Maintaining Low Inflation: Money, Interest Rates, and Policy Stance

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Abstract

This paper examines the usefulness of considering monetary aggregates when assessing monetary policy stance relative to an inflation objective, and contrasts monetary analysis to the current mainstream monetary policy analysis. Monetary developments, unlike interest rate stance measures, are shown to provide quantitative information on subsequent price levels. Moreover, ignoring money and focusing on interest rates and real activity measures neglects crucial information as short-term velocity movements are fully part of the monetary policy transmission process. The analysis also sheds light on the recent change in inflation volatility and persistence as well as on the Phillips curve flattening. The empirical analysis is based on US data since the 1960s as well as euro area and Swiss data since the 1970s.

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1. INTRODUCTION

There is nowadays a large gap between mainstream monetary policy analysis and policymakers' concerns. Most models currently used for monetary policy analysis or forecasting are linearized or normalized around a given inflation steady-state or average. The implicit assumptions behind these models are that the central bank announces an inflation target, the public believes in the intention and ability of policymakers to reach this target, and that central bankers know how to optimally move a short-term interest rate as a function of an unobservable frictionless real equilibrium interest rate and of fundamental economic shocks in order to remain on that steady-state target and conduct optimal cyclical policy. These "normalized" monetary policy analyses and estimations are thus in fact focusing on relative instead of general price level fluctuations, leaving the issue of deviations from price stability to indeterminacy mechanisms. As a result, assumptions have to be made regarding the behavior of steady-state or trend inflation, which have taken different forms. Under their most simplistic form, data are detrended. Fancier formulations include stochastic trends, moving inflation targets, and "sunspot equilibria".

An implication of that analysis is that policymakers preferences can be expressed in the form of a loss function: central banks in that world care about minimizing inflation deviations around a given target and output deviations around its potential. Such a loss function has been explicitly derived from theoretical models (see Woodford, 2003) and is extensively used in monetary analysis.

Such an analysis is at odds with policymakers concerns and behavior. First, the main concern of central banks and of the population in general, and what matters for welfare, is not small inflation deviations around a given steady-state but rather a drifting away from low inflation towards higher inflation or deflation. Whether inflation is at 1.7 rather than 1.3 percent is not of much importance. Monetary policy cannot fine tune and control such small orders of magnitudes, and inflation is not perfectly measured anyway. Nowadays, most central banks have, implicitly or explicitly, an admissible range for inflation, and their concern is to prevent inflation from drifting substantially and persistently above or below that range. The position of the inflation rate within that range is not important as long as it is and is forecasted to remain in the desirable range. Figure 1 displays inflation data for the economies and sample considered[1]. The inflation developments which need to be explained are: the high inflation of the 1970s, the subsequent disinflation, the temporary inflation increase in the late 1980s / early 1990s, as well as the low and stable inflation thereafter.

Furthermore, the identification of macroeconomic shocks is difficult. Even the most obvious shock, a spike in oil prices, and its related "second round effects" are not easy to identify. Moreover, it is evident from recent policymakers' public statements that it is neither clear where the neutral interest rate is, nor how far one should be from it in a given economic situation. Thus it is not clear how fast and how far beyond the neutral rate central banks should go in a normalization period[2]. These considerations

[1] Price series are the GDP price deflator for the US, the harmonized CPI for the euro area, and the CPI for Switzerland. The samples considered, chosen according to availability of the data series used in the analysis, are 1959Q1-2006Q2 for the US, 1973Q1-2005Q4 for the euro area, and 1975Q1-2006Q4 for Switzerland. US data are from the Federal Reserve Bank of St. Louis FRED database and are released by the Federal Reserve Board, the Bureau of Economic Analysis and the Bureau of Labor Statistics. Euro area data are from the European Central Bank and Eurostat. Swiss data are from the Swiss National Bank and the Swiss Federal Statistical Office. All series except interest rates are seasonally adjusted.

