Stability of money demand function in Pakistan

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Abstract:

This paper is an attempt to contribute to the ongoing debate, if central bank of Pakistan should adopt the inflation targeting or should continue with the monetary targeting, monetary policy strategy. A pre-requisite for monetary targeting strategy is a stable money demand function, which in turn requires stability in velocity. Instability in velocity on the other hand is believed to stem from the volatility of the interest rate. Therefore purview of this paper is to check the stability of velocity of money. Estimation shows that 'base' and 'broad' money velocity's are independent of the interest rate fluctuations. The results further confirm that all three velocities have stable relationship with its determinants. These findings validate use of monetary aggregates as 'nominal anchor'. As policy implication, this paper does not find support for those arguing that the central bank should abandon the monetary targeting monetary policy strategy against inflation targeting.

JEL Codes: E12, E5
Key Words: monetary targeting, income velocity of money, money demand function

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Introduction

Pakistan is a moderate inflation country, as the single digit average of last thirty years of inflation indicates. The moderate inflation expectation incorporated over time, not only limits the government's desire to indulge in the inflationary growth but also tame central banks ability to divulge in time inconsistency.

Typically, low inflation anticipation anchors with an inflation targeting central bank. On contrary, the State Bank of Pakistan (SBP), the central bank of the country [hence forth SBP], is among the few keen central banks which uses monetary targeting strategy for the conduct of its monetary policy. In such a strategy, monetary aggregates are used as a 'nominal anchor' which indirectly serves to its 'basic objective' of price stability. The achievement of expected/targeted inflation remains less binding[2] with this regime still the deviation of realized inflation from the targeted one could be used as a measure of performance of a central bank. Based on such measure adopted by Omer and Saqib (2009), the SBP's performance on achieving price stability remains deceptive, specifically in the post financial liberalization period.

Recent surge in inflation in Pakistan since last couple of years and stories of successes with inflation targeting in various countries, renewed the debate on the monetary targeting strategy followed by SBP. Numbers of authors have argued for and against the adoption of inflation targeting strategy or in other words, switching from or sticking to monetary targeting strategy such as, Moinuddin (2009), Felipe (2009), Akbari and Rankaduwa (2006) , Khalid (2006), Khan and Schimmelpfening (2006), Chaudhry and Choudhary(2006). Also, a substantial number of authors have assessed, whether Quantity Theory of Money [hence forth QTM] in words of Friedman (1956), holds for Pakistan [Omer and Saqib (2009), Qayyum (2006), Kemal (2006) and Abbas and Husain (2006)].

Besides the above two directions, a few authors revisited the assumptions of QTM that forms the building block of the monetary targeting strategy. Of assumptions, two are critical, first income velocity of money or its growth rate is constant, and second since monetary shock doesn't have a

[2] Inflation targets are the inflation expectations the government have while framing the fiscal policy of a particular period.

long run 'real effect', a stable velocity implies a stable money demand function over long run.

Latest contribution of Moinuddin (2009), and Omer and Saqib (2009) are the development in the third direction. Moinuddin (2009) investigated money demand function for Pakistan and found them unstable. Omer and Saqib (2009) while testing the QTM also tested the constant velocity assumption. They tested the stationarity of the velocities related with all three definitions of monetary aggregate and reported that velocities are not 'mean reverting' and hence unstable. To them, the SBP has very limited ability to control the monetary aggregates or money supply; however it has significant control over the interest rates due to money endogeniety. Therefore, the SBP should adopt interest rate as its nominal anchor. However, both papers have been criticized on the basis of either specification or methodology adopted and will be discussed in next section in detail.

In contrast, Mishkin (2004) argues that the choice of the 'nominal anchor' for conduct of the monetary policy depends on the stability of the money demand function. A stable money demand function makes monetary aggregates a favorable candidate for the intermediate target. Otherwise, interest rate should be adopted for the same.

For money demand function, interest rate is believed to be the major source of instability. Volatility in the interest rate makes the velocity volatile and hence the money demand function. Alternatively, as indicated by the Bordo and Junong (2004) the changing definition of money and or development of financial institutions could be a stronger source of instability.

The objective of this paper is therefore first to check if the interest rate is a significant determinant of velocity in Pakistan, as generally perceived by theorists. Second, if this relationship of velocities with its determinants is stable in the long run. Either an insignificant interest rate in the velocity function or a stable relationship of velocities with its determinants, and/or both will lend necessary support to the 'monetary aggregates' for its use as a nominal anchor. As a policy implication, the result of this paper would strengthen the contention that the central bank should continue with the monetary targeting, monetary policy strategy. An unstable velocity on the other hand, not only set the premise of the unstable money demand function but

may also support the contention of Omer and Saqib (2009) that the central bank of Pakistan should revisit its monetary targeting strategy in framing the monetary policy of Pakistan. In other words, it would strengthen the argument for adoption of inflation targeting, monetary policy.

The rest of the paper is structured as follows. Section I presents some explanatory facts about the financial sector liberalization in Pakistan. Section II reviews the existing literature on the stability of money demand function. Section III synthesizes the money demand function using velocity of money. Section IV explains the variables and the data sources. Section V provides details of the methodology adopted. Section VI discusses the result of the velocity function. Finally, Section VII is concluding remarks.

Section I: Some Facts about Financial Liberalization in Pakistan

With fall of Bretton Woods system, SBP switched to monetary targeting strategy and continued with its various forms to frame the monetary policy for Pakistan[3]. Starting from the second quarter of fiscal year 1973 to August 1992, SBP used the 'selective credit/credit ceilings'; between September 1992 to September 1995, 'credit to deposit ratio'; and since September 1995 to date, it used M2 as a nominal anchor.

SBP experimented with nominal anchors particularly from 1989 onwards as Pakistan embarked upon a reform program aimed at instilling competition in the market so as to achieve the efficient allocation of financial resources. The major initiative in the direction surfaced in 1991 when government of Pakistan for the very first time auctioned the short term (6-month) Market Treasury Bills (MTBs) and the long term (3, 5, and 10 years) Federal Investment Bonds (FIBs). Structure of a well functioning money market quickly developed with the introduction of auctioning process of short and long-term government securities.

In the decades of nineties, measures were taken to strengthen institutions; banking laws went through changes, domestic debt management was improved; foreign exchange and capital market were reformed and liberalized. Activities in foreign exchange market also expanded rapidly after residents were allowed to open foreign currency accounts in addition to granting licenses to money changers. Similarly, Capital market activities expanded very quickly in response to opening up of equity markets to foreigners.

