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On Stability of Money Demand Model in Pakistan: A Super Exogeneity Testing Approach Using Indicator Saturation

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Abstract

The study attempts to test the stability of money demand (M-D, hereafter) model in case of Pakistan under the shade of super exogeneity testing procedure with an amalgamation of recently developed techniques of selecting breaks or location shifts (data driven) using Indicator Saturation like; Impulse Indicator Saturation (IIS), Step Indicator Saturation (SIS) and Trend Indicator Saturation (TIS). The estimated VECM model of money demand (M2) with Real Income, Inflation Rate, interest rates (short and long term), Financial Innovation and Financial Development; reveals that the parsimonious model is structurally invariant and remain super exogenous to relevant class of interventions for parameters of interest during the stipulated period (1972-2018) in Pakistan and hence can be used for policy purposes. Consequently, Lucas critique refuted in case of Pakistan.

Key Words: Money Demand, Super Exogeneity, Indicator Saturation, GETS Modeling
JEL Codes: E41, E52, C520, O53

1 Introduction

Demand for money has received an enormous attention from researchers in Pakistan since early 1970's. Some of the

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studies have used classical econometric techniques like Classical Regression and OLS[4] in estimating the demand for money (Abe et al., 1975; Ahmad & Khan, 1990; Akhtar, 1974; Mangla, 1979; Nisar and Naheed, 1983), but results produced in these studies were mainly misleading due to the usage of small data sets and some found insignificant results or even did not pass the stability tests, if checked. Many researchers in Pakistan have endeavored to re-estimate the M-D model before the concept of cointegration came up to the canvas. Later, the implementation of cointegration shed light on some issues with respect to the estimation of M-D function. These issues were mainly, the selection of appropriate variables in terms of scale, opportunity cost of holding money and the appropriate functional form of M-D equation. In spite of the fact that the significance of a few measures of income within M-D model has continuously been backed up with empirical evidences, there has been no agreement on the significance of the interest rate portion. A few thinks about found interest rate to be a critical variable whereas other fizzled to discover its importance within the M-D equation. The role of financial innovation and financial development, separately, well documented in (Adil et al., 2020; Mbazima-Lando & Manuel, 2020; Mlambo & Msosa, 2020; Sanya, 2019; Sarwar et al., 2013). The study encompasses both to check their impact on M-D in presence of data driven structural breaks.

The State Bank of Pakistan (SBP) initially used narrow money (M0) to target broad money (M2) as an instrument till 2008 to achieve a dual macroeconomics objectives of price stability and output growth (Shafiq & Malik, 2018)[5.] The standing literature so far has been able to classify several reasons of causing instability in M-D function includes–structural breaks in economy, degree of monetization, financial innovation and divergences between money supply and money demand (Khan & Hossain, 1994). A plethora of studies have focused to single out the relevant determinants of M-D function in Pakistan from 1990's to onward

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[4] Ordinary Least Squares

[5] But in August 2009, SBP established an Interest Rate Corridor (IRC) as a policy rate with SBP reverse repo rate and SBP repo rate named as ceiling and floor rate respectively. The goal of introducing IRC is to promote stability in money market and strengthening the transmission of monetary policy resulting in stable prices ultimately.

like (Ahad, 2017; Anwar & Asghar, 2012; Hossain, 1994; Iftekhar et al., 2016; Khan & Hossain, 1994; Qayyum, 1998) while on the stability of M-D function several studies are also available like (Faridi & Akhtar, 2013; Omer, 2010; Qayyum, 2005; Sarwar et al., 2013). For any monetary policy analysis, the stability of the demand for money is considered to be of prime interest. The success of monetary targeting based policy significantly relying on stability of M-D model. For a M-D function to be stable, it is considered that the quantity of money is in all likelihoods related to a subset of variables which relates money with real sector (Friedman, 1987; Judd & Scadding, 1982). The extensive overview of literature summaries and importance of the topic has been observed an increase in research and can be viewed in (Goldfeld & Sichel, 1990; Omer, 2010; Sriram, 1999).

Testing the stability of the M-D function is crucial if monetary authorities plan to target a monetary aggregate or use it as an instrument (e.g., the discussions in Hossain, 2019). However, there are additional factors that necessitate this testing – for example, the effect of quantitative easing on long-term interest rates and its consequences for the M-D relationship. In recent years, formulating a proper M-D function and testing its stability has gained importance as economies face various changes caused by global economic developments. These include trade tensions, accommodative monetary policy, and volatile commodity prices (Hossain, 2019; Taylor, 2019). Another justification for testing stability is the implementation of structural and other reforms within economies.

It is argued that the stability of the M-D model is largely affected by location shifts in the economy and as a result leads to an ineffective monetary targeting. The motivation of this study as suggested by (Hendry & Ericsson, 1991) that researchers would may be in need of using data driven breaks spanning over the sample to check the model constancy in future. Later on (Castle et al., 2011, 2012, 2021; Hendry et al., 2008; Johansen & Nielsen, 2008; Pretis, 2021) highlighted usefulness of indicator saturation while establishing a stable model. Consequently, we check the constancy of the model under the shade of data driven breaks, we opted three types of dummy saturation (like; IIS, SIS and TIS). The novelty of the study is two-fold. First, to the best of our knowledge so far, whilst modeling M-D round the globe in general and in Pakistan particularly; hardly one can find a single paper incorporating Indicator Saturation with its types proposed in (Ericsson, 2012; Johansen & Nielsen, 2008) to capture the effect of shifts in the data. Second, the empirical modeling of M-D function along with application of super exogeneity testing procedure following (Hendry & Ericsson, 1991; Hendry & Santos, 2006) make this piece of study a worth producing in the field of applied econometrics. The application of these testing can be seen in (Beyer, 1998; Das & Mandal, 2000; Ericsson, 1998; Favero & Hendry, 1992; Kurita, 2007; Togay & Kose, 2013).

The plan of the study is as follows: Section 2 poses a review of literature on modeling M-D nationally and internationally. Data, Model and Empirical Methodology opted in this study will be discussed in Section 3. Study findings and their interpretations will fall under Section 4 and finally, Section 5 will highlight the several conclusions and policy recommendations for deciding an optimal monetary strategy. Lastly, the graphs of variables used in this paper see, Appendix at the end.

2 Literature Review

Akhtar (1974) considered as the first case study for estimating the demand for money by employing the classical regression techniques. Other researchers tried to capture key determinants of M-D function using classical linear regression technique like (Abe et al., 1975; Mangla, 1979). Nisar and Naheed, (1983) focused on the usage of term structure interest rate while modeling a stable demand for money using OLS. Ahmad and Khan, (1990) argued that stability can be achieved by inclusion of banking system based on Islam using MLE[6] with time varying parameters. On the other hand, the use of cointegration technique brought disputes while modelling M-D function mainly concerned with selection of scale and interest rate variables. Some researchers used Johansen and Juselius (JJ) cointegration approach with Error Correction Mechanism (ECM) to model stable M-D in Pakistan like (Ahad, 2017; Qayyum, 1998, 2005; Sarwar et al., 2013; Shafiq & Malik, 2018). However, (Khan et al., 2000) highlighted that the forecast performance of cointegration equation is better than the Error Correction

[6] Maximum Likelihood Estimation

Mechanism. Furthermore, it was suggested that a disaggregated approach to model money demand is more useful in Pakistan.

On literary diaspora, many researchers found that the variables in their study didn't have the same order of integration hence they preferred the usage of ARDL methodology over JJ cointegration in Pakistan, like (Anwar & Asghar, 2012; Asad et al., 2011; Azim et al., 2010; Faridi & Akhtar, 2013; Ghumro & Karim, 2017; Hannan & Ishaq, 2021; Iftekhar et al., 2016; Khan & Hye, 2013). Some valuable contributions by researchers other than Pakistan tried to identify key determinants of M-D function, like (Adil et al., 2020; Kumar, 2014; Ramachandran, 2004) in India, (Dritsaki & Dritsaki, 2020) in Italy, (Nel et al., 2020) in Hungary, (Baba et al., 1992; Bahmani-Oskooee & Maki-Nayeri, 2018; Ebadi, 2019) in US, (Adhikari, 2018; Cho & Ramirez, 2016) in Nepal and Korea respectively, (Nduka, 2014; Ogbonna, 2015) in Nigeria, (Achsani, 2010) for Indonesia, (Chen et al., 2021; Jiang, 2009) for China, (Hossain, 2006) for Bangladesh (Ericsson et al., 1998) in UK and (Hasanov et al., 2022) in Saudi Arabia. However, (Das & Mandal, 2000; Qayyum, 2005) are few interesting studies to read in which the authors tried to model M-D in India and Pakistan using the concepts of exogeneity.

