilization of Divisia type monetary aggregates does generate a complementarity with the short run interest rates in the stance of monetary policy. To our best knowledge, there is no any other study that constructs the Divisia aggregates for Turkey for the past decade. This episode corresponds to a more interest rate-oriented inflation targeting regime. The wavelet analysis provides for a relatively high comovement between the indicators of output – change in the logarithm of GDP and output gap – and both types of monetary aggregates but at low frequencies. The wavelet-measure reveals a break date in the sample period after which the comovement gets intensified for Divisia and simple-sum M2 aggregates. Besides, there arises a moderate correlation between inflation and both Divisia and simple sum M2 aggregates at very high frequencies which in turn may imply relatively high price stickiness in the last decade. From the wavelet transformation analysis, it is seen that at the peak of the crisis episode, there is no comovement between output growth and changes in both Divisia and simple sum M2 aggregates at relatively high frequencies implying for the underutilization of the simple sum monetary aggregates in the conduct of monetary policy. In addition to this, structural VAR models for Turkey with short run and long run specifications are estimated through which both Divisia and simple sum monetary aggregates are incorporated into the economic theory. In those estimated models, the monetary policy instruments are endogenized in order for seeing the dynamic effects of those instruments when modelled together in a multivariate system grounded on the theoretical sphere. It is found that there arises the relative power of Divisia aggregates in predicting quantity and price variables compared to its simple sum counterpart and that there is much more complementarity between Divisia type money stock and short-term interest rates in conduct of monetary policy. However, in explanation of inflation, there is no primary role neither for interest rate nor the monetary aggregates, at least in the short run. In the long run specification, however, it seems that the quantity theory of money holds. All in all, a well-rounded theoretical articulation of Divisia type monetary aggregation can be argued to be no that much empirically justified for the case of Turkey.

For the future research, on the theoretical sphere, in construction of the Divisia index, the rate of return on both sight and time deposits on foreign currencies can be extended to include both forward and backward expectation with which more accurate representations of returns on foreign assets are to be obtained. On the empirical sphere, the benchmark Taylor-type policy rule can be redefined by including the alternative money supply indices within the rule.

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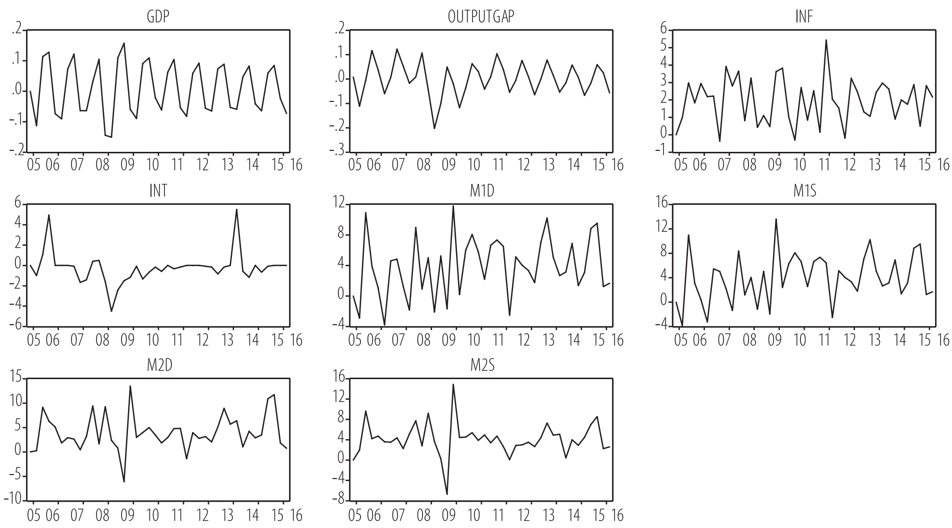
Appendix