[2] For example, Thomas Hoenig, president of the Federal Reserve Bank of Kansas City, said that "[m]onetary policy works with a lag, but it's hard to appreciate that when you're in the midst of the cycle. [...] I'm still very much opposed to allowing inflation pressures to get out. I also, though [...] want to be reasonable confident of not overshooting" (reported by *The Wall Street Journal Europe*, May 22, 2006). Alan Blinder (Federal Open Market Committee Meeting Transcript, November 15, 1994) stated that "[t]he classic mistake of monetary policy [...] is overdoing it. [...] The classic

are model dependent.

Monetary policymakers thus need to have some quantitative guidelines regarding price developments after policy lags – which are one regularity documented in this paper – have taken effect, in order to avoid the substantial and long-lasting inflation swings characterizing any country time series data. A wait-and-see approach carries the risk of "being behind the curve" or, on the opposite, "overdoing it". This paper assesses the usefulness of monetary aggregates in providing these guidelines, and contrasts monetary analysis to the current mainstream monetary policy analysis.

In this paper I organize data in such a way as to characterize the relationship between money and price developments with some regularities that can be used to assess monetary policy stance relative to an inflation objective as well as to interpret some empirical results and address critiques and misconceptions regarding the usefulness of monetary aggregates for monetary policy. Moreover, the analysis is used to shed light on apparent changes in inflation dynamics that appeared recently. As argued by Orphanides (2003), given our limited knowledge of economic dynamics and the resulting fact that various models with different implications for inflation dynamics coexist in the literature, evaluating stance measures based on historical macroeconomic developments for practical monetary policy purposes requires an analysis that is not dependant on specific models. In addition, the stylized facts presented in this paper suggest inherent instability of reduced-form estimated inflation equations. Furthermore, as discussed above, existing macroeconomic models that have tried to incorporate microeconomic foundations are linearized around a given steady-state, which is not appropriate to address the issues of interest for this study.

reason for this error [...] is impatience in waiting for the lagged effects of what already has been done".

The analysis of this paper thus imposes only a minimal structure on data, adjusting for offsetting influences of potential output and (the inverse of) equilibrium velocity on money with respect to price developments, and characterizes the observed relationship between monetary and price developments, contrasting it to the information contained in interest rate stance measures and to current inflation dynamics modeling. This analysis is of course no substitute for structural model building, but it provides stylized facts that structural models designed to model inflation dynamics and address monetary policy issues should be able to replicate. The analysis shows that monetary developments, unlike interest rate stance measures, provide qualitative and quantitative information on subsequent price levels and inflation developments. Moreover, ignoring money and focusing on short-term interest rates and real activity measures neglects crucial information with respect to the monetary policy transmission process and inflation dynamics.

It is commonly argued that the long-term relationship between money growth and inflation comes only from a money demand relationship and is of no relevance for the horizon of interest of central banks. It is also claimed that short-term velocity movements due to implicitly accommodated money demand shocks – i.e. through an interest rate based policy – or to monetary policy reacting to other fundamental economic shocks blur the short-term relationship between money and prices, especially in low inflation economies. It is further argued that, as a result, in a successful inflation targeting strategy the link between money growth and inflation should vanish. In contrast to those claims, this paper shows that when the relationship between prices and money is characterized in a way that accounts for equilibrium velocity changes and prices asymmetric behavior, we do not observe significant monetary developments that are not followed by corresponding price developments. Nor do we observe significant price movements not preceded by corresponding monetary movements. Contrary to what is usually argued and modeled, what are considered as velocity "shocks" provide information on subsequent price levels, pointing to a weakness of models that represent policy actions with a short-term interest rate only. Moreover, the quantitative importance of other economic shocks to inflation is small in the samples considered. In summary, monetary developments can be used to characterize inflation trends, changes in trends, as well as fluctuations around these trends, and provide guiding information on these inflation developments.

Monetary regularities are then used to shed light on recent changes in inflation patterns and estimated relationships, i.e. on inflation reduced persistence and volatility as well as on the flattening of the Phillips curve. Moreover, the implications of the leading information of velocity for estimation and forecasting using Phillips curves is discussed.