In some circumstance, the estimated model might still be unable to capture all the major features of M-D. This insufficiency generally results from both theoretical and data/country-specific issues, as discussed by (Hendry, 2018; Hendry & Johansen, 2015) and (Hoover et al., 2008) among others. In particular, (Arrau et al., 1995), inter alia, discussed how traditional M-D specifications have been criticized for fundamental misspecification. These studies argue that this misspecification might be caused by a failure to account for the financial innovation effect. Consequently, it is better to consider a combination of both theory and data-driven approaches (see e.g., Hendry, 2018). We therefore use a combination of theory as well as data-driven approaches to design a more representative M-D function for Pakistan.

At the end, many researchers tried different methodologies to model demand for money, but to the best of our knowledge, considering the effects of data driven structural breaks was completely ignored with exception of (Bangura et al., 2022; Ben-Salha & Jaidi, 2014; Dritsaki & Dritsaki, 2022; Nduka, 2014; Nyong, 2014; Qayyum, 2005; Ramachandran, 2004; Rasasi,

2020) after 2000, in which the impact of structural break (not data driven) on demand for money was partially discussed. Despite an impressive and worth reading number of studies, a few of them have focused on in depth stability of demand for money and none of the available literature tried to model the effect of structural changes (data driven) while modeling money demand in Pakistan. On this ground one would say that all those models were not well specified and leaving a loop to be fulfilled.

3 Data, Model & Empirical Methodology

Friedman (1987) has identified the key determinants of real money demand balances. Accordingly, M-D model relates the real money demand to real income for scale variable, a vector interest rate variables includes call money rate and government bond yield representing opportunity cost of holding money following (Qayyum, 2001, 2005) and other key determinant like; inflation rate, financial innovation in (Adil et al., 2020; Hye, 2009) and financial development found in (Ahad, 2017; Hassan et al., 1993) . In functional form it may be written as:

$$M2_t/P_t = f(Y_t/P_t, CMR_t, BY_t, CPI_t, FI_t, FD_t) \qquad (3.1)$$

Where u_t = White noise[7] error term

In this study we used annual time series data ranges from 1972-2018. The data are collected from different data sources like; SBP[8], WDI and IFS. Broad Money (M2) used as M-D measure. Real output is measured by deflating the nominal Gross Domestic Product by GDP Implicit Price Deflator, Money Call Rate (short term), Govt. Bond Yield (long term) are representatives of interest rate and Inflation is measured as annual rate of change in CPI. The Financial Innovation is measured by $\langle {}^{M2_t}/_{M1_t} \rangle$ ratio and Financial Development is measured by Domestic Credit to Private Sector as a percentage of GDP.

Since it is difficult to measure financial innovation directly, many researchers have developed proxies for it like ATM machines, M2/M1 and a dummy variable that capturing time of innovation. Studies that used ATM concentration as a proxy are (Lippi & Secchi, 2009; Mlambo & Msosa, 2020; Sichei & Kamau, 2012) and those used dummy variable (Augustina et al., 2010;

[7] A stationary process with all of its autocorrelation functions equal to zero

[8] State Bank of Pakistan

Hafer & Kutan, 2003; Sanya, 2019). Researchers like (Dunne & Kasekende, 2016; Hye, 2009; Mbazima-Lando & Manuel, 2020) used M2/M1 as a proxy for financial innovation. The main reason for considering this measure is that as when there is an increase in financial innovations, people tend to move towards less liquid assets, which are reflected in M2. Unlike more liquid assets, reflected in M1.

Banks provide assistance to private sectors in terms of finance at low cost, helping entrepreneurs to start their own business causing an increase in demand of goods. Increase in high demand of goods causes an increase in industrialization and development by increasing money demand (Shahbaz & Rahman, 2012). Following (Ahad, 2017), we try to capture the impact of financial development on money demand both in short run as well as in long run.

The following steps explain the structure of the empirical modeling strategy that has been used in this paper.

On functional form (Seaks & Layson, 1983) stressed upon to use log-linear form as it is more superior than simple linear form based on their results both as theoretical and empirical. Further, (Ehrlich, 1996) and (Schrooten & Stephan, 2005) suggested that a log-linear form is more suitable than a linear form. The graphs of variables used in the study can be seen via Figure 1 to Figure 4 (see Appendix).

Unit Root Test by (Dickey & Fuller, 1979) are used to check stationarity of the data. Variables found to be integrated of order one i.e. I (1), therefore (Johansen, 1988) MLE approach is used to test the co-integration between variables, if exist. The Dynamic Vector Error Correction Mechanism (VECM) by (Sargan, 1964) is used to obtain the short run adjustment dynamics.

Several tests of super exogeneity are available in literature like; (Hendry & Ericsson, 1991) and further discussed in (Hendry & Santos, 2006). The paper is a scuffle to apply the same on M-D model in case of Pakistan.

Lastly, to capture breaks, crises or jumps in the data, Impulse Indicator Saturation (IIS), Step Indicator Saturation (SIS) and Trend Indicator Saturation (TIS) proposed in (Ericsson, 2012) used here, using R-Package “gets” by (Sucarrat et al., 2020).

At the end, a battery of diagnostics tests applied to check the parsimony of the estimated model. For description of unit root test, VAR model, cointegration and VECM see section 4. However, the concept of super exogeneity and its testing procedure have explicitly been discussed in this section for the reader.

Considering econometrics into account (Engle et al., 1983) highlighted that the purpose to estimate an econometric model primarily relies on three grounds. These are mainly, its utilization for statistical analysis, for forecasting purposes and for policy implications linking them with weak exogeneity, strong exogeneity and in super exogeneity respectively. An econometric model could encompass any or all of inference, forecasting and policy implications provided that the assumption of exogeneity is valid. Otherwise, estimation of the conditional model alone could lead to some unreliable and invalid inferences hence taking us to misleading results.

Now in statistical terms the dynamic joint density function can be written as $F_X(X_t, \Theta)$. If we bifurcate X_t into Δm_t[9] and Δz_t representing the determinants of the targeted variable i.e. (Δy_t, Δcr_t, Δby_t, Δi_t, Δfi_t, Δfd_t). Then the joint density function $F_X(X_t, \Theta)$ can be further factorized into the conditional model i.e., $F_{\Delta m_t|\Delta z_t}(\Delta m_t|\Delta z_t, \lambda_1)$ times the marginal model i.e., $F_{\Delta z_t}(\Delta z_t, \lambda_2)$.

The relationship between the conditional and marginal model is:

$$F_X(\Delta m_t, \Delta z_t|X_{t-1}, \Theta) = F_{\Delta m_t|\Delta z_t}(\Delta m_t|\Delta z_t, X_{t-1}, \lambda_1). F_{\Delta z_t}(\Delta z_t|X_{t-1}, \lambda_2) \quad (3.2)$$

Now the conditional function of M-D can be written as:

$$\Delta m_t = \omega_1 \Delta z_t + \omega_2 t + \sum_{i=1}^{k} \Gamma_i \Delta m_{t-i} + \Pi \sum_{i=1}^{k} \Psi_i X_{t-i} + \mu_t + D_{1t} + \varepsilon_{1t} \quad (3.3)$$

$$\Delta z_t = \alpha + \alpha_1 \Delta m_t + \alpha_z \beta' X_{t-1} + \sum_{i=1}^{k} \Gamma_i \Delta X_{t-i} + D_{2t} + \varepsilon_{2t} \quad (3.4)$$

This sort of factorization allows us to test the system for the presence of weak exogeneity of the parameters in the (3.4).