As a result of these developments, the character of Pakistan's economy, especially that of financial sector, changed. There were now more banks and other financial intermediaries, more innovations and therefore more financial products.

Following nuclear detonation on 28th May 1998, economic sanctions were imposed on Pakistan by certain donor countries and multilateral institutions. The state of uncertainty regarding

[3]See SBP (2001, 2005) for a detailed review of the financial sector reforms.

Pakistan's ability to meet its external obligations provoked SBP to undertake the strict measures specifically in foreign exchange market. The balance of payments crisis was addressed by extensive controls on foreign exchange transactions, all foreign currency accounts were frozen, multiple exchange rate regime were introduced, capital outflow discouraged and speculative activities in the foreign exchange interbank market were prevented.

As the impact of sanctions started diluting, SBP proceeded with the second generation of reforms from 1999 onwards, which transformed the dynamics of the financial sector significantly. For example, market based unified exchange rate system was adopted, unofficial cap on rupee trading removed and Rupee was put to a complete float. The free float of exchange rate was a major achievement in the area of exchange rate management.

In 2000s, Karachi Interbank Offered Rates (KIBOR) and the system of Primary Dealers were introduced in the money market that strengthened the monetary transmission mechanism of monetary policy. Economic hardship of 1998 annihilated the long term securities market, therefore Pakistan investment Bond were floated initially with 3-, 5-, and 10- years and later extended to 30 years of maturity.

In banking sector, legal infrastructure developed, regulatory and supervisory framework strengthened, and institutional capacity were increased. To reduce the risks inherent in the financial sector, measures were taken to mitigate them by adopting international best practices; strengthening capital base, institutionalizing corporate governance and enhancing the capabilities of the Credit Information Bureau. To increase the speed and reliability of the financial sector, payment system also upgraded.

Besides, to diversify the financial products and the instruments, SME, Microfinance, and Islamic banking system (compliant with the *Sharia laws*) were encouraged. In tandem with the banking sector, separate regulations were formulated for the non-banking financial institutions which later brought under supervision of Security and Exchange Corporation of Pakistan (SECP).

The resolve to continue reforms in the financial sector paved way for the successful

implementation of these reforms. As a result of substantial improvement in financial health, financial sector witnessed rapid growth in assets during 2000-2006 that led to the strengthening of macroeconomic fundamentals, and sustained economic growth.

Section II: Review of Stability of Money Demand Function

In literature money demand function has been studied using both 'velocity' and 'conventional formulation. This section presents the detail review of the literature on money demand function using both formulations separately, to account for the overall progress on this area.

Before the collapse of the Bretton Woods System, M1 money was consensually considered stable in the industrialized economies. However, since 1974 the conventional M1 money demand function began to over predict the demand for money, which Goldfeld (1976) termed as the case of 'missing money. The woes of conventional money demand function increased in the 1980s as it under predicted the velocity (PY/M), which rose faster than expected. Economists have since been concerned that the velocity of Ml and several other monetary aggregates from 1981 to at least 1986, declined to an unpredicted extent. They have questioned the continued pursuit by central banks of monetary targets. Unpredictability of velocity is the key reason policymakers in the United States and elsewhere have given for abandoning monetary targeting since 1982.

Inherent role of velocity in the stability prompted researchers to conducts a detailed study of money demand function using velocity. Velocity is another way in which money demand function can be expressed [Siklos,1993]. Bordo and Junong (1981, 1987, 1990, and 2004) using long term data studied the behavior of velocity among number of developed economies, and found that velocity declined in these economies in phase of monetization and then recovered with the financial innovations and deregulations. As a tool for empirical analysis, the authors used ordinary least square in most of their studies. Later on, Bordo et. al., (1997) provided necessary methodological support to their 'institutional hypothesis' using advance techniques of co-integration and the error correction.

In comparison to the relatively limited literature on the velocity, 'conventional' money demand attracted a large number of researchers, primarily because of its easy to understand formulation. Even if one starts with the post Bretton Woods period, Goldfeld (1973), Boughton (1981), Arango and Nadiri (1981), Butter and Fase (1981), Rose (1985), Hendry and Ericsson (1991), Mehra (1991), and Leventakis (1993), are a few among the vast pool of the authors who made a

significant contribution in this field, banking on the conventional models. **Table1** gives a brief summary of recent literature that discusses conventional money demand function in terms of stability.

[Table 1 Here]

Among selected developed countries, except Germany, UK and Switzerland, the money was found to have stable and long run relationship with its determinant. Unification of Germany is cited by Hamori and Hamori (1999) for structural break found in 1990, cause of the instability.

Similarly, among the selected group of the developing countries, except China and Nepal, the money demand was found to be stable. The instability in the Chinese money demand stems from the rapid financial developments started since eighties. Lee and Chien (2008) found the structural breaks in 1980 and in 1993, which they linked with the critical financial and economic developments.

In terms of Pakistan, to the best of my knowledge, literature relating the stability of velocity is lacking. Among the available lot, Bilquees and Shahnaz (1994) in their short paper documented a slowdown in velocity between 1974-75 and 1991-92. To their end, they used the number of bank branches as proxy for the financial development and concluded that financial development in Pakistan was significantly affecting the velocity of money. Neither they attempted to investigate the long run relationship nor did they conduct any stability test of their findings.

Omer and Saqib (2009) on the other hand used "instability" in the money velocity as one of the reason for disapproving the monetary targeting strategy adopted by the SBP. They argued that QTM assumes a constant or stationary velocity while income velocities of M0, M1, and M2 money's in Pakistan are not 'mean reverting' or stationary. On the basis of their findings, they concluded that all three velocities are unstable. Their result of non-stationary velocities has been criticized also, of being non robust.

[Table 2 Here]

Table 2 gives the summary of the recent literature that has investigated the stability of the conventional money demand function for Pakistan. Except Moinuddin (2009), all three studies have reported a stable money demand function for Pakistan.

The estimation results of Moinuddin (2009, pp. 07) show a large negative intercept for the estimated broad money model. Surprisingly, no satisfactory explanation was provided for those relatively large negative intercept, which leads to suspicion of specification bias. For example, Bordo and Junong (1990) suggest that in an economy where interest rate is not free to respond to the market forces (regulated economy) the expected inflation should be included in the demand function. On contrary, the period Moinuddin (2009) covers in his study also includes the span of 1975 -1991, when economy was heavily regulated. Inclusion of expected inflation in his study, as proposed above, therefore might have improved the estimation result further.

As far as other studies are concerned, the samples used by Brahmani-Oskooee and Rehman (2005) and Qayyum (2006) do not go beyond the year 2000. Therefore, their results should be viewed with caution as their samples do not fully encompass the effect of second generation of financial reforms initiated in 2000s.