In the analysis, I use data from the US, the euro area, and Switzerland. These economies have had different structures and policy regimes; the Federal Reserve has a dual mandate, with no explicit inflation target, and has been confronted with very different inflation environments during the post-war period. The euro area is an aggregation of individual countries with different pre-euro policies and experiences. Finally, the Swiss National Bank had monetary targets till the end of the 1990s and has been characterized as a precursor of the inflation targeting approach (see Bernanke, 1998). The Swiss case is also interesting as there have been several distinct inflation environments even though average inflation has remained one of the lowest in the world. The samples considered are thus from low inflation economies, with however significant changes in inflation environments and monetary policy responses. These characteristics allow us to address critiques that the relationship between money and inflation is weaker in lower inflation environments and depends on monetary policy regimes.

Section 2 discusses weaknesses of interest rate policy stance measures; section 3 presents monetary regularities, analyzes the usefulness of monetary stance measures as well as the role of short run velocity and output gaps in the monetary policy transmission process, and addresses critiques with respect to the usefulness of monetary aggregates for monetary policy. This monetary analysis is used in section 4 to shed light on recent changes in estimated inflation dynamics, and section 5 concludes. Money demand estimates used in the analysis are presented in the appendix.

2. INTEREST RATE STANCE MEASURES AND INFLATION

Current mainstream monetary policy analysis is done in terms of deviations around a given steady-state. An optimal interest rate function is derived, which generates the desired inflation deviations around steady-state, given the model considered. It has been shown that, given the implied loss functions, simple Taylor rules, which were initially presented by Taylor (1993) as a descriptive and organizing device for monetary policy decisions, can deliver close to optimal results[3] (see Woodford, 2003). These types of rules are also often used to measure monetary policy stance and in forecasting models.

The standard Taylor rule can be expressed as

$$i = r^* + \pi^* + 1.5\,(\pi - \pi^*) + 0.5\,(y - y^*)\,, \tag{1}$$

[3] The optimal parametrization is however model dependent.

where i is a short-term nominal interest rate, $r^*$is the equilibrium real interest rate[4], π is the inflation rate, π^* is the inflation objective, y is (log) real output and y^* is (log) real potential output. The timing of variables differs across studies, which consider past, current or future deviations from steady-state.

The transmission from the monetary policy instrument i to the inflation gap $(\pi - \pi^*)$ operates via the output gap $(y - y^*)$ in New-Keynesian models and depends on each model's specifications. The timing and amplitude of inflation deviations from target then depend on optimally derived coefficients of the interest rate equation (1), although many analyses and forecasting exercises use ad hoc coefficients, like the 1.5 and 0.5 values used here. The two last expressions, $1.5\,(\pi - \pi^*) + 0.5\,(y - y^*)$, are thus implicitly the orders of magnitudes people refer to when they argue whether or not a central bank should go above the equilibrium nominal interest rate $(r^* + \pi^*)$ in order to control future inflation/output gap developments as well as when the pace of interest rate normalization is discussed.

The fact however is that a simple look at inflation time series, as e.g. in Figure 1, suggests that it does not make much sense to think of and characterize inflation developments as deviations from a given steady-state. It seems even difficult to think in terms of underlying steady-state shifts, i.e. with level shifts characterizing specific inflation regimes. What we observe and need to think about are protracted inflation movements with strong amplitudes. After all, many econometric tests characterize inflation as having a unit root. Models solved around a steady-state inflation rate and their implied tools and concepts (e.g. loss functions) are thus not well suited to

[4] r^* is not directly observable and has been subject to much discussion recently but is well approximated by a filter or sample average for practical purposes. My argument will not rely on a precise estimate of r^* as the potential fluctuations of r^* are relatively small compared to inflation movements.

analyze inflation and address issues of concerns for central banks.

When assessing the monetary policy stance, the discussion needs to somehow relate an instrument on which central banks have a direct or indirect influence, such as a short-term interest rate or a monetary aggregate, to a target variable, e.g. inflation. As monetary policy cannot be based mechanically on a specific model, central banks look for different relationships/frameworks linking the instrument to the target. To avoid drifting away from a given inflation range or from a steady-state to another steady-state, policymakers thus need to think in terms of where to set i in order to attain a given target, and not merely deviations from target, which amounts to a consideration of cyclical policy only. In addressing the drifting issue, central bankers also want to have something more useful and practical than discussions on unstable systems, indeterminacy and sunspot equilibria. Characterizing the 1970s period in the US as an indeterminate equilibrium is of not much use for a central bank that wants to reach and remain in a given inflation range, whether it is 1-3 percent or price stability, nor for an economist who wants to model inflation in Argentina or in some European countries in the pre-euro era. Therefore, we have to understand the relationship between variables indirectly controlled by central banks and major inflation developments.