Table 1: Group statistics-Descriptive statistics of all the variables

	GDP	GAP	INF	INT	M1S	M1D	M2S	M2D
Mean	0.006958	3.25E-12	1.943878	-0.238095	3.964623	3.902790	4.072155	3.121095
Median	-0.01081	0.007078	2.099933	-0.083333	3.694302	3.907561	3.935038	2.867014
Maximum	0.157386	0.123035	5.439257	5.500000	13.60423	11.78862	14.86906	14.44049
Minimum	-0.151002	-0.202263	-0.369884	-4.500000	-3.848208	-3.825510	-6.689262	-7.433835
Std. Dev.	0.08634	0.067848	1.328328	1.542094	3.984742	3.924830	3.252058	4.429320
Sum	0.292248	1.37E-10	81.64289	-10.00000	166.5142	163.9172	171.0305	131.0860
Sum Sq. Dev.	0.305641	0.188735	72.34270	97.50022	651.0050	631.5761	433.6110	804.3740
Observations	42	42	42	42	42	42	42	42

Figure 8: Historical series for Turkey (2005Q4-2016Q1)



Note: the period is between 2005Q4-2016Q1. The variable GDP denotes the first difference in logarithm of GDP, OUTPUTGAP denotes the cyclical component around the trend of GDP, INF denotes the quarterly changes in CPI, INT denotes the first difference of – short-term interest rates, and, M1D, M1S, M2D, M2S denote the percentage change in Divisia and simple-sum aggregates for M1 and M2, respectively.

Table 2: Correlation matrix for the sample period 2006Q1 – 2016Q1

	GDP	GAP	INF	INT	M1D	M1S	M2D	M2S
GDP	1.000000	0.641926	-0.479772	0.186517	0.498536	0.464177	0.059276	-0.111970
GAP	0.641926	1.000000	-0.196717	0.355173	0.390175	0.350920	0.146494	0.028481
INF	-0.479772	-0.196717	1.000000	0.171605	0.073339	0.100734	0.269443	0.258978
INT	0.186517	0.355173	0.171605	1.000000	0.115727	0.078151	0.224907	0.108684
M1D	0.498536	0.390175	0.073339	0.115727	1.000000	0.988359	0.769629	0.648637
M1S	0.464177	0.350920	0.100734	0.078151	0.988359	1.000000	0.765167	0.673498
M2D	0.059276	0.146494	0.269443	0.224907	0.769629	0.765167	1.000000	0.921512
M2S	-0.111970	0.028481	0.258978	0.108684	0.648637	0.673498	0.921512	1.000000

Table 3: Model 1 (INF, INT, GDP, M2D) for short run SVAR

	Coefficient	Std. Error	z-Statistic	Prob.
C(2)	0.258927	0.182179	1.421276	0.1552
C(4)	0.020550	0.541234	0.037969	0.9697
C(5)	**1.047571**	**0.458309**	**2.285732**	**0.0223**
C(7)	**-0.045634**	**0.008381**	**-5.444834**	**0.0000**
C(8)	**0.017701**	**0.007546**	**2.345753**	**0.0190**
C(9)	0.002899	0.002448	1.184115	0.2364
C(1)	1.300465	0.145396	8.944272	0.0000
C(3)	1.498400	0.167526	8.944272	0.0000
C(6)	4.343259	0.485591	8.944272	0.0000
C(10)	0.067255	0.007519	8.944272	0.0000

Note: model 1 includes the divisia index for M2 aggregates, first difference of log of total output, inflation and first difference of interest rate. Lag length is specified as 1. The log likelihood of the SVAR model is -204.4897.

Figure 9: Responses of model variables to structural shock on M2D in Model 1 for short run SVAR