In my view, the result by Abbas and Husain (2006) should also be viewed with caution, since they do not explicitly undertake any stability test and rely on the 'significance' of regression as indication of the "long run and stable" M2 demand function.

The above review of existing literature clearly shows that conventional formulation of money demand is more popular among the researchers precisely due to its easy to work formulation and interpretation. However, I will prefer velocity formulation of money demand function for this study. As indicated earlier, one purpose of this study is to investigate the stability of velocity, which is not possible using conventional money demand. Moreover, the velocity formulation is strongly based on economic theory of permanent income hypothesis propounded by Milton Friedman's. On contrary, those who worked with conventional money demand function, a large number of them have used Arango and Nadiri (1981)'s model, albeit with minor change.

Nevertheless, the model adopted by Arango and Nadiri (1981) has been severely criticized being ad hoc and lacking theoretical foundation.

Section III: Velocity of Money Demand Function

Milton Friedman (1956) while restating the QTM, advocated for demand function of real money balances in terms of permanent income, own interest rate, expected inflation, and individual tastes and preferences (Felipe, 2009), that is

$$M^d / P = f(Y^P, i, \dot{P}^e, u) \qquad (1)$$

Where M^d / P is the demand for the real money balances, Y^P is permanent income, i is own interest rates or return on the financial assets, and $\dot{P}^e$ is the expected rate of inflation.

The above function (1) could be explained in terms of per capita relationship such as,

$$\log(M / PN) = \alpha_0 + \alpha_1 \log(Y / PN)^P - \alpha_2 i + \alpha_3 \dot{P}^e + \varepsilon \qquad (2)$$

where M / PN is per capita real cash balance and $(Y / PN)^p$ is the per capita real permanent income. Following the synthesis of Bordo and Junong (2004) the equation (2) could be manipulated with the help of equation of exchange $(MV = PY)$, to arrive at the velocity function, given below[4], that is;

$$\log V(m) = \beta_0 + \beta_1 \log(Y / PN)^P + \beta_2 i + \beta_3 \log Cycle + \beta_4 \dot{P}^e + \varepsilon \quad (3)$$

where $V(m)$ is income velocity of money, and m = 0, 1, 2 for the respective monetary aggregates of M0, M1 and M2. $Cycle$ represents the impact of the transitory income. It is measured as the ratio of the measured per capita income and permanent per capita income.

Theoretically, the per capita permanent income in equation (3) is expected to have positive sign, indicating any increase in the real permanent income will increase the number of transaction in

[4] for detail, see appendix A

the economy thereby affecting the velocity positively.

Transitory income or 'Cycle' on the other hand should have a unity coefficient in the regression. A coefficient that is positive but less than one would indicate that the velocity moves pro-cyclically and would be consistent with the Friedman's permanent income hypothesis. Over the cycle, the transitory income would increase the demand for money, because cash balances serves as a buffer stock. In the long run these transitory balances would then be worked off, returning to the coefficient to unity (Bordo and Junong, 1990).

Like income, real interest rate is also expected to have a positive sign. Theoretical explanation is based on the fact that any rise in the real interest rate will decrease the demand of real money balances however, causing velocity (PY/M) to increase. The impact of the inflation on velocity is ambiguous and the coefficient could take either positive or negative sign.

Section IV: Data and Variable Detail

[Table 3 here]

For the data, I have largely used SBP (2006) available at SBP website (www.sbp.org.pk), published in 2006. This book contains detail financial statistics for Pakistan since 1950. For the period 2005 onward, I have used the monthly statistical bulletin also available at SBP website. Nominal and real GDP data have been updated using the revised figures from monthly Statistical Bulletin.

For all estimation purposes I have used the annual data starting from 1975 to 2006. The choice of the estimation period is primarily based on the design to make this study comparable with the earlier studies relating to Pakistan, on this topic. Additionally, 1975 corresponds to the official division of all financial and statistics between East and West Pakistan [Bilquees and Shahnaz, 1994] and 2006 is the last year for which official estimates of M1 available. Furthermore, 2007 and 2008 should not be considered as normal years, primarily because of the political disturbances in Pakistan were at its peak.

Although the literature contested the validity and stability of M1 and M2 monetary aggregates and its respective velocities, I have reported all three versions of velocities for two reasons. First, Omer and Saqib (2009) has reported results of all three monetary aggregates and their velocities. Secondly, M2 is currently being used as the intermediate target; the M0 remains the operational target, the key instrument for operational purposes. Therefore, the behavioral information of M0 could provide the additional education in understanding the monetary dynamics of Pakistan. Moreover, I have used current inflation as proxy for the expected inflation.

Before estimation, logarithmic transformation applied to all variables except Real Call Money Rate (RCMR) and the Inflation. The variable per capita real permanent income constructed using the long term trend in the log of per capita real GDP. For this purpose following Bordo and Junong (1990), I have applied HP filter (λ= 100) on per capita real GDP since 1950. Although, the study is confined to 1975 and 2006, the use of longer term data is more appropriate for

obtaining a longer term trend in the constructed per capita real permanent income variable. Cycle on the other hand constructed as a ratio of the per capita real income and the per capita real permanent income, thus obtained. Therefore, both permanent income per capita and the cycle are inherently logarithmic series and need no further transformation.

The setback of using HP filter is that the analysis becomes purely historical and static in nature. In another word any new information can create wide fluctuation in the derived variable from HP filter. Therefore, quantum of coefficients estimated may change significantly, raising issues of robustness. Moreover, the estimated coefficients using the derived variable are unsuitable for making forecast.

Section V: Velocity of Money and ARDL Approach

In order to test the long run relationship among the variables various methods have been prescribed including Engle and Granger (1987), Johansen (1988) and (1991) and Johansen and Juselius (1990). Since then, many authors have revisited the long run relationship between the money demand and its determinants. Examples are Hafer and Jansen (1991), Hoffman and Rasche (1991), Mc Nown and Wallace (1992), Siklos (1993), for US and Frankel and Taylor (1993), Hafer and Kutan (1994), and Bahmani-Oskooee and Shabsigh (1996) for other developing countries. The performance of these models, however, is restricted when the sample size is small, a likely situation for most of the developing countries, or when the order of the co-integrating variables is not the same.