We thus have to think in other terms than optimal rule coefficients around steady-states and need to compare observed interest rates to benchmarks with the aim of reaching a certain (average) inflation rate. The analysis of this section shows that thinking in terms of interest rates or Taylor rules fails to address those issues in a satisfactory way, in contrast to the monetary analysis of section 3.

Figure 2 displays the US 3-month T-bill rate (TB3m) together with the Taylor rule

(Taylor) from equation (1) and the inflation rate π to which the real interest rate r^* is added (Fisher)[5]. This latter variable corresponds to the Fisherian interest rate, i.e. $r^* + \pi$, where $r^*$is set equal to 2. Several interesting features appear from this graph.

An obvious fact that is often overlooked when discussing interest rules is that major interest rates movements are driven by changes in inflation environments rather than monetary policy reaction to the economy or policy stance. Higher interest rates during the 1970s did not mean than monetary policy was more restrictive then than during the 1990s; this merely represents the only clearly established relationship between interest rates and inflation, i.e. the Fisher effect. But, by examining interest rates, what can we say about monetary policy stance and implied future inflation? What information do interest rates convey for future inflation? Given the lack of theory and empirical evidence, interpreting interest rate movements beyond the Fisher equality becomes difficult and, given the focus on around steady-state analysis, recent research has not provided us with useful ways of thinking about it.

From Figure 2, the value added of Taylor rule over a Fisherian interest rate is not clear. Intuitively, both variables should give a similar message: if the interest rate is above (below) the Fisherian interest rate, i.e. if the real interest rate is above (below) its equilibrium, inflation should decrease (increase). We can say then that monetary policy was too loose in the 1970s, leading to an increasing inflation, and restrictive in the 1980s, bringing inflation down. This interpretation is thus consistent with the direction of inflation changes, but what indication do we get about inflation rates?

Thinking in terms of inflation rates is difficult as interest rates are increasing functions of inflation rates via both the Fisher effect and the policy reaction function.

[5]Interest rates are 3-month rates. Potential output is real potential GDP (Congressional Budget Office) for the US, HP filtered real GDP for the euro area, and is derived from a production function approach (SNB) for Switzerland.

Moreover, an increase in average inflation is associated first with low (policy induced) interest rates but later with higher rates (due to the Fisher effect). In other words, as interest rates rise in a normalization period, for example, after a weak activity/inflation period and as the economy is strengthening, it is hard to distinguish between an increase that is policy driven (i.e. a change "recommended" by the term $1.5\,(\pi - \pi^{*}) + 0.5\,(y - y^{*})$) and an increase that reflects a rise in steady-state (average) inflation. The latter case would be an unwelcome change in the variable π^{*} in a case where the policy target has effectively not been changed. Different models yield different results on where to set the interest rate in a given situation in order to reach a given inflation level, and a wait-and-see approach with incremental steps (i.e. wait and see how a certain interest rate change affects the economy and inflation) carries the risk of "being behind the curve" as there are lags in monetary policy effects.

Evaluating the monetary policy stance content of a Taylor rule in a world when inflation is not fluctuating around a given steady-state level requires focusing attention on the variable π^{*} of equation (1). The value of π^{*} originally used by Taylor (1993) and used to compute the Taylor rule in Figure 2 is 2 percent. However, when comparing the Taylor rule relative to the observed interest rate with realized inflation (which on Figure 2 corresponds to the Fisher interest rate variable minus 2), we see that the Taylor rule has been unsuccessful in delivering its own implied target. Over the 1980s and 1990s, the actual 3-month T-bill rate has been consistently above the Taylor rule rate associated with a 2 percent inflation. Despite that fact, inflation reached 2 percent only in the late 1990s and only for a few years if the CPI is considered. In other words, inflation has almost always been above the implied target (2 percent) without the actual interest rate being below the Taylor rule. There is thus not a useful relationship between the implied inflation target and observed inflation. Moreover, there is no indication why inflation should have picked up to 4 percent around 1990; the T-bill rate was even above the rule implying 2 percent inflation before and during this inflation increase. Furthermore, we would have expected a strong decrease in inflation following the high interest rate relative to the Taylor rule seen in the second part of the 1990s. There is also no indication why inflation began to accelerate in the mid-1960s, the beginning of the "great inflation", when the T-bill rate was at or above the Taylor rule just prior. And finally, in the 1970s, it is difficult to assess what inflation observed interest rates would have implied, given that they have been consistently below the Taylor rule.