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[9] $\ln\left(\frac{M2_t}{P_t}\right) = m_t, \ln\left(\frac{Y_t}{P_t}\right) = y_t, \ln(CMR_t) = cr_t, \ln(BY_t) = by_t, \ln(CPI_t) = i_t, \ln(FI_t) = fi_t, \ln(FD_t) = fd_t$. Variables in small italic are in natural logarithmic form.

The conditional model in (3.3) reflects the immediate impact of change in Δz_t (set of currently dated regressors) has on Δm_t. The term ΠX_{t-1} (where, $\Pi = \alpha\beta' < 0$) specifies the effect on change in Δm_t of having Δm_{t-1} out of the equilibrium state with $\beta\Delta z_{t-1}$. The long-run ECM requires that $\Delta m_t = \beta\Delta z_t$. The parameters of the conditional as well as the marginal model are interrelated if the cointegrating vector β enters into (3.3) and as well as into (3.4). So, to get inferences about the parameters efficiency, a full system is required. The non-invertibility of conditional into marginal is conformation of super exogeneity (Hendry & Ericsson, 1991). Further, the existence of super exogeneity is enough to refute Lucas Critique (Favero & Hendry, 1992). For the critique (see; Lucas, 1976).

Considering the dummy saturation method, three of them are being used here in marginal model via their individual Data Generating Processes (DGPs). IIS is a set of zero-one dummies i.e., I_{it} = 1; for t = i and zero otherwise. SIS (Super Saturation) is set of step dummies i.e., S_{it}= 1; for t ≥ i and zero otherwise. TIS (Ultra Saturation) is a set of broken linear trend dummies i.e. T_{it}= $t - i + 1$; for $t \geq i$ and zero otherwise. Throughout in our analysis of capturing dummies for average retention of each type, we deliberately opt $\alpha = 0.05$ significance level. This will capture more impulses as compared to much tight level of $\alpha = 0.025$ or even with $\alpha = 0.01$.

Initially a test of super exogeneity is proposed by (Hendry & Ericsson, 1991). The process can be applied to the marginal models for the currently date regressors. First, the related significant breaks in marginal model are obtained. Secondly, those recorded breaks are then placed in the conditional model. A marginal model has been extended to following form with all types of breaks:

$$\Delta z_t = \alpha_0 + \alpha_1 \Delta m_t + \sum_{j=1}^{s} \Pi_j X_{t-j} + \sum_{i=1}^{m} \rho_{i,\alpha_1} 1_{\langle t = t_i | t \geq i | t-i+1 \rangle} + \varepsilon_t^* \quad (3.5)$$

Where, the estimated coefficients for all recorded dummies are denoted with ρ_{i,α_1}, α_1 is the significance level used in the marginal model. The second stage of the testing procedure is to add these set of m retained dummies from the marginal model to the conditional model as below:

$$\Delta m_t = \mu_0 + \beta' \Delta z_t + \sum_{i=1}^{m} \tau_{i,\alpha_2} 1_{\langle t = t_i | t \geq i | t - i + 1 \rangle} + \varepsilon_t \qquad (3.6)$$

The significance of these breaks can be tested individually using t-statistic and jointly using F-test as proposed by (Engle & Hendry, 1993) at level α_2. The method of dummy variables and the testing the super exogeneity of currently dated regressors was used by (Hendry & Ericsson, 1991). Therefore, it is sufficient enough to conclude the super exogeneity of these regressors if someone estimates the stability of conditional against the relevant class of interventions causing instability in marginal model (Perez, 2002).

4 Empirical Results and Interpretation

This section covers the results and their interpretations in detail. Before cointegration analysis one has to check the order of integration of variables. Therefore, unit root test is being used in this study. Several studies used interest rates and inflation rate in logarithmic form (see; Asad et al., 2011; Iftekhar et al., 2016; Qayyum, 2005, 1998).

4.1 Unit Root Test

Previously, the time series data were considered to be stationary but later on, researchers came up with an idea that mostly time series data is not stationary. The analysis based on non-stationary data while using OLS can be deceptive (Granger & Newbold, 1974). We use ADF unit root test to check the presence of unit root in the data with three different specifications i.e. (no intercept & trend, intercept only and intercept & trend). The critical-values are available in (MacKinnon, 1996). Based on the results, we found that variables are non-stationary at levels but stationary at first difference in their logarithmic form.

4.2 VAR & Cointegration Analysis

Many researchers have focused on the application of ECM, l ike (Hendry & Ericsson, 1991) and (Hendry, 1995) believed that ECM has different formulations. However, (Johansen, 1988) reported that, one of the formulation of getting ECM is the application of vector autoregressive (VAR) model. We apply conventional VAR to estimate interdependence of the variables which generally can be written as:

$$X_t = A_o + A_1 \sum_{i=1}^{k} X_{t-i} + A_2 D_t + \varepsilon_t \qquad (4.1)$$

Where X_t is the vector of variables. D_t is an exogenous dummy named as DUM_{1989}[10] used in VAR model and $\boldsymbol{\varepsilon_t}$ is white noise error term. The decision about the adjusted likelihood ratio (LR) statistics is drawn from AIC, SBC and HQ criteria and lag length of one is selected. The seminal work done by (Johansen, 1988) proposed two LR-test statistics known as Trace-Statistic and Maximum-Eigen Value Statistic. Trace-statistic indicated one cointegrating equation while maximum-eigen value reported two cointegrating vectors among variables. In case, they report that the number of cointegrating relations are different then trace test is considered to be more powerful because in case of non-normality it contains all $k-r$ values of the least eigen vector (Cheung & Lai, 1993) and (Hubrich et al., 2001) preferred trace test over maximum-eigen value test. Therefore, we use trace test to determine number of cointegrating relations.

Traditionally, the first normalized equation is considered as the long run equation and written in (4.2). It was suggested that if there is growth pattern in variables, then intercept should not be entered in the cointegrating space but could be used unrestrictedly (Johansen, 1995). The income elasticity is 2.79 leads to diseconomies of scale. A one percent increase in real income increases M-D by 2.79 percent, implying that the SBP should increase the money supply by 2.79 percent for each 1 percent increase in real GDP. The income coefficient is greater than unity. This may be due to inflexibilities in economy or diseconomies of scale in holding money (Nisar & Naheed, 1983). The coefficient of interest rate on bank deposits (own rate) is 1.10 positive significant and 0.79 a negative significant for the government bond yield. The hypotheses of opportunity cost of holding money i.e., difference between cr_t and by_t, yield significant too. The results are aligned with some earlier studies by (Adil et al., 2020; Qayyum, 2001, 2005). The coefficient of inflation rate is 0.80 negative and significant. It fulfills our theoretical expectations that when inflation rises the demand for real money decreases. This aspect of the result are in the line with (Asad et al., 2011; Bangura et al., 2022; Dou, 2019; Nel et al., 2020; Qayyum, 2001, 2005). This implies that, people tend to substitute cash balances for

[10] The House Building Finance Corporation (HBFC) had shifted its rent sharing operations to interest based system resulting in demand for money to increase as the cost of the capital become flexible and less stringent.

physical assets as the rate of inflation increases. The coefficient of financial innovation is positive and significant. A 1% rise in financial innovation leads to 0.66% surge in real M-D. These key findings are in the line with (Adil et al., 2020; Columba, 2009; Hye et al., 2009; Odularu & Okunrinboye, 2009; Sarwar et al., 2013). On contrary to (Ahad, 2017; Shahbaz & Rahman, 2012) the coefficient estimate for financial development in Pakistan found to be negative and significant. This negative coefficient would imply that increasing money supply will improve financial environment in the country.

$$m_t = 2.79\, y_t + 1.10\, cr_t - 0.79\, by_t - 0.80\, i_t + 0.66\, fi_t - 0.41\, fd_t \quad (4.2)$$

(6.49) (8.46) (-7.18) (-3.08) (4.40) (-1.95) (t-stats)

[42.12] [71.57] [51.55] [9.49] [19.36] [3.80] [χ^2-val.]