Based on the above facts, Bahmani-Oskooee (2001), Akinlo (2006), and Bahmani Oskooee and Rehman (2005) and a few more have used ARDL approach to test the long run relationship of the monetary aggregates, for the developing countries. There are several advantages of applying this approach. First, it can be applied on a time series data irrespective of whether the variables are I(0) or I(1) [Pesaran and Pesaran, 1997]. Second, it takes sufficient numbers of lags to capture the data generating process in a general-to-specific modeling framework [Laurenceson and Chai, 2003]. Third, a dynamic Error Correction Model (ECM) can be derived from ARDL through a simple linear transformation [Banerjee et al., 1993]. The ECM integrates the short-run dynamics with the long run equilibrium without losing long-run information.

Although the aim is to estimate the long-run relationship and examine their stability, the ARDL approach also incorporates the short run dynamics as only relying upon long run estimates will not be sufficient. Indeed, Laidler (1993) argues that only relying on long-run money demand function is inappropriate, as some of the problems of instability in the money demand function could stem from inadequate modeling of the short-run dynamics characterizing departures from the long-run relationship.

Following the ARDL approach proposed by Pesaran et. al (1999), the existence of long run relationship could be tested using equation (4) below:

$$\Delta LV(m) = \gamma_0 + \sum_{1}^{p} \gamma_{1_i} \Delta LV(m)_{t-i} + \sum_{0}^{q} \gamma_{2_i} \Delta LPCYD + \sum_{0}^{r} \gamma_{3_i} \Delta RCMR + \sum_{0}^{s} \gamma_{4_i} \Delta INF +$$

$$\sum_{0}^{w} \gamma_{5_i} \Delta Cycle + \gamma_6 LV(m)_{t-1} + \gamma_7 LPCYD_{t-1} + \gamma_8 RCMR_{t-1} + \gamma_9 INF_{t-1} + \gamma_{10} Cycle_{t-1} + \zeta_t \quad (4)$$

Where, $\gamma_6, \gamma_7, \gamma_8, \gamma_9, \gamma_{10}$ are the long run coefficients while, $\gamma_{1_i}, \gamma_{2_i}, \gamma_{3_i}, \gamma_{4_i}, \gamma_{5_i}$ and ζ_t represents the short run dynamics and random disturbance term respectively.

The null hypothesis that the long run relationship doesn't exist that is, $\gamma_6 = \gamma_7 = \gamma_8 = \gamma_9 = \gamma_{10} = 0$ tested against the alternative hypothesis $\gamma_6 \neq \gamma_7 \neq \gamma_8 \neq \gamma_9 \neq \gamma_{10} \neq 0$ by means of familiar F-test. However, the asymptotic distribution of this F-statistic is non-standard irrespective of whether the variables are I(0) or I(1). Pesaran et al. (2001) have tabulated two sets of appropriate critical values. One set assumes all variables are I(1) and another assumes that they are all I(0). This provides a band covering all possible classifications of the variables into I(1) and I(0) or even fractionally integrated[5]. If the calculated F-statistic lies above the upper level of the band, the null is rejected indicating cointegration.

Although Peseran and Pesaran (1997), requires a significant cointegration relationship to move to the next stage of estimation, Bahmani-Oskooee and Bohl (2000) calls the above cointegration results preliminary. The reason being, the choice of lags in the estimation of long run relationship are arbitrary. They further argued that the cointegration evidence based on error correction is more efficient.

Next step in ARDL estimation, as outlined by the Pesaran and Pesaran (1997), is estimation of the long run relationship based on the appropriate lag selection criterion such as Adjusted R^2 criterion, Akaike Information Criterion (AIC), or Schwarz Bayesian Criterion (SBC). The choice of lag selection criteria is important and only an appropriate lag selection criterion will help in identifying the true dynamics of the model. Once determined, the ARDL model gives the long run cointegrating coefficients of equation (3).

[5] By 'fractionally integrated' we mean the situation when the F-stats fall between the lower and upper bound of the tabulated values of F-stats [Bahmani-Oskooee, 2005) pp; 775)].

Based on these long run coefficients, the estimation of dynamic error correction is carried out using formulation of equation (5). The coefficients $\delta_{1_i}, \delta_{2_i}, \delta_{3_i}, \delta_{4_i} and \delta_{5_i}$ show the short run dynamics of the model and δ_6 indicate the divergence/convergence towards the long run equilibrium. A positive coefficient indicates a divergence, while a negative coefficient indicates convergence. Kremers et. al (1992) describes this cointegration evidence using the lagged error correction (ECM) term is relatively more efficient.

$$\Delta LV(m) = \delta_0 + \sum_{1}^{p} \delta_{1_i} \Delta LV(m)_{t-i} + \sum_{0}^{q} \delta_{2_i} \Delta LPCYD + \sum_{0}^{r} \delta_{3_i} \Delta RCMR + \sum_{0}^{s} \delta_{4_i} \Delta INF + \sum_{0}^{w} \delta_{5_i} \Delta Cycle + \delta_6 ECM_{t-1} + \vartheta_t \quad (5)$$

As discussed earlier, test of stability conducted using CUSUM and CUSUMQ tests, proposed by the Brown et.al (1975). CUSUM test uses cumulative sum of recursive residuals based on the first *n* observations. It is updated recursively and plotted against the break points. If the plots of the CUSUM statistics stays within 5 percent significance level, (portrayed by the two straight lines) whose equations are given in the Brown et al (1975), then the coefficient estimates are said to be stable. CUSUMQ also applies the similar process, although based on the squared recursive residuals.

Besides CUSUM and CUSUMQ a battery of tests also applied to the residuals, such as Lagrange's Multiplier (LM) test for serial correlation, Ramsey Reset test for functional form misspecification, and Jarque-Berra Test for normality. The LM test assumes null hypothesis that residuals are serially uncorrelated while Ramsey Reset assumes that the specified model has linear functional form. Similarly, Jarque-Berra test hypothesizes that the residuals are normally distributed. All of the above hypotheses are tested at 95 percent level of confidence.

Since Microfit 4.0 inherently undertakes the stability tests and other diagnostic test on residuals, at early stages of estimation [with equation (3) here], following Bahmani-Oskooee and Bohl (2000), Bahmani-Oskooee and Hafez (2005), and Akinlo (2006), I prioritized to undertake these tests at more efficient stage of estimation that is, with equation (5).

Section VI: Discussion of Results

Table 4 shows result of the Augmented Dickey Fuller (ADF) test applied to the variable used in various estimations. The test results shows that the per capita permanent income and three velocities are differenced stationary, as reported by Omer and Saqib (2009), while Cycle, INF and RCMR are level stationary. Therefore, the variables are at different level of integration that is some are I(0) while others are I(1). A generally prescribed procedure for using difference of a variable in such estimation is not efficient and may involve unnecessary loss of significant information. Therefore, neither Engle and Granger (1987) nor Johansen (1988) or Johansen and Jesulieus (1990) are appropriate in this situation. ADF test result thus provides necessary theoretical supports for the use of ARDL methodology, adopted in this paper. However, the result of unit root test reported here, have no direct bearing on the estimation results of this paper.