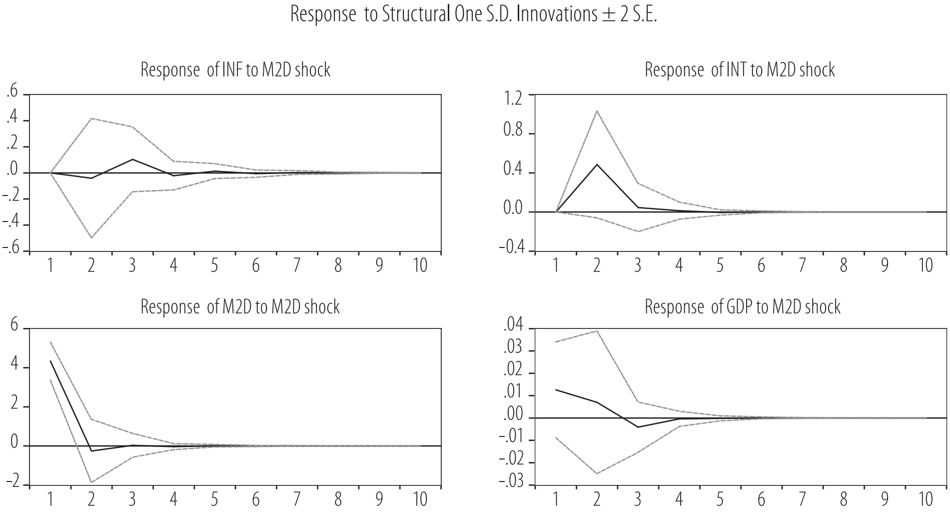


Table 4: Model 1 (INF, INT, GDP, M2S) for short run SVAR

	coefficient	Std. Error	z-Statistic	Prob.
C(2)	0.241200	0.189424	1.273336	0.2029
C(4)	0.542009	0.410404	1.320672	0.1866
C(5)	0.238225	0.335829	0.709362	0.4781
C(7)	**0.043820**	**0.008626**	**-5.079818**	**0.0000**
C(8)	**0.021361**	**0.006953**	**3.072153**	**0.0021**
C(9)	0.002242	0.003253	-0.689167	0.4907
C(1)	1.293570	0.144625	8.944272	0.0000
C(3)	1.549724	0.173264	8.944272	0.0000
C(6)	3.291570	0.368009	8.944272	0.0000
C(10)	0.067724	0.007572	8.944272	0.0000

Note: model 1 includes the simple sum index for M2 aggregates. Lag length is specified as 1. The log likelihood of the SVAR model is -194.8117

Figure 10: Responses of model variables to the structural shock on M2S in Model 1 for short run SVAR

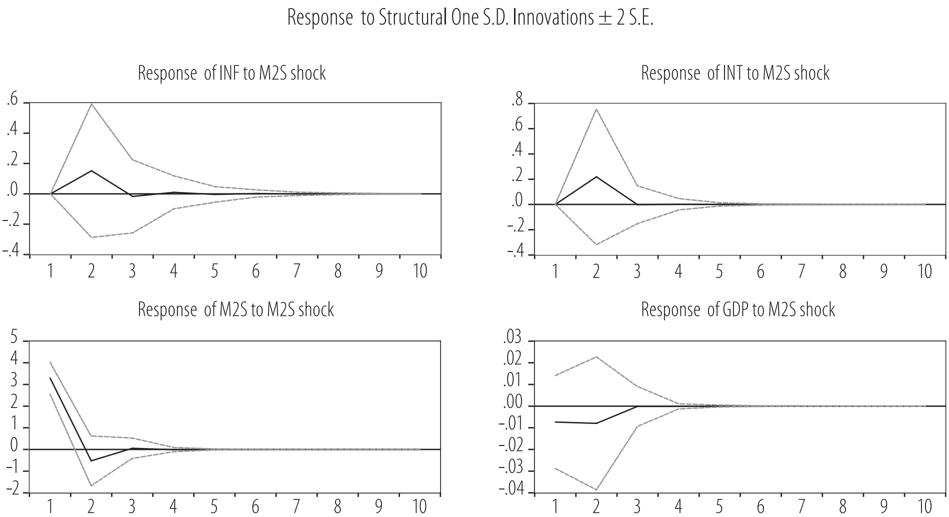


Table 5: Model 2 (OUTPUT GAP, INF, INT, M2D) for short run SVAR

	coefficient	Std. Error	z-Statistic	Prob.
C(2)	8.466202	2.604160	3.251030	0.0011
C(4)	12.00599	3.570160	3.362873	0.0008
C(5)	0.560437	0.192787	2.907029	0.0036
C(7)	5.923183	12.93361	0.457968	0.6470
C(8)	0.468558	0.678677	0.690398	0.4899
C(9)	0.905873	0.505750	1.791149	0.0733
C(1)	0.066118	0.007392	8.944272	0.0000
C(3)	1.088975	0.121751	8.944272	0.0000
C(6)	1.327776	0.148450	8.944272	0.0000
C(10)	4.247081	0.474838	8.944272	0.0000

Note: model 2 includes the Divisia index for M2 aggregates, first difference of log of total output, inflation and first difference of interest rate. Lag length is specified as 1. The log likelihood of the SVAR model is -190.2457.