4.3 Dynamic Error Correction Model

According to (Engle & Granger, 1987), variables that are cointegrated must have an error correction representation, otherwise simple regression would lead to spurious correlations. The dynamic error correction model by (Sargan, 1964) is estimated using General to Specific Methodology introduced in (Hendry, 1992; Hendry & Ungern-Sternberg, 1981). The conditional distribution of Δm_t can then be represented by an error correction model that explains changes in Δm_t by its own lags, the error-correction term, and by simultaneous changes and the lags of the weakly exogenous variables (Johansen, 1995). The model may also contain deterministic terms like a constant and breaks which are represented here in the model as Dum_{2000}[11] variable. The coefficient of error correction term is likely to be negative (theory consistent) significant. Its low value shows the speed of adjustment is slow towards equilibrium. This slow adjustment could be a possibility due to several reasons. First, the equilibrium adjustment of actual money holding is high. The speed of adjustment towards equilibrium is low if the ratio of the cost of moving to the new equilibrium with respect to to the cost

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[11] General Musharraf took over the charge and leaves a significant impact on financial side during his tenure. In July 2000, the Pakistani rupee put on free float and thus as a result monetary and exchange rate policies were thought to be fully integrated.

of being out of equilibrium is high (Thornton, 1983). Consequently, economic agent may respond slowly to adjust over time. Second, reported often, is the nominal cost of being out of equilibrium. Lastly, the low value of error correction term is an indication towards the saving behavior of household sector than investment. In case, where precautionary savings depends on future income and rates of interest in the long run, then a low adjustment is expected (Cuthbertson & Taylor, 1990). The following equation (4.3) is the estimated short run equation for M-D in Pakistan.

$$\Delta m_t = 1.05\,\Delta \boldsymbol{y_t} + 0.05\,\Delta by_{t-2} - 0.51\,\Delta i_t + 0.29\,\Delta \boldsymbol{fi_t}$$
(3.83)[12] (2.03) (-3.09) (3.86)

$$+0.29\,\Delta \boldsymbol{fd_t} - 0.10\,Dum_{2000} - 0.004\,ect_{t-1} \qquad (4.3)$$
(3.51) (-2.00) (-2.76)

R^2 = 0.64, $\bar{R}2$ = 0.58, Log lik. 220.78, Auto. LM $\chi2$ (1) = 0.81(0.36),
Norm. JB $\chi2$ (2) = 1.70 (0.42), BPGHetro $\chi2$ (7) = 6.30(0.51),
ARCHHetro $\chi2$ (1) = 1.04(0.31), DW=1.72

Where ect_{t-1} is the error correction is term and determined as:

$$ect_t = m_t - \alpha_0 - \beta_1 t - \beta_2 y_t - \beta_3 cm_t - \beta_4 by_t - \beta_5 i_t - \beta_6 fi_t - \beta_7 fd_t$$

It is worth noting that the sign of financial development in short run is positive but in long run it is negative. This may be due to the credit creation by the banks. For example, loan to a factory (say) which pays to someone who deposits in banks for a short time, which is again given as credit and so on. Therefore, M2 increases. But a negative sign in the long run indicates that the credit circle has created so much M2 in the economy that it is actually needs to cut it back as no more money can be absorbed.

Some of the problems of instability could stem from scant modeling of the short-run dynamics characterizing departures from the long run relationship. Therefore, it is convenient to incorporate the short run dynamics for constancy of long run parameters. In view of this we apply the CUSUM (mean stability) and CUSUMSQ (variance stability) tests proposed by (Brown et

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[12] (.) Values therein are *t-ratios,* also, Auto. LM is the Lagrange Multiplier test for autocorrelation, Norm. JB is Jarque-Bera normality test while BPG_{Hetro}, $ARCH_{Hetro}$. are tests for heteroskedasticity and DW represents Durbin Watson statistic.

al., 1975). The stability of the model can be seen in Figure 5 (see Appendix).

4.4 Testing Super Exogeneity

Since the aim of modeling M-D function is its usage for policy implication. So, super exogeneity comes into play to determine the constancy of the model. For that it is necessary to check whether the estimated conditional model remains stable against interventions or not? To address this historically significant question, we try to detect breaks in the data set using recently developed technique of capturing interventions like; IIS, SIS and TIS. The variables entering as a currently dated regressor in (4.3) is separately checked for their DGPs and all significant dummies are reported below for each case were added in their marginal models and then entered conditional model to check their significance and insignificance respectively.

The VECM indicated that the income, inflation, financial innovation, and financial development are currently dated regressors highlighted as a bold one in (4.3). Therefore, to test the super exogeneity we have to test first, the instability of marginal models of these putative regressors and secondly, the stability of conditional M-D model (4.3) under the shade of these interventions. In order to test super exogeneity of these putative regressors in M-D model against the unknown external breaks, which could cause instability in marginal model, we used dummy saturation technique proposed by (Ericsson, 2012).

4.4.1 Testing for Δy_t

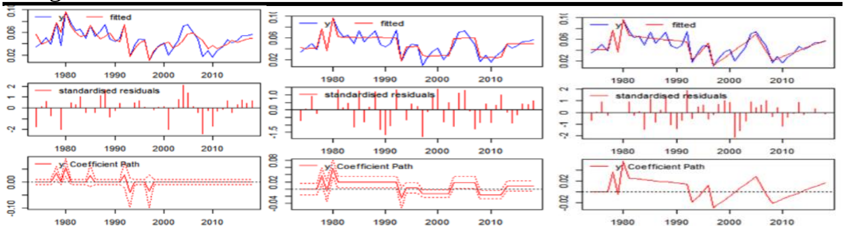
For DGP of Δy_t, starting with 6th order AR model and left the outcome mentioned in Table 1 following (Hendry & Ericsson, 1991). Where, Panel a retaining all those dummies after implementing IIS. Panel b and Panel c are having those significant dummies while using SIS and TIS respectively. Some tests are also reported at the end of the each Panel like; (Ljung & Box, 1978) tests autocorrelation in residuals and squared residuals and (Jiao & Pretis, 2018) proportion and count outlier tests are for checking whether the proportion (or number) of outliers detected using IIS is different from the proportion (or number) of outliers expected under the null hypothesis of no outliers.

Table: 1
Data Generating Process for Δy_t

Impulse Indicator Saturation (Panel a)		**Step Indicator Saturation** (Panel b)	**Trend Indicator Saturation** (Panel c)
Regression Type/ Break Year	**IIS**	**SIS**	**TIS**
Const.	0.022*	0.039*	0.040*
Δy_{t-1}	0.487*	0.048**	0.018**
1978	0.036*	0.036*	0.036*
1979	-	- 0.042*	- 0.078*
1980	0.057*	-	0.102*
1981	-	- 0.037*	- 0.092*
1982	-	-	0.030**
1985	0.026**	-	-
1992	0.027**	-	-
1993	- 0.052*	-0.044*	- 0.032*
1994	-	0.029**	0.043*
1997	- 0.036*	- 0.016**	- 0.051*
1998	-	-	0.048*
2003	-	0.031*	-
2006	-	-	- 0.023*
2008	-	- 0.034*	-
2009	-	-	0.020*
2013	-	0.024*	-

Note: (*) and (**) represents 1% and 5 % significance level respectively.

Diagnostics and Fit	**IIS**	**SIS**	**TIS**
Ljung-Box AR(1)	χ^2 (1) = 1.78 (0.18)	χ^2 (1) = 0.19 (0.66)	χ^2 (1) = 0.02 (0.90)
Ljung-Box ARCH(1)	χ^2 (1) = 0.45 (0.50)	χ^2 (1) = 0.00 (0.95)	χ^2 (1) = 0.98 (0.16)
Jiao-Pretis Prop.	Stat. 3.85(0.01)	-	-
Jiao-Pretis Count	Stat. 6.00 (0.03)	-	-
S.E.	0.012	0.010	0.009
R^2	0.67	0.78	0.81
Log like.	139.20	148.38	150.58



Source: Authors own estimation

Now the marginal model can be attained by overturning our conditional model and letting Δy_t as dependent and Δm_t as regressor along with identified set of dummies mentioned in Table 2. It can be seen that most of the dummies significantly entered in marginal model of Δy_t and cause instability in marginal distribution (Table 2, (4.4)) of Δy_t while using IIS. For SIS, we enter all significant dummies from Panel b as independent regressor in our marginal model for Δy_t. Therefore, (Table 2, (4.5)) capturing the effect of SIS on Δy_t.