It is important to note that the I(1) integration of both money velocities implies important structural developments in Pakistan's economy. The financial deregulation that started in early nineties induced the financial innovations in Pakistan, as well. However the introduction of new instruments were rather slow that kept the money velocities, only differenced stationary. Alternatively, more rapid innovation might have resulted in higher order of integration, for example I(2), in these variables, which is not the case.

[Table 4 here]

Since the co-integration is sensitive to the choice of lag length and the adopted ARDL procedure accepts only maximum lag in the first phase of bound test, I have conducted three bound test for each model, setting maximum lag length from 1 to 3. Limiting maximum lag to 3 is normal practice in literature dealing with the annual data. The choice of this procedure is to explore the possible cointegration relationships that might be emerging at various lag levels.

Table 5 shows the result of the bound test which determines the long run relationship between the variables. The explanatory variables, per capita permanent income, real interest rate, Cycle

and inflation are found to be forcing both velocities LV1 and LV2[6]. In other words following Peseran and Pesaran (1997) the evidence shows that both LV1 and LV2 have long run co integrating relationship.

However as discussed earlier, Bahmani-Oskooee and Bohl (2000) considers these results as preliminary, precisely due to arbitrary choice of lag selection, and rely more on the other stages of estimation which are more efficient.

[Table 5 here]

In the next stage, ARDL chooses the optimal lag length for a given model and estimates long run dynamics of the model. According to Pesaran (1997), AIC and SBC performs relatively well in small samples, although the SBC is slightly superior to the AIC (Pesaran and Shin, 1999). Besides, SBC is parsimonious as it uses minimum acceptable lag while selecting the lag length and avoid unnecessary loss of degrees of freedom. Therefore, I have used SBC, as a criterion for the optimal lag selection, in all cointegration estimations.

[Table 6 here]

Table 6 shows the estimates of the long run co-integrating relationship of velocities with its variables. Coefficients of all three models of velocities 1, 2 and 3 are in conformity with our theoretical foundation. Per capita permanent income bears a positive sign in both LV0 and LV2 velocity function, as envisaged earlier. In quantum, one percent increase in the per capita permanent income will increase the LV2 velocity by 1.54 percent in the long run. For LV1 however the relationship was found to be negative but insignificant.

The impact of transitory income is also positive and significant but very small for LV1 and LV2. This implies first, both LV1 and LV2 are pro-cyclical which links the underlying behavior of velocity with the per capita permanent income. Second, the impact of the business cycle

[6] For Model 2 (LV1), bound test for cointegration initially conducted with intercept, and result thus obtained indicated LV1 is fractionally cointegrated [Bahmani-Oskooee, 2005) pp; 775)]. Later, trend was introduced in estimation which remarkably improved the result of the bound test. Therefore, test results for LV1 includes trend.

fluctuation on the money demand is although very trivial but significant.

Both interest rates and the inflation bears the correct positive sign in all three models however, both variables are found significant only for the LV1 velocity. The significance of interest rates in the LV1 velocity is rather intriguing. Fundamentally, M1 depends on the demand deposits, which is supposed to be less sensitive with the interest rate compared to the time deposits.

The insignificant real interest rate in case of 'narrow' LV0 and 'broad' LV2 money velocities indicates that the behavior of these velocities remains independent of the real interest rate. This result in fact answers one of the primary research questions of this thesis.

Also, insignificant inflation in both LV0 and LV2 indicates that inflation has no significant impact on velocity. Theoretically, the insignificant inflation is expected in a typically low inflation country. The finding that inflation in Pakistan is orthogonal to the velocities therefore supports the existing perception that Pakistan is not a high inflation country. Nevertheless, in LV2 model, the coefficient of inflation bears a t-statistics of 1.6767 which implies dropping inflation from the model could lead to specification bias, even if it is insignificant.

Table 7 shows the short run dynamics of the velocities of money and the error correction. Model 1, 2 and 3 are related to LV0, LV1 and LV2 velocities respectively. Not much interpretation could be attached to the short-run coefficients. All they show is the dynamic adjustment of these variables.

However, the negative coefficient of the error correction term with significant t-statistics confirms the cointegration among the variables in all three velocities. As argued by Bahmani-Oskooee and Bohl (2000), this evidence of cointegration is more efficient than the bound test. These cointegrating relationships are due to the interest rate, inflation, and cycle in the LV1 velocity, and due to per capita permanent income and the 'cycle' in the LV0 and the LV2 velocities.

Besides, the results show that all three estimated models cannot reject the null hypotheses of LM

tests, Ramsay- reset test and the Jarque-Berra test. In other words residuals are serially uncorrelated, normally distributed, and the specified models are functionally linear. These test results show that the estimated error correction models are statistically adequate.

[Table 7 here]

The graphical presentation of CUSUM and CUSUMSQ tests is provided in (Appendix C) in figure 1A, 1B, and 1C.

[Graph 1A, 1B and 1C here]

All the graphs of CUSUM and CUSUMQ statistics stay comfortably well within the 5% band indicating that the estimated relationships of all three velocities are stable.

This thesis therefore, finds supports for non-stationary velocity as found by Omer and Saqib (2009), however, significantly cointegrating and stable relationships of velocities with its determinants weakened their contention that the money velocities in Pakistan are unstable.

Section VII: Concluding Remarks

In this paper, first I have assessed the factors, specifically the interest rate, that determines the long run behavior of money velocity. The estimated result shows that in long run the both LV0 and LV2 depends on the income and the business cycle fluctuations and independent of the interest rate fluctuation, a believed root cause for velocity instability. On the other hand the estimate confirms that LV1 significantly depend on the interest rate and inflation besides income.

In terms of the policy perspective, independence of both LV0 and LV1 money velocities from interest rate fluctuation strengthens role of their respective monetary aggregates i.e., M0 and M2 as 'nominal anchors'. In Pakistan, M0 and M2 are used as nominal anchors for operational and the intermediate targets, respectively. M1, on the other hand, had never been used officially for policy purposes and its official reporting by SBP has been abandoned since 2006.