Figure 11: Responses of model variables to the structural shock on M2D in Model 2 for short run SVAR

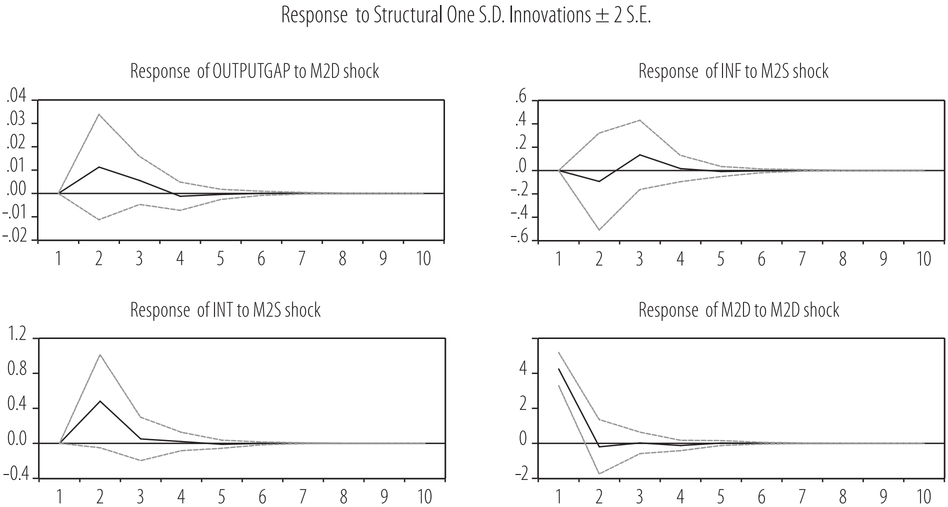


Table 6: Model 2 (OUTPUT GAP, INF, M2S) for short run SVAR

	coefficient	Std. Error	z-Statistic	Prob.
C(2)	8.368695	2.566675	3.260520	0.0011
C(4)	13.16624	3.633429	3.623639	0.0003
C(5)	0.545060	0.198947	2.739722	0.0061
C(7)	2.776752	10.02618	0.276950	0.7818
C(8)	0.287266	0.519108	0.553383	0.5800
C(9)	0.328316	0.378569	0.867254	0.3858
C(1)	0.066897	0.007479	8.944272	0.0000
C(3)	1.085950	0.121413	8.944272	0.0000
C(6)	1.366399	0.152768	8.944272	0.0000
C(10)	3.271546	0.365770	8.944272	0.0000

Note: model 2 includes the simple sum index for M2 aggregates. Lag length is specified as 1. The log likelihood of the SVAR model is -182.0422.

Figure 12: Responses of model variables to the structural shock on M2S in Model 2 for short run SVAR