It can be seen that about half of the SIS impulses significantly entered in the marginal model but cause a severe instability in it. This may be due to the selection of $\alpha = 0.05$. Had it been settled at $\alpha = 0.01$, would lead to capture more number of significant step impulses. However, we are still confident and hoping that by easing to this level even then it will not affect the stability of our conditional model.

Table:2.

Instability in Marginal Model for Δy_t w.r.t Breaks in DGP

	(4.4)	**(4.5)**	**(4.6)**
	Marginal model with IIS	**Marginal model with SIS**	**Marginal model with TIS**
	Dependent Variable Δy_t	Dependent Variable Δy_t	Dependent Variable Δy_t
Regressor	Co-efficient	Co-efficient	Co-efficient
Δm_t	0.09	0.09	- 0.04
Δby_{t-2}	- 0.02	- 0.01	- 0.003
Δi_t	- 0.10	- 0.10	0.08
Δfi_t	- 0.08*	- 0.08*	- 0.05*
Δfd_t	- 0.08	0.01	0.05*
Dum_{2000}	0.01	- 0.01	0.01
1978	0.05*	- 0.03**	0.04*
1979	-	0.05*	- 0.10*
1980	0.05*		0.12*
1981	-	- 0.03*	- 0.10*
1982	-	-	0.03*
1985	0.03**	-	- 0.04*
1992	0.03**	-	0.05*
1993	- 0.03*	- 0.001	-
1994	-	- 0.01	-
1997	- 0.03	- 0.02**	- 0.05*
1998	-	-	0.04*
2003	-	0.02	-
2006	-	-	- 0.02*

2008	-	- 0.02*	-
2009	-	-	0.02*
2013	-	- 0.002	-
ect_{t-1}	0.002*	- 0.006*	- 0.004*
Diagnostic Tests	**(4.4)**	**(4.5)**	**(4.6)**
$LM_{Auto.}\ \chi^2(1)$	9.73 (0.02)	7.40 (0.01)	7.01 (0.01)
$JB_{Norm.}\ \chi^2(2)$	2.09 (0.35)	8.69 (0.01)	0.51 (0.77)
$ARCH_{Hetro.}\ \chi^2(1)$	0.25 (0.61)	0.07 (0.79)	0.35 (0.55)
$BPG_{Hetro.}\ \chi^2(df)$	7.43 (0.88)	18.04 (0.32)	25.33 (0.12)
R^2	0.51	0.60	0.88
DW stat.	1.21	2.49	2.58

Note: (*) and (**) represents 5% and 10 % significance level respectively and *df* of BPG_{Hetro} test for (4.4), (4.5), (4.6) is 13, 16, 18 respectively.

Now for TIS in case of Δy_t, the significant trend impulses in panel c of Table 1 above that are being captured in DGP of Δy_t. The marginal model with TIS is reported in (4.6). Interestingly, all TIS impulses are highly significant and entered in our marginal model, causing instability in it. Now, after checking the significance of each type of impulse saturation in marginal model. We will check the stability of (4.3) in presence of breaks. Below Table 3 is the stability test of (4.3) against each type of impulses. All the impulses went insignificant and don't cause any instability in the estimates of the parameters of interest. Therefore, IIS, SIS and TIS type significant breaks in the marginal model of Δy_t do not alter the conditional distribution (4.7), (4.8) and (4.9) respectively.

Table: 3

Stability of Conditional Model w.r.t Breaks in DGP of Δy_t

	(4.7)	(4.8)	(4.9)
	Conditional model with IIS	**Conditional model with SIS**	**Conditional model with TIS**
	Dependent Variable Δm	Dependent Variable Δ	Dependent Variable
Regressors	Co-eff	Co-eff.	Co-eff.
Δy_t	1.16*	0.48**	- 0.57*
Δby_{t-2}	0.05**	0.03*	0.05**
Δi_t	- 0.48*	- 0.93*	- 0.62*
Δfi_t	0.29*	0.26*	0.22*
Δfd_t	0.08*	0.25*	0.25*
Dum_{2000}	- 0.10*	- 0.12*	- 0.08**
1978	0.02	- 0.01	0.03

1979		- 0.05	- 0.07
1980	- 0.03	-	0.06
1981	-	- 0.02	- 0.08
1982	-	-	0.06
1985	- 0.04	-	-
1992	- 0.04	-	-
1993	0.03	- 0.02	- 0.06
1994	-	- 0.03	0.05
1997	- 0.03	0.002	- 0.05
1998	-	-	0.07
2003	-	0.008	-
2006	-	-	- 0.05*
2008	-	- 0.004	-
2009	-	-	0.04**
2013	-	- 0.06*	-
ect_{t-1}	0.002*	- 0.02*	- 0.02*
Diagnostic Tests	**(4.7)**	**(4.8)**	**(4.9)**
$LM_{Auto.}$ χ^2 (1)	0.21 (0.64)	1.94(0.16)	0.83(0.36)
$JB_{Norm.}$ χ^2 (2)	1.90 (0.64)	1.44(0.48)	1.49(0.78)
$ARCH_{Hetro.}$$\chi^2$(1)	2.62 (0.11)	0.20(0.65)	0.42(0.52)
$BPG_{Hetro.}$ χ^2(df)	9.70 (0.71)	12.57(0.70)	15.37(0.64)
R^2	0.68	0.79	0.80
DW stat.	1.83	2.37	2.20

Note: Same as under *Table 2*

All the step dummies are insignificant apart from the 2013, even though it will not affect the stability of the model. However, Δy_t is significant at 10% level of significance. All the trend indicators are insignificant apart break year 2006 and 2009, even then it will not affect the stability of the model. However, Δby_{t-2} and Dum_{2000} are significant at 10% level of significance. So, we can conclude that our estimated frugal model (4.3) is stable against relevant interventions in the marginal process of putative conditioning variable Δy_t .

4.4.2 Testing for Δi_t

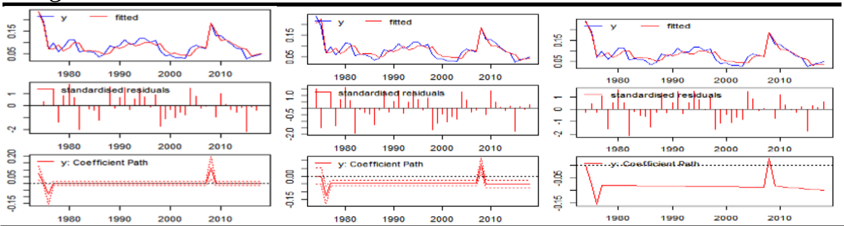
As inflation variable contemporaneously enters in (4.3). Therefore, DGP for Δi_t through each type of impulse has been reported (see Table 4) retaining all the significant dummies in case of IIS, SIS and TIS at $\alpha = 0.05$ level of significance under (Panel d- Panel f).

Table: 4
Data Generating Process for Δi_t

	Impulse Indicator Saturation (Panel d)	Step Indicator Saturation (Panel e)	Trend Indicator Saturation (Panel f)
Regression Type/Break Year	**IIS**	**SIS**	**TIS**
Const.	0.022*	0.068*	0.112*
Δi_{t-1}	0.677*	0.652*	0.621*
1975			-0.078*
1976	-0.082*	-0.123*	
1977		0.081*	0.154*
1978			-0.076*
2008	0.113*	0.111*	0.115*
2009		-0.119*	-0.226*
2010			0.109*

Note: (*) and (**) represents 1% and 5 % significance level respectively.