Second, to assess the assertion of Omer and Saqib (2009) that the non stationary velocities are unstable, I have investigated the velocity function for Pakistan. Following monetarist's approach and using Bordo and Junong (2004)'s synthesis, I have estimated the income velocity of money using recently developed ARDL technique of cointegration proposed by Peseran and Shin (1999).

My estimation with the given data does not reject the existence of stable and long run relationship of money velocities and its determinants such as, per capita real permanent income, and transitory income. The stability test using CUSUM and CUSUMQ test shows that all three model of money velocities are stable. This result implies first, that the contention of Omer and Saqib (2009) that non-stationary velocities are unstable can not be validated. Second, the finding of Moinuddin (2009), that money demand function in Pakistan is unstable, could not be confirmed.

As suggested by Mishkin (2004), these results provide support for the monetary targeting strategy for conduct of monetary policy for Pakistan. This conclusion also finds support from Narayan et.al (2009), which uses panel cointegration to estimate the money demand function in

South Asian countries of India, Pakistan, Bangladesh, Sri Lanka and Nepal. Based on their finding of stable money demand function for the above countries (except Nepal), they suggested that the monetary targeting is viable option for conduct of monetary policy for the central banks of these countries including SBP.

The caveat of this study is small sample size, which may raise questions on the robustness of estimation results. I have used bootstrap simulation technique to check the deviation of the variance, and the result shows that the bootstrap standard error remains close to the estimated standard error. However, this result is not sufficient to complement the robustness tests recommended in literature, which couldn't be taken due to small sample size. Even if the recent annual informations are incorporated in the existing sample, the sample size remains insufficient for the conduct of the robustness tests. Thus, a natural way out is to use the quarterly data. Therefore, working with the quarterly data that provides substantial data size to conduct the robustness tests on the estimated parameter, could be a future possibility.

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Appendices

Appendix A. Mathematical Detail of Equation (3)

Logarithmic transformation of per capita equation of exchange gives us;

$$LogV = \log(Y/PN) - Log(M/PN) \qquad \text{(A)}$$

Substituting equation (2) in (A) gives us,

$$LogV = Log(Y/NP) - \alpha_0 - \alpha_1 Log(Y/NP)^P + \alpha_2 i - \alpha_3 \dot{P}^e + \varepsilon \qquad \text{(B)}$$

Adding and subtracting $Log(Y/NP)^P$ from equation (B);

$$LogV = Log(Y/PN) - Log(Y/NP)^P - \alpha_0 + (1-\alpha_1) Log(Y/NP)^P + \alpha_2 i - \alpha_3 \dot{P}^e + \varepsilon \qquad \text{(C)}$$

Or,

$$LogV = Log(Y/Y^P) - \alpha_0 + (1-\alpha_1) Log(Y/NP)^P + \alpha_2 i - \alpha_3 \dot{P}^e + \varepsilon \qquad \text{(D)}$$

Which can be written as;

$$\log V = \beta_0 + \beta_1 \log(Y/PN)^P + \beta_2 i + \beta_3 \log Cycl + \beta_4 \dot{P}^e + \varepsilon \qquad (3)$$

Where, $\beta_0 = \alpha_0, \beta_1 = (1-\alpha_1), \beta_2 = \alpha_2, \beta_3 = 1, \beta_4 = -\alpha_3 and Cycl = Log(Y/Y^P)$,

Appendix B.: Tables

Table 1: Recent studies on the Stability of Money Demand Function

Study	Country	Sample	Methodology*	Variables	Findings
Asano (1999)	Australia	1965-1995	JJ Cointegration and VECM	Real Output, Money Stock, Price and Interest Rate	money Demand Function is Stable
Haug and Lucas (1996)	Canada	1953:1 - 1990:4	EG, JJ, PO, Cointegration	M1, real Income, Short term Interest Rates	Stable Cointegration relationship
Hamori and Hamori (1999)	Germany	1969:1 -1994:4	JJ Cointegration; Chow test for Stability	Real GDP, Real M1, M2 and M3, Call Rates	Unstable
Bahmani-Oskooee M (2001)	Japan	1964:1 - 1996:3	ARDL Cointegration, CUSUM & CUSUMQ for Stability	M2, Real Income and Interest Rate	Relationship Is Stable
Narayan (2008)	USA	1959:01 - 2004:02	LM Structural Break Unit root, Bound test for long run relationship	M1, M2, real Income, 3-m T bills rates	M2 demand is stable
Bahmani-Oskooee and Chomsisengphet (2002)	OECD 12 Countries (Australia, Austria, Canada, France, Italy, Japan, The Netherlands, Norway, Sweden, Switzerland, UK and USA)	1979:1- 1998:3, 1967:1-1998:3, 1957:1-1998:4, 1977:1-1998:3, 1974:1-1998:3, 1966:1-1998:4, 1966:1-1998:3, 1969:1-1998:4, 1975:4-1998:4, 1957:1-1998:2, 1957:1-1998:2, 1957:1-1998:4	JJ test for Cointegration, CUSUM and CUSUMQ test for stability	Real M2, Real Income, Long run Interest rate, Nominal Effective exchange rate	Money Demand is stable in most of the countries except Switzerland and UK

Study	Country	Sample	Methodology*	Variables	Findings
Narayan et.al. (2009).	India, Pakistan, Bangladesh, Sri Lanka, Nepal	1974 - 2002	Panel Unit Roots, Cointegration, and Granger Causality	Real M2, real GDP, real Exchange Rate, Short term domestic and foreign Interest Rates.	Cointegrated and stable money demand for all countries except Nepal
Lee and Chien (2008)	China	1977 -2002	ADF and ZA unit root test for Structural Break, Johansen for Cointegration	M1, M2, real Income, 1-yr time deposit rate	Unstable
Ramchandran N(2004)	India	1952-2001	CUSUM and CUSUMQ test for structural stability, JJ test for Cointegration	M3, Real Income, Prices	Stable relationship
Darrat, and Al-Mutawa (1996)	UAE	1974:1- 1992:2	Cointegration and Chow and FH Test for structural Stability	M1 real money balances, non-oil GDP Deflator, non-oil real GDP, Expected inflation, domestic interest rate, foreign interest rate, nominal exchange rate	The explanatory variables exert significant effect on M1 money holding. Additionally the relationship is stable.
Akinlo (2006)	Nigeria	1970:1-2002:4	ARDL Cointegration, CUSUM & CUSUMQ for Stability	M2, Real GDP, Nominal Exchange Rate, Interest Rate	Cointegration and stable relationship exists between the variables
Bahmani-Oskooee and Rehman (2005)	India, Indonesia, Malaysia, Pakistan, The Philippines, Singapore, Thailand	1972:1- 2000:4	ARDL Cointegration, CUSUM & CUSUMQ for Stability	Real M1, M2, Real GDP, Inflation rate and Exchange rate	M1 Money demand is Stable in India, Indonesia, and Singapore. For remaining countries M2 is stable.