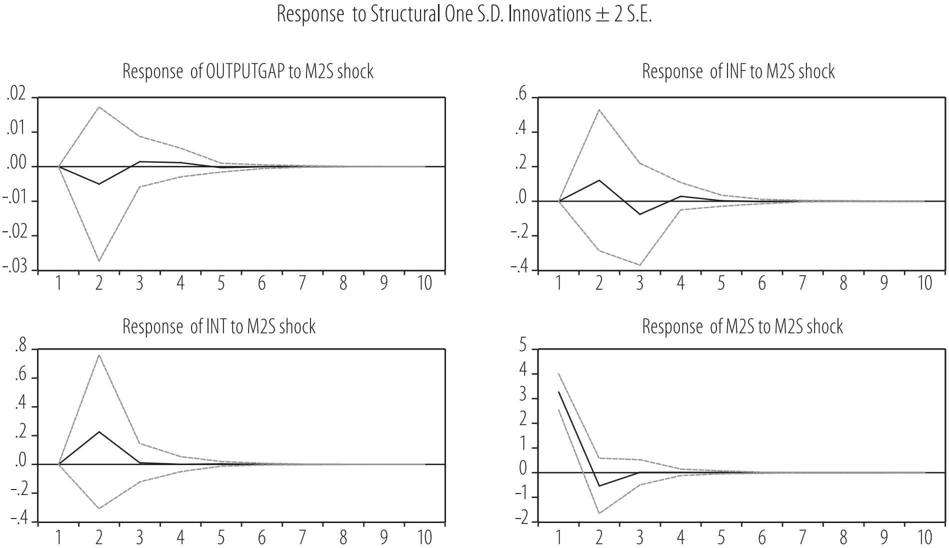


Table 7: Model 3 (OUTPUT GAP, INF, INT, M2D) for long run SVAR

	coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.077208	0.008632	8.944272	0.0000
C(2)	0.022957	0.146489	0.156712	0.8755
C(3)	1.019558	0.312092	3.266848	0.0011
C(4)	0.878149	0.661009	1.328497	0.1840
C(5)	0.926336	0.103568	8.944272	0.0000
C(6)	1.173772	0.259203	4.528392	0.0000
C(7)	1.142846	0.641068	1.782723	0.0746
C(8)	1.413709	0.158057	8.944272	0.0000
C(9)	1.834910	0.593764	3.090302	0.0020
C(10)	3.524028	0.393998	8.944272	0.0000

Note: model 3 includes the Divisia index for M2 aggregates. Lag length is specified as 1. The log likelihood of the SVAR model is -190.9766.

Figure 13: Responses of model variables to the structural shock on M2D in Model 3 for long run SVAR

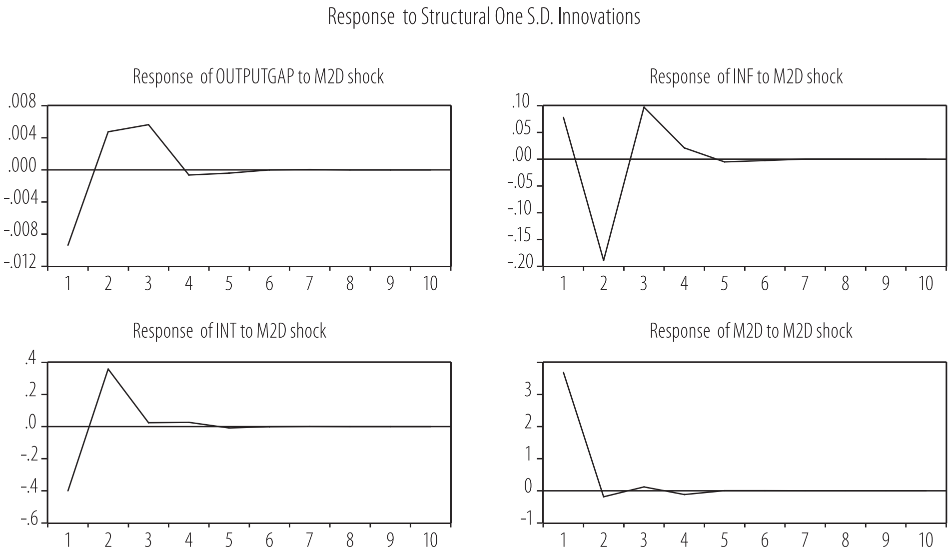


Table 8: Model 3 (OUTPUT GAP, INF, INT, M2S) for long run SVAR

	coefficient	Std. Error	z-Statistic	Prob.
C(1)	-0.081439	0.009105	-8.944272	0.0000
C(2)	-0.050719	0.145409	-0.348802	0.7272
C(3)	**-1.207553**	**0.317738**	**-3.800464**	**0.0001**
C(4)	-0.413669	0.446085	-0.927331	0.3538
C(5)	0.918950	0.102742	8.944272	0.0000
C(6)	**1.148950**	**0.257351**	**4.464529**	**0.0000**
C(7)	0.605034	0.438494	1.379800	0.1676
C(8)	1.410366	0.157684	8.944272	0.0000
C(9)	0.545218	0.428935	1.271097	0.2037
C(10)	2.685291	0.300225	8.944272	0.0000

Note: model 3 includes the simple sum index for M2 aggregates. Lag length is specified as 1. The log likelihood of the SVAR model is -184.0422.

Figure 14: Responses of model variables to the structural shock on M2S in Model 3 for long run SVAR