Diagnostic & Fit	**IIS**	**SIS**	**TIS**
Ljung-Box AR(1)	χ^2 (1) = 0.15 (0.70)	χ^2 (1) = 0.01 (0.95)	χ^2 (1) = 0.13 (0.72)
Ljung-Box ARCH(1)	χ^2 (1) = 1.51 (0.22)	χ^2 (1) = 1.22 (0.27)	χ^2 (1) = 1.82 (0.18)
Jiao-Pretis Prop.	Stat. 0.77 (0.44)	-	-
Jiao-Pretis Count	Stat. 2.00 (0.50)	-	-
S.E	0.02	0.02	0.02
R^2	0.80	0.79	0.81
Log like	114.30	112.23	115.20



Source: Authors own estimation

Inverting (4.3), for Δi_t to be dependent leads to the estimates shown in Table 5. The impulse dummies entered significantly in marginal model and lead to instability in the marginal process (4.10); similarly for case of SIS and TIS dummies captured in Panel e and Panel f alter the distribution of marginal models (4.11) and (4.12). So, we can conclude that the marginal distribution of contemporaneously happened regressor Δi_t in (4.3) is largely affected by the shifts in its DGP.

Table: 5

Instability in Marginal Models for Δi_t w.r.t Breaks in DGP

	(4.10)	(4.11)	(4.12)
	Marginal model with IIS	***Marginal model with SIS***	***Marginal model with TIS***
	Dependent Variable Δi_t	*Dependent Variable* Δi_t	*Dependent Variable* Δi_t
Regressor	*Co-eff.*	*Co-eff.*	*Co-eff.*
Δy_t	0.79*	0.75*	0.10
Δby_{t-2}	0.03	0.04	0.01
Δm_t	- 0.29*	- 0.44*	- 0.20**
Δfi_t	0.22*	0.24*	0.06
Δfd_t	- 0.08	- 0.06	0.02
Dum_{2000}	- 0.06	- 0.08**	- 0.03
1975	-	-	- 0.09*
1976	0.03*	0.05**	-
1977	-	- 0.10*	0.06**
1978	-	-	0.02
2008	0.08*	- 0.04**	0.10*
2009	-	0.01	- 0.14*
2010	-	-	0.03
ect_{t-1}	-0.004*	-0.01*	-0.01*
Diagnostic Tests	**(4.10)**	**(4.11)**	**(4.12)**
$LM_{Auto.}\ \chi^2\ (1)$	1.10 (0.29)	1.39(0.24)	13.56 (0.00)
$JB_{Norm.}\ \chi^2\ (2)$	3.57 (0.17)	2.30(0.32)	1.44 (0.49)
$ARCH_{Hetro.}\ \chi^2(1)$	1.19 (0.27)	1.44(0.23)	0.02 (0.89)
$BPG_{Hetro.}\ \chi^2(df)$	11.57 (0.24)	14.69(0.20)	10.28 (0.67)
R^2	0.35	0.47	0.69
DW stat.	1.56	1.65	1.23

Note: (*) and (**) represents 5% and 10 % significance level respectively and *df* of BPG_{Hetro} test for (4.10), (4.11), (4.12) is 9, 9, 13 respectively.

From Table 6, the stability of conditional distribution in the presence of these shifts can be seen. Below (4.13-4.14) is evidently depicting that IIS, SIS shifts do not alter the parameters of conditional distribution. However, TIS alter the parameters of (4.3) as discussed in (4.15).

Table: 6
Stability of Conditional Model w.r.t Breaks in DGP of Δi_t

	(4.13)	(4.14)	(4.15)
	Conditional model with IIS	***Conditional model with SIS***	***Conditional model with TIS***
	Dependent Variable Δm_t	*Dependent Variable* Δm_t	*Dependent Variable* Δm_t
Regressor	*Co-eff.*	*Co-eff.*	*Co-eff.*
Δy_t	0.89*	1.04*	0.54
Δby_{t-2}	0.06*	0.05*	0.04**
Δi_t	- 0.39*	- 0.63*	- 0.54*
Δfi_t	0.27*	0.30*	0.24*
Δfd_t	0.32*	0.20*	0.30*
Dum_{2000}	-0.09*	- 0.12*	- 0.10*
1975	-	-	- 0.01
1976	0.01	0.09	- 0.01
1977	-	- 0.10	0.002
1978	-	-	-
2008	- 0.08	- 0.06	- 0.04
2009	-	0.05	0.11
2010	-	-	- 0.06
ect_{t-1}	-1.46*	- 0.01**	- 0.01
Diagnostic Tests	**(4.13)**	**(4.14)**	**(4.15)**
$LM_{Auto.}$ χ^2 *(1)*	0.48 (0.49)	1.14 (0.71)	1.41(0.24)
$JB_{Norm.}$ χ^2 *(2)*	1.75 (0.42)	1.21 (0.55)	1.59(0.45)
$ARCH_{Hetro.}$ $\chi^2(1)$	1.19 (0.27)	1.44 (0.23)	0.32(0.57)
$BPG_{Hetro.}$ $\chi^2(df)$	7.16 (0.62)	13.12 (0.29)	10.28(0.67)
R^2	0.65	0.71	0.69
DW stat.	1.78	1.87	1.68

Note: Same as under *Table 5*.

Although, all impulses for TIS insignificantly enter in the model but model doesn't pass the stability test for this type of impulses. However, preferred model is stable against IIS and SIS and also pass the stability test of super exogeneity.

4.4.3 Testing for Δfi_t

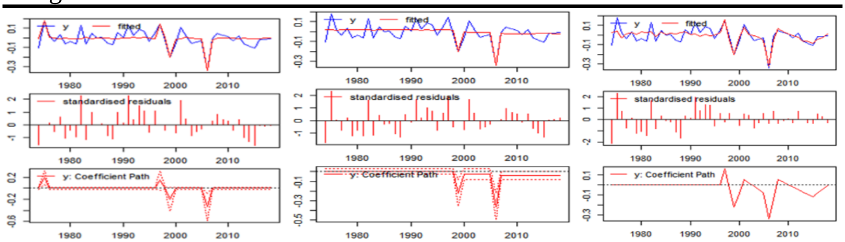
The DGP process using 6th order AR process and by dropping out the insignificant lags using general to specific modeling what we left with are being reported in the following Table 7.

Table:7
Data Generating Process for Δfi_t

	Impulse Indicator Saturation (Panel g)	Step Indicator Saturation (Panel h)	Trend Indicator Saturation (Panel i)
Regression Type/Break Year	**IIS**	**SIS**	**TIS**
Const.	-0.003	0.018*	0.016
Δfi_{t-1}	0.064*	-0.020**	0.238**
1975	0.190*		
1997	0.145*		0.159*
1998			-0.350*
1999	- 0.198*		
2000		0.196*	0.329*
2002			-0.171*
2006	-0.337*	-0.335*	-0.225*
2007		0.322*	0.455*
2009			-0.221*
2016			0.063**

Note: (*) and (**) represents 1% and 5 % significance level respectively.

Diagnostics and Fit	**IIS**	**SIS**	**TIS**
Ljung-Box AR(1)	χ^2 (1) = 0.02 (0.90)	χ^2 (1) = 0.42 (0.52)	χ^2 (1) = 0.12 (0.73)
Ljung-BoxARCH(1)	χ^2 (1) = 0.01 (0.92)	χ^2 (1) = 0.52 (0.47)	χ^2 (1) = 6.26 (0.01)
Jiao-Pretis Prop.	Stat. 1.80 (0.07)	-	-
Jiao-Pretis Count	Stat. 4.00 (0.30)	-	-
S.E	0.06	0.07	0.02
R^2	0.60	0.48	0.63
Log like	65.94	59.87	66.85



Source: Authors own estimations

However, inverting our conditional model into marginal model for financial innovation, following three equations (4.16 -

4.18) signify the impact of IIS, SIS and TIS on Δfi_t in Table 8 causing instability in the parameters.