* EG stands for Engle and Granger; PO for Phillips and Ouliaris and ;JJ for Johnsons and Julius; VECM for Vector Error Correction Method; ARDL for Auto Regressive Distributed Lag ; ZA for Zivot and Andrew; ADF for Augmented Dickey Fuller; CUSUM for Cumulative Sum of Recursive Residuals; CUSUMQ for Cumulative Sum of Squares of Recursive Residuals; FH for Farley- Hinich Test.

Table 2: Some Recent Studies on the Stability of Money Demand in Pakistan

Study	Samples	Variables	Findings
Moinuddin (2009)	1974-2006	M2, GDP, interest rate	M2 is unstable
Abbas and Husain (2006)	1972-2005	M2, GDP, inflation, interest rate, financial innovation	M2 demand is stable
Bahmani-Oskooee and Rehman (2005)	1975-2000	M1, M2, GDP, inflation, exchange rate	M1 is unstable , M2 is stable
Qayyum (2006)	1960-1999	M2, GDP, inflation, interest rate, government bond rate	M2 demand is stable

Table 3: Variable Details

Variables Name	Details*
M0	CC + other deposits with the SBP+ Currency in Tills of SB + Banks Deposit with SBP
M1	CC + other deposits with SBP+ SB Demand Deposits
M2	M1 + SB's Time Deposits + Resident's Foreign Currency Deposits
LV0	Log of Income velocity of broad money (=Py/M0)
LV1	Log of Income velocity of broad money (=Py/M1)
LV2	Log of Income velocity of broader money (=Py/M2)
RCMR	Real Inter-bank call money rate
Nominal Income (NGDP)	Gross Domestic Product (Market price) based on the current factor cost
PCYD	Per capita Permanent Real Income
INF	Domestic Inflation, calculated as a growth rate of CPI
CYCL	Cyclical fluctuation in the per capita real permanent income

*SB: Schedule Bank, SBP: State Bank of Pakistan, CC: Currency in Circulation.

Table 4: Stationarity Tests of Variables*

	DF		ADF					
	(No Lag)		One Lag (n=1)		Two Lag (n=2)		Three Lag (n=3)	
Variables	**Level**	**1st Diff.**	**Level**	**1st Diff.**	**Level**	**1st Diff.**	**Level**	**1st Diff.**
				Panel A				
LV0		-5.8785		-3.3687				
LV1		-6.2301		-3.7018				
LV2		-4.6379		-4.4727		-3.5998		-3.7463
LPCYD		-5.0046		-4.0692				-3.1567
CYCL	-9.6699		-7.0339		-5.6065		-4.3116	
INF	-4.4897		-5.1241		-3.9034		-3.6043	
RCMR	-3.3722		-3.4150		-3.6154		-3.3862	

*Dickey-Fuller regressions include intercept but not trend; 95% Critical Value = -2.9706

Tables 5: F-Test for Cointegration

	Lag 1	Lag 2	Lag3
LV0	0.95864	2.321	1.695
LV1[n]	3.6802	7.6956	4.6223
LV2	2.1978	8.2214	4.5264

At 95% level Critical Values of bound is 2.850 - 4.049

[n] Estimated using trend

Table 6: Full Information Long Run Coefficient Estimation

Variables	Models 1(LV0)	Model 2(LV1)	Model3(LV2)
LPCYD	1.6101*	-0.3670**	1.5425*
	(3.1888)	*(-1.7593)*	*(2.589)*
RCMR	0.0093	0.0396*	0.0023063
	(0.8364)	*(7.2307)*	*(0.25478)*
INF	0.00924	0.0476*	0.015088
	(0.799)	*(7.9165)*	*(1.6767)*
CYCL	-0.0000299	0.00008516*	0.00006380*
	(-1.1513)	*(3.5878)*	*(3.0711)*
INPT	1.7988*	0.016583*	079531*
	(17.655)	*(4.6035)*	*(10.3148)*
Trend		0.01658*	
		(12.1766)	

* indicates 5% level of significance; ** 10% level of significance; figures in parenthesis are t-statistics

Table 7: Full Information Short Run Estimate with ECM

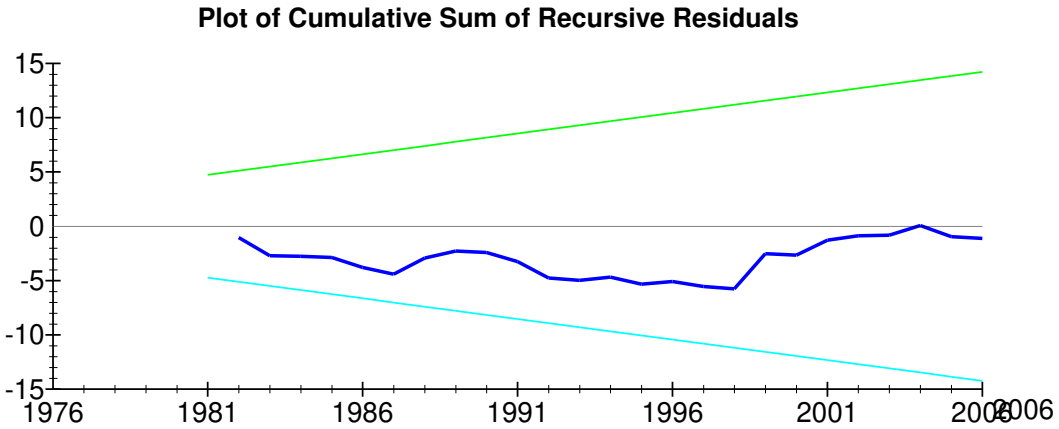
	Model 1: Dependent Variable LV0 (1.0.0.0.0)			Model 2: Dependent Variable LV1 (0.0.3.3.2)			Model 3: Dependent Variable LV2 (3.3.0.0.0)		
Variables with lag order	**0**	**1**	**2**	**0**	**1**	**2**	**0**	**1**	**2**
D(Lag Dependent)								0.60577*	0.46344*
								(4.1988)	*(2.5642)*
DLPCYD	0.83669*			-0.2758			0.4413*	-1.2775*	-0.74551*
	(3.1512)			*(-1.1479)*			*(2.087)*	*(-4.5471)*	*(-2.4441)*
DRCMR	0.00233			0.0084	-0.03824*	-0.0259*	0.00278		
	(0.4096)			*(1.6776)*	*(-4.3949)*	*(-3.8558)*	*(0.5225)*		
DINF	0.0025			0.00643	-0.04928*	-0.03185*	0.00996**		
	(0.4134)			*(1.103)*	*(-4.893)*	*(-4.0826)*	*(1.9623)*		
DCYCL	0.00001*			-0.000003	-0.00004*		0.000026*		
	(2.4416)			*(-0.471)*	*(4.1155)*		*(3.9138)*		
D(Trend)				0.01603*					
				(2.1611)					
ECM(-1)		-0.32639*			-0.99373*			-0.40861*	
		(-2.4416)			*(-6.8025)*			*(-4.0396)*	
Adjusted R^2		0.33545			0.78378			0.62068	
LM Stats		0.25309			2.7326			6.6712	
Ramsey's Reset		0.0082659			0.0875			1.9861	
Normality		1.6282			0.5304			4.7073	