To assess the nominal anchor properties of a Taylor rule, i.e. what inflation we could expect following a given observed interest rate, I plug the observed 3-month interest rate i_t into the Taylor rule equation (1) and allow π^* to vary, i.e. I compute π_t^* as

$$\pi_t^* = 2\left(\pi_t + r^* - i_t\right) + \pi_t + \left(y_t - y_t^*\right) \qquad (2)$$

with $r^* = 2$. I then compare the implied target π_t^* to observed inflation. Figure 3 presents the implicit inflation target π_t^* (Implicit Target) together with observed inflation (Inflation). Implied inflation was much higher than observed inflation during the 1960s and 1970s and much lower during the disinflation period and in the 1980s and 1990s. Consequently, measuring monetary policy stance with interest rate levels does not give valuable information and guidance regarding subsequent inflation levels. The fact that interest rate rules that are not related to inflation objectives are describing monetary policy in many models used for analysis or forecasting should be concerning.

Similar issues arise when the "natural growth rule", i.e.

$$\Delta i = 0.5\left(\pi - \pi^{*}\right) + 0.5\left(\Delta y - \Delta y^{*}\right), \tag{3}$$

discussed (in its forecast-based formulation) by Orphanides (2003) is used to evaluate policy stance. The 3-month T-bill rate follows the rule relatively well over the 1980s and 1990s while inflation was most of the time above target. This measure of stance also missed the inflation increase of the late 1980s / early 1990s.

Orphanides argues that equation (3) is equivalent to a money growth rule. This however is the case only under his particular assumption that velocity deviations from equilibrium are a function of the interest rate. With a more conventional money demand where velocity itself is a function of the interest rate, a money growth rule implies that the change of the equilibrium nominal interest rate appears in equation (3). Both money demand formulations are equivalent only in the case of constant equilibrium nominal interest rate, which is not plausible with data characterized by long-lasting inflation swings. Moreover, Orphanides disregards the change in the money demand error term, arguing that short-term velocity fluctuations are the suggested drawback in considering money. The analysis of this paper, however, will show that these short-term velocity fluctuations contain additional information for price developments that non-monetary analyses miss.

Swiss interest rates, i.e. the short-term (3-month LIBOR) as well as the Taylor and Fisher rates, where r^{*} is set to 1 (historical average) and π^{*} is set to 1 as well, are presented in Figure 4. Since 2000 the Taylor rule and the actual interest rate have evolved close to each other and inflation has fluctuated around 1 percent. However, such a rule fails to account for the loose policy stance preceding the two inflationary periods of the early 1980s and early 1990s and provides no quantitative information of subsequent price levels during these episodes. Furthermore, the Taylor rate is constantly and substantially below the actual interest rate during the 1990s despite the fact that inflation was reduced to and remained around 1 percent. The next section will show that, in contrast to the lack of information of interest rate stance, money provides quantitative indications on subsequent price levels.

3. MONETARY AGGREGATES AND INFLATION

3.1. SOME MONETARY REGULARITIES

Money and the price level

This section presents stylized facts on the relationship between money and price levels. The monetary variable considered is defined as

$$m_t^* \equiv c + m_t - y_t^* + \beta i_t^*, \tag{4}$$

where c is a normalization (negative of a money demand estimated) constant, m is the observed money level, y^* is real potential output, β is an estimated interest rate semi-elasticity of a real money demand equation where a unitary income elasticity has been imposed, and i^* is an HP filtered short-term interest rate or opportunity cost of money[6]. All variables except interest rates are in logarithms. Conceptual