Table:8

Instability in Marginal Models for Δfi_t w.r.t Breaks in DGP

	(4.16)	(4.17)	(4.18)
	Marginal model with IIS	***Marginal model with SIS***	***Marginal model with TIS***
	Dependent Variable Δfi_t	*Dependent Variable* Δfi_t	*Dependent Variable* Δfi_t
Regressor	*Co-eff*	*Co-eff.*	*Co-eff.*
Δy_t	-1.31*	-1.84*	-1.07**
Δby_{t-2}	-0.02	-0.08	-0.03
Δi_t	0.82*	0.98*	0.65*
Δm_t	0.81*	1.01*	0.67*
Δfd_t	-0.21**	-0.24	-0.25*
Dum_{2000}	0.06	0.05	0.08**
1975	0.07		
1997	-0.12*		0.12**
1998			-0.26*
1999	-0.17*		
2000		-0.06*	0.25*
2002			-0.15*
2006	-0.28*	0.06**	-0.16**
2007		-0.03	-0.32*
2009			-0.14*
2016			0.05**
ect_{t-1}	0.003**	0.01	0.002
Diagnostic Tests	**(4.16)**	**(4.17)**	**(4.18)**
$LM_{Auto.}\,\chi^2$ *(1)*	0.60 (0.44)	0.10 (0.75)	2.26(0.13)
$JB_{Norm.}\,\chi^2$ *(2)*	1.03 (0.60)	15.7 (0.00)	0.61(0.74)
$ARCH_{Hetro.}\chi^2$*(1)*	1.19 (0.27)	1.44 (0.23)	0.32(0.57)
$BPG_{Hetro.}\,\chi^2$*(df)*	14.38 (0.21)	9.50 (0.49)	18.87(0.22)
R^2	0.76	0.46	0.73
DW stat.	1.77	2.01	2.27

Note: (*) and (**) represents 5% and 10 % significance level respectively and *df* of BPG_{Hetro} test for (4.16), (4.17), (4.18) is 11, 10, 15 respectively

The influence of these breaks is captured by each marginal model individually. Therefore, these breaks are insignificant in chosen model staying behind the parameters of the conditional model stable against these relevant class of breaks (see 4.19-4.21) from Table 9.

Table: 9
Stability of Conditional Model w.r.t Breaks in DGP of Δfi_t

(4.19)		(4.20)	(4.21)
Conditional model with IIS		***Conditional model with SIS***	***Conditional model with TIS***
Dependent Variable Δm_t		*Dependent Variable* Δm_t	*Dependent Variable* Δm_t
Regressor	*Co-eff.*	*Co-eff.*	*Co-eff.*
Δy_t	1.13*	0.95*	0.51**
Δby_{t-2}	0.05**	0.05**	0.06**
Δi_t	-0.06*	-0.49*	-0.46*
Δfi_t	0.43*	0.29*	0.34*
Δfd_t	0.26*	0.27*	0.26*
Dum_{2000}	-0.10*	-0.10**	-0.10**
1975	0.03		
1997	0.10		-0.09*
1998			0.14**
1999	0.05		
2000		0.02	-0.06
2002			-0.03
2006	0.08	-0.04	-0.02
2007		0.01	-0.04
2009			0.05
2016			-0.01
ect_{t-1}	-0.004*	-0.004**	-0.01*
Diagnostic Tests	**(4.19)**	**(4.20)**	**(4.21)**
$LM_{Auto.}$ χ^2 (1)	0.62 (0.43)	0.66 (0.42)	1.46 (0.23)
$JB_{Norm.}$ χ^2 (2)	2.18 (0.37)	1.87 (0.39)	1.23 (0.52)
$ARCH_{Hetro.}$ $\chi^2(1)$	0.49 (0.48)	0.42 (0.52)	0.13 (0.72)
$BPG_{Hetro.}$ $\chi^2(df)$	10.87 (0.36)	9.45 (0.49)	13.67 (0.55)
R^2	0.72	0.66	0.71
DW stat.	1.75	1.77	1.67

Note: Same as under *Table 8*

4.4.4 Testing for Δfd_t

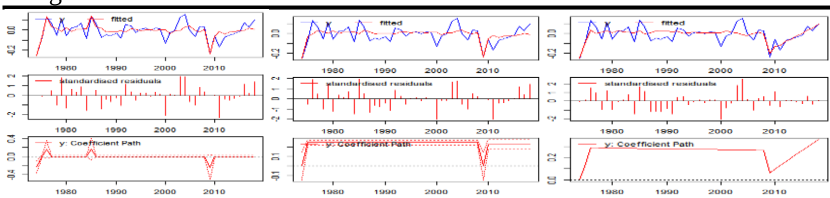
The DGP of Δfd_t can be seen in Table 10. However, inverting our conditional model into marginal model for financial development and then add significant dummies from DGP, following three equations (4.22 - 4.24) indicate the impact of IIS, SIS and TIS on Δfi_t as reported in Table 11.

Table: 10
Data Generating Process for Δfd_t

Impulse Indicator Saturation *(Panel j)*		***Step Indicator Saturation*** *(Panel k)*	***Trend Indicator Saturation*** *(Panel l)*
Regression Type/Break Year	**IIS**	**SIS**	**TIS**
Const.	-0.001	-0.239*	-0.263*
Δfd_{t-1}	0.257**	0.165	-0.150
1975		0.249*	0.144*
1976	0.155*		
1977			-0.144*
1985	0.160**		
2009	-0.242*	-0.249*	-0.200*
2010		0.229*	0.234*

Note: (*) and (**) represents 1% and 5 % significance level respectively.

Diagnostics and Fit	**IIS**	**SIS**	**TIS**
Ljung-Box AR(1)	χ^2 (1) = 0.04 (0.55)	χ^2 (1) = 0.10 (0.76)	χ^2 (1) = 0.49 (0.49)
Ljung-BoxARCH(1)	χ^2 (1) = 0.00 (0.99)	χ^2 (1) = 0.15 (0.70)	χ^2 (1) = 1.71 (0.19)
Jiao-Pretis Prop.	Stat. 1.80 (0.07)	-	-
Jiao-Pretis Count	Stat. 3.00 (0.40)	-	-
S.E	0.07	0.07	0.07
R^2	0.51	0.39	0.50
Log like.	61.70	56.64	61.12



Source: Authors own estimations

We can easily see that each type of impulses in most of the cases entered significantly into the marginal process of Δfd_t and cause huge disturbances in the parameters of the models (see 4.22-

4.24). Therefore, these dummies have their impact on the marginal distribution of Δfd_t.

Table: 11

Instability in Marginal Models for Δfd_t w.r.t Breaks in DGP

	(4.22)	**(4.23)**	**(4.24)**
	Marginal model with IIS	***Marginal model with SIS***	***Marginal model with TIS***
	Dependent Variable Δfd_t	*Dependent Variable* Δfd_t	*Dependent Variable* Δfd_t
Regressor	*Co-eff.*	*Co-eff.*	*Co-eff.*
Δy_t	-0.41	-0.40	-0.51
Δby_{t-2}	-0.05	-0.06	-0.05
Δi_t	-0.04	-0.14	0.41
Δfi_t	-0.16	-0.15	-0.15
Δm_t	0.63*	0.65*	0.69*
Dum_{2000}	-0.07	-0.10	-0.08
1975		0.001	0.12**
1976	0.10**	-	-
1977		-	-0.11*
1985	0.12**		-
2009	-0.15*	-0.16*	-0.18*
2010		0.11**	0.20*
ect_{t-1}	-0.004*	-0.001	0.03
Diagnostic Tests	**(4.22)**	**(4.23)**	**(4.24)**
$LM_{Auto.}\ \chi^2(1)$	1.73 (0.19)	0.16 (0.68)	1.46(0.23)
$JB_{Norm.}\ \chi^2(2)$	0.91 (0.63)	1.25 (0.54)	0.21(0.90)
$ARCH_{Hetro.}\ \chi^2(1)$	0.81 (0.37)	0.31 (0.57)	1.47(0.22)
$BPG_{Hetro.}\ \chi^2(df)$	9.27 (0.51)	6.65 (0.75)	13.04(0.18)
R^2	0.53	0.48	0.58
DW stat.	1.60	1.82	2.08

Note: (*) and (**) represents 5% and 10 % significance level respectively and *df* of BPG_{Hetro} test for (4.22), (4.23) (4.24) is 15, 10, 11 respectively.

Lastly, we will check their significance in the conditional model. Following three estimated equations (see 4.25 - 4.27) in Table 12, explain the stability of the preferred model under these shocks. We will incorporate these impulses in (4.3) for each subset of impulses and check their significance.