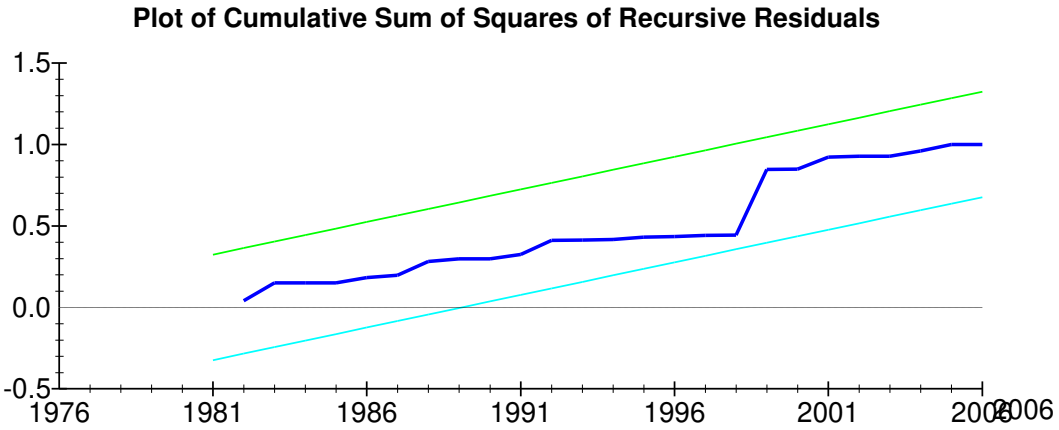
* indicates 5% level of significance; ** 10% level of significance; figures in parenthesis are t-statistics

Notes: LM is the Lagrange multiplier test of residual serial correlation. It has a $\chi 2$ distribution with four degrees of freedom. RESET is Ramsey's test for functional misspecification. It has a $\chi 2$ distribution with one degree of freedom. Normality statistic is based on a test of skewness and kurtosis of residuals.

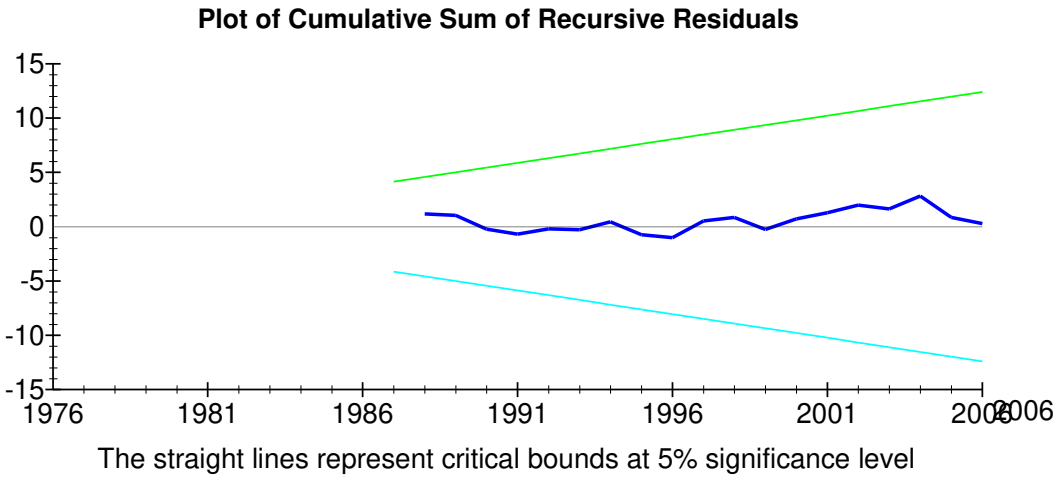
Appendix C: Figures

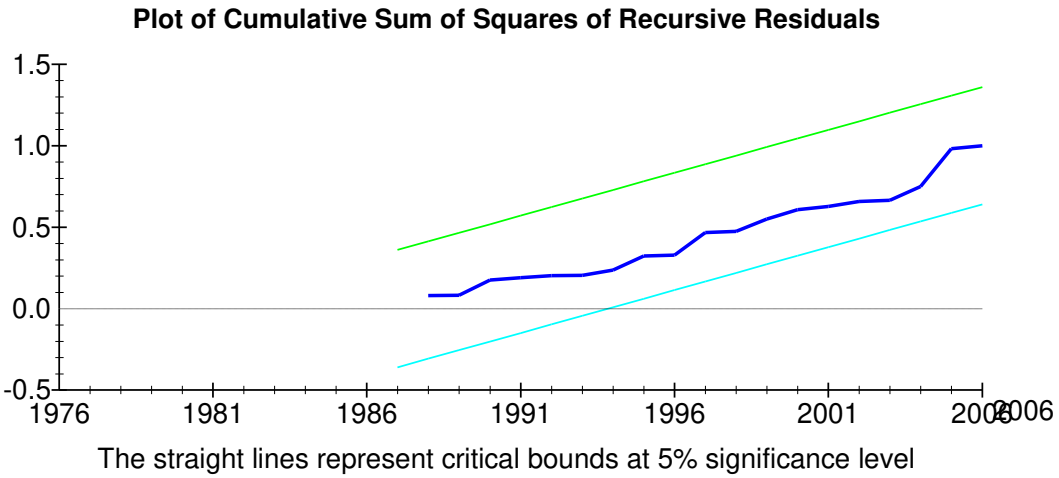
Figure 1
A) Model 1: CUSUM and CUSUMQ Test for Stability Test of LV0





B) Model 2: CUSUM and CUSUMQ Test for Stability Test of LV1





C) Model 3: CUSUM and CUSUMQ Test for Stability Test of LV2