[6] Monetary aggregates are M2- for the US, M2 for the euro area, and M2 for Switzerland. Some results will also be presented with the euro area M3 aggregate adjusted by portfolio shifts, as the ECB assigns an explicit role on that aggregate in its strategy. US M2- corresponds to M2 minus small time deposits, and includes cash, demand and checking deposits, savings accounts, money market deposit accounts, and retail money market funds. Euro area M2 includes currency, overnight deposits, deposits with an agreed maturity up to 2 years, and deposits redeemable at a period of

considerations underlying the computation of m^* and the choice of monetary aggregate are presented in Reynard (2006), thus only a brief description is provided in the next paragraphs. Money demand estimates used for the required low-frequency level adjustments are presented in the appendix.

I consider an asset as monetary if it yields an interest rate below the 3-month rate and provides direct or indirect transaction services. An aggregate composed of such assets is the most likely to exhibit a close and stable relationship to nominal GDP. Moreover, such an aggregate gives the right monetary policy stance signal, i.e. it increases when the policy rate decreases and vice versa, as interest rates paid on transaction accounts are relatively sticky and move only with persistent changes in the 3-month market rate. Broader monetary aggregates do not necessarily provide with the right stance signal, as the additional assets included in them with yields at or above the 3-month rate are positively correlated with the policy rate[7]. Monetary aggregates defined according to this transaction concept are characterized by an estimated unitary income elasticity, which is not the case of broader aggregates. The latter aggregates are generally associated with an income elasticity above unity and sample-dependent. My preferred approach regarding the choice of monetary aggregate is not to switch from one aggregate to the other as apparent instability occurs,

notice up to 3 months. Euro area M3 consists of M2 plus debt securities up to 2 years, repurchase agreements and money market funds. Swiss M2 includes cash, sight and savings deposits. The interest rate used is the opportunity cost of money (3-month rate minus the weighted average of rates paid on the different monetary assets) when available, i.e. for US M2- and euro area M3, and the 3-month rate otherwise, i.e. for Swiss and euro area M2.

[7] For the euro area, M2 does not exactly corresponds to my preferred concept, as it includes some time deposits with maturity over 3 months. Moreover, it does not include money market funds, contrary to M2- in the US. However, whether or not these latter assets are included does not matter much empirically for money demand or the money/price relationship; issues arise mainly when assets with yields close to checking or transaction accounts are not included, and/or if significant amounts of assets with yields above the 3-month interest rate are included. Euro area M3 contains in addition debt securities, which are not related to the transaction concept, but M3 information value for inflation is considered as its growth rate is an explicit element of the ECB strategy.

but rather to choose an aggregate that is closely related to the transaction concept and then identify and explain apparent aggregate instability episodes. The aggregates chosen in this paper have been stable over the sample periods considered, except for two episodes in the US case where aggregate instability is clearly related to changes in extensive margins of money demand[8].

The money level considered has been adjusted by potential output and equilibrium velocity, i.e. by low-frequency changes in the opportunity cost of money, where the estimated long run interest rate semi-elasticity of money demand is used to make the adjustment. The latter protracted cost-driven changes in money holdings, or equilibrium velocity movements, reflect mainly changes in inflationary environments, i.e. Fisher effects, but could also reflect real equilibrium interest rate changes. Not accounting for these equilibrium movements biases econometric results in the forms of less than one-to-one and often non-significant relationships between money growth and inflation. However, adjusting money growth for equilibrium velocity changes results in significant estimated dynamic relationships between money growth and subsequent inflation in various VARs specifications, using US and euro area data, and in a one-to-one low frequency relationship. It is an empirical issue of drawing the line between low-frequency cost-driven adjustments and policy-induced liquidity effects affecting subsequent price developments, but empirical analysis shows that an HP filter adjustment is well suited to distinguish between these two effects. Moreover, the analysis below is not significantly affected if a backward-looking filter, like the

[8] Changes in extensive margins are measured by changes in financial market participation, i.e. in the fraction of households holding non-monetary assets, like e.g. stocks or bonds, as part of their portfolio. An increase in that fraction means that some households that were holding only monetary assets decide to invest part of their financial wealth in non-monetary assets, thus affecting money demand via the extensive margins. For more details on the measurement, causes and effects of extensive margins changes, see Reynard (2004).

filter proposed by Cogley (2002), is used instead of the HP filter, thus the equilibrium velocity adjustment can be applied in real time.

The output adjustment ensures that if money and potential output offset each other, no influence on prices follows. I use a unitary income elasticity, a result that clearly appears from the data when changes in extensive margins (US) and sample issues (related to the euro area disinflation) as well as the choice of monetary aggregate are correctly dealt with.

The definition of m^* is equivalent to the variable labeled p^* in P*-models, initially presented by Hallman, Porter and Small (1991), and the difference between m^* and the actual price level, i.e. $m_t^* - p_t$, corresponds to a measure of excess liquidity used, for example, in analyses of monetary developments by Fed, ECB and SNB economists (see e.g. Orphanides and Porter (2001), Masuch, Pill and Willeke (2001), and Peytrignet and Reynard (2004)): using equation (4), the difference between m_t^* and p_t can be expressed as

$$m_t^* - p_t = m_t - \widehat{m}_t, \tag{5}$$

where $\widehat{m}_t$ is the money demand that would prevail at equilibrium output and interest rate, given the current price level, i.e.

$$\widehat{m}_t = -c + p_t + y_t^* - \beta i_t^*. \tag{6}$$

The difference between m_t^* and p_t thus represents a measure of excess liquidity, i.e. money in excess of an estimated long run equilibrium money demand. The interpretation of money and price developments in this paper however differs from P*-models interpretation of excess liquidity. The relationship between excess liquidity and inflation, and the relative developments of the variables considered and thus excess liquidity measures differ as well given different treatments of equilibrium velocity, and in some instances a different choice for the monetary aggregate concept. These differences will be discussed below.

In the analysis of this paper, monetary aggregates represent a "quantity-side" measure of monetary conditions induced by monetary policy, a terminology used in Nelson (2003, p.1043), in the sense that money movements implicitly – i.e. given the operating procedure and regime – represent monetary policy exogenous shocks as well as endogenous reactions to various variables and shocks.

To illustrate the effect of the equilibrium velocity adjustment, consider Figure 5, which displays both the velocity adjusted (M^*, i.e. $c+m_t-y_t^*+\beta i_t^*$) and non-velocity-adjusted (M, i.e. $c+m_t-y_t^*$) money levels for the US, together with the price level (P). People held relatively fewer real money balances as inflation increased in the 1960s and 1970s, and relatively more real money balances as inflation decreased in the 1980s and 1990s. Not accounting for these low-frequency money demand Fisherian level effects blurs the money/price relationship. As only the low-frequency (HP filtered) movements of interest rates are removed, the liquidity or monetary policy driven effects on money remain, as it will become clear from the analysis below. The US monetary aggregate is in addition adjusted by an upward velocity shift in money demand due to a change in money demand extensive margins which occurred from the mid-1960s to the mid-1970s, as described in Reynard (2004), as well as for a downward velocity shift between 2001 and 2003. A discussion of these additional adjustments is provided in the appendix.

Figures 5-8 present the evolution of monetary aggregate (M^*) and price (P) levels for the US, the euro area with my preferred measure M2 as well as the official aggregate M3 adjusted for portfolio shifts by ECB staff[9], and Switzerland. These observed reduced-form relationships between money and prices can be characterized as follows. When $m_t^* \geqslant p_t$, increases in money levels are followed by proportional increases in price levels. However, the lag before prices start reacting to a relatively faster money increase is time-varying, and the upward price adjustment pace or period length is also time-varying. As a result of these time-varying adjustment periods, the overall increase in the price level from its initial level could be approximately characterized as proportional to the corresponding preceding money increase in addition to the price increase that occurred during the lag period; moreover, the inflation rate during the adjustment may not exactly match the preceding money growth rate. This latter adjustment seems to be faster in high than in low inflation environments, i.e. inflation rates usually match closely previous money growth rates when inflation is high, like in the 1970s, but are lower otherwise. When the money growth rate decreases or when $m_t^* < p_t$, the inflation rate decreases; whether money levels increase or decrease while $m_t^* < p_t$ does not seem to affect price developments in different ways. Thus m^* draws the price level upwards, but a decreasing or relatively low money level with respect to prices causes only the inflation rate to decrease.

This evolution of the price level can be expressed in a quantity theoretic way, i.e. according to the evolution of the money level m^*, with some additional stylized facts, as follows. A higher money level relative to the price level (i.e. $m_t^* > p_t$) is followed, with a time-varying lag and pace, by a proportional increase in the price level. Consider first the Swiss case in Figure 8. Inflation was relatively low in the

[9] M3 adjusted by portfolio shifts is the result of ECB analyses that have tried to account in real time for the particular financial market developments which occurred in between 2001 and 2003 (see ECB, 2004). This series has been computed back to 1980 only.

late-1970s and mid-1980s preceding the two major money increases – relative to the price level, i.e. with $m_t^* > p_t$ – that started in 1977 and 1986 respectively, and the price levels around 1982 and 1993 ended up, after a relatively faster increase, at a level close to the money level peaks of 1979 and 1988 respectively. The relative inflation increases of the mid-1980s and late 1990s can be characterized in a similar way.

In the US, as displayed in Figure 5, relatively faster increases in the money level preceded the beginning of the "great inflation" as well as each inflation peak of the 1970s, i.e. the peaks of around 1970, 1975 and 1980. During each of these increases, the inflation rate approximately matches the preceding money growth rate. Compared to Swiss data, the price level following the late 1970s money increase ended up relatively higher as the price increase during the lag period was stronger. Two episodes of relatively high money levels occurred after the early 1980s disinflation period, starting around 1986 and 1998, and were followed by corresponding upward price adjustments in the late 1980s and in the recent period.

Similarly, in the euro area, as displayed in Figures 6 and 7, relatively higher money levels starting in the late 1970s and late 1980s were followed by corresponding upward price adjustments. In the euro area case, inflation follows so closely money growth, as can be seen on Figure 9, that it is difficult to distinguish relative level movements graphically.

An important fact however is that no downward movement in the price level has been observed in the samples considered. A money level decline is thus not followed by a decline in the price level. After prices have adjusted to a relatively higher money level, prices do not adjust downwards to m_t^* if the latter is below prices. Rather than observing a decline in prices as the money level decreases or as the money growth rate declines, we observe a decrease in the inflation rate. The fact that a distinction has to be made between the cases $m_t^* > p_t$ or $m_t^* < p_t$ regarding whether an increase in money is followed by a proportional increase in prices or no movements at all thus seems to be due to an asymmetric price behavior, which could be caused by various frictions.

Even if this analysis does not allow to distinguish between endogenous versus exogenous monetary movements, the only times when it is the price level that appears to lead the money level, rather than vice versa, are during disinflation periods – which however have been preceded by monetary contractions. This fact, particularly apparent with US data in the early 1980s and with Swiss data in the early 1980s and early 1990s, has already been pointed out for end of hyperinflation episodes by Sargent (1993) and is well illustrated in King (2002), who displays money and price level time series for a few hyperinflation episodes[10]. It is important to notice that real money balances adjust upward only after the inflation rate has decreased. In these episodes, the money level reaches the price level from below. This is most probably money demand which adjusts to the new price level, as it is difficult to think of monetary authority deliberately adjusting money to a given price level.

Short run velocity, output gaps, and monetary policy lags

This sub-section discusses the role of short run velocity and output gaps in the monetary policy transmission process, and relates findings to mainstream ways of modeling inflation and to some critiques and misconceptions regarding the role of money in the monetary policy transmission process.

[10] See King's chart 5. However, on that chart, disinflations are not preceded by monetary contractions. I suspect that this is due to not accounting for equilibrium velocity changes.

First, consider equation

$$m_t = -c + p_t + y_t - \beta i_t + \varepsilon_t, \tag{7}$$

where ε_t corresponds to the residual of a cointegrating relationship between these variables, usually interpreted as a real money demand equation where a unitary income elasticity has been imposed; ε_t is what is usually referred to as "velocity shock", i.e. money movements not associated with contemporaneous interest rate or output fluctuations