Table: 12
Stability of Conditional Model w.r.t Breaks in DGP of Δfd_t

	(4.25)	(4.26)	(4.27)
	Conditional model with IIS	***Conditional model with SIS***	***Conditional model with TIS***
	Dependent Variable Δm_t	*Dependent Variable* Δm_t	*Dependent Variable* Δm_t
Regressor	*Co-eff*	*Co-eff.*	*Co-eff.*
Δy_t	1.06*	0.08*	0.56**
Δby_{t-2}	0.05*	0.04**	0.04**
Δi_t	-0.51*	-0.49*	-0.68*
Δfi_t	0.29*	0.28*	0.24*
Δfd_t	0.26*	0.23*	0.30*
Dum_{2000}	-0.10*	-0.12*	-0.11*
1975	-	0.05	0.12
1976	0.02	-	-
1977	-	-	0.003
1985	-0.03	-	-
2009	-0.04	-0.05	0.03
2010	-	0.05	-0.03
ect_{t-1}	-0.003*	-0.001*	-0.01**
Diagnostic Tests	**(4.25)**	**(4.26)**	**(4.27)**
$LM_{Auto.}$ χ^2 (1)	0.27 (0.61)	1.06(0.30)	1.82(0.18)
$JB_{Norm.}$ χ^2 (2)	1.05 (0.59)	1.92(0.38)	1.56(0.46)
$ARCH_{Hetro.}$ $\chi^2(1)$	1.38 (0.24)	2.62(0.11)	0.95(0.32)
$BPG_{Hetro.}$ $\chi^2(df)$	9.89 (0.45)	10.28(0.42)	6.70(0.82)
R^2	0.66	0.66	0.68
DW stat.	1.82	1.68	1.64

Note: Same as under *Table 11*.

From above three Equations one can inferred that the conditional model remains stable under the influence of all impulses when included in (4.3). On concluding remarks, the estimated frugal model is super exogenous against three types of impulses captured in DGPs of all currently dated regressors, apart from one single time for a single type of impulse i.e., TIS see (4.15) above, where it doesn't pass the stability test, however it remains stable for the other two types of the same marginal model. Therefore, on the grounds of this stability check one can inferred that the model can be used for policy purposes.

5 Conclusion

On concluding remarks, the path of finding a stable and well-defined M-D function can be a nerve-racking task in the case of developing economies like Pakistan where high inflation and not much developed financial systems could prove to be significant constraints. It is considered as cornerstone of a country's monetary policy. In this study, we find a long run relationship between the variable. The signs are well supported by the economic theory and previously available literature. Moreover, it was argued that the inclusion of structural break in the data may lead to generate instability in the parameter estimates of the model. This significantly valid question is being aptly carried out by incorporating location shifts of three different types of breaks like; IIS, SIS and TIS individually, though other types of breaks can also be tested as reported in (Ericsson, 2012). The retention of dummy saturation is set at $\alpha = 0.05$ significance level and can be fixed at a level of significance $\alpha = 0.025$ or even at $\alpha = 0.01$. The stability of the model is well tested via implying indicator saturation through super exogeneity test. The stability of the model via such testing procedure strengthens the argument of previous studies that a stable M-D function could exist for Pakistan see; Section 2. The conditional model of real money appear to be constant, so the empirically inverted non-constant marginal models with univariate DGPs for real income, inflation, financial innovation and the financial development imply the super exogeneity of those variables in the conditional model. Since, estimated frugal model remain stable against the set of relevant class of interventions. Therefore, it can be used for policy purposes. However, these results may be different as reported here, if the retention of dummy saturation is set at $\alpha = 0.01$ significance level. Also, one can simply use all three types of impulses at a time in DGPs but it will reduce the number of breaks of each type that we obtained by using IIS, SIS and TIS separately. Therefore, to check the impact of each type of dummies in DGPs in marginal model and then in conditional model, we suggest using these separately would be more informative. The super exogeneity of contemporaneous regressors in estimated M-D model indicates the invalidation of Lucas Critique in case of Pakistan.

In a macroeconomics policy-making context, if M-D model is stable, then a monetary policy aiming to increase the rate of some monetary sizes, can contribute in the stabilization of the economy. Thus, if M-D is stable, then money supply will be a trustworthy way where stability in inflation rate can be achieved. Furthermore, real income will increase in the long run on a steady pace. With this, the only determinative factor of inflation will be the increasing rate of money supply. In this case, inflation will be a monetary phenomenon in the long run. On the other hand, if M-D is unstable, then shocks on M-D will convert to changes of real and nominal interest rates in the framework of supply, leading to economic fluctuations. In this case, an alternative policy on interest rates is important and not on money supply, as this policy can improve the result. The money supply will adjust the shocks on M-D keeping interest rates stable as well as the economic activity. In conclusion, we can claim that the volatility of M-D plays a fundamental role in a country's monetary policy. Having a stable M-D function, the policymaker at central bank can use monetary aggregates as an indicator or information variable to predict output gaps and inflationary expectations under the inflation-targeting framework (Adil et al., 2022).

Lastly, it would be an interesting thing to incorporate and to check the impact of other types of data driven breaks as discussed in (Ericsson, 2012; Johansen & Nielsen, 2008) even if someone use quarterly data set to estimate M-D model. Also, it would be an addition to future research if someone captures nonlinearities in the model rather than estimating a linear model to analyze the behavior of money demand in case of Pakistan.

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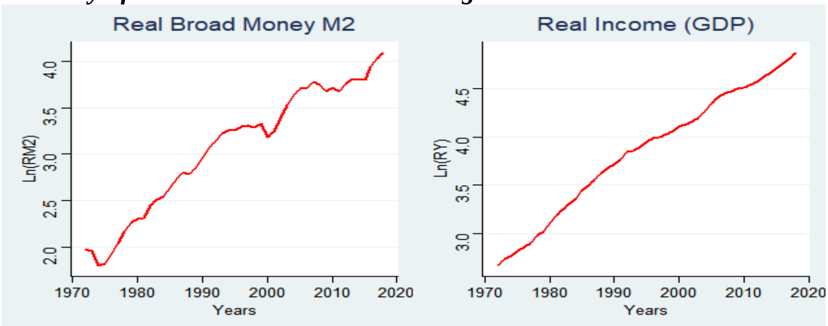
Appendix

Figure: 1

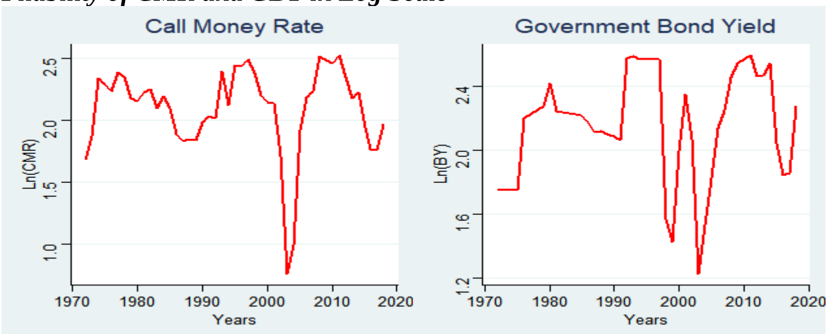
Pliability of Real M2 and Real GDP in Log Scale



Source: SBP and WDI

Figure: 2

Pliability of CMR and GBY in Log Scale



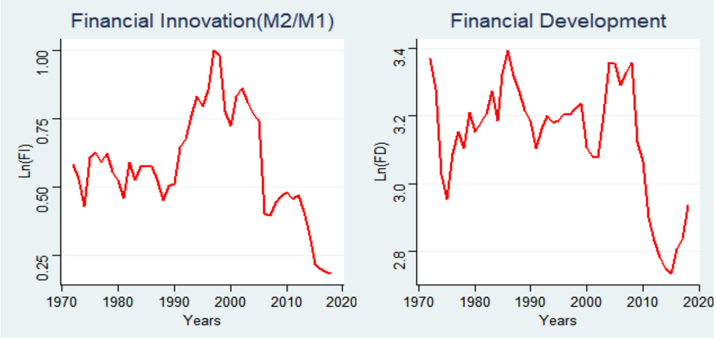
Source: IFS and SBP

Figure: 3

Pliability of CPI

Source: WDI

Figure: 4
Pliability of FI and FD



Source: SBP and WDI

Figure: 5
CUSUM and CUSUM Sq. Plot with 5 % Significance Level Critical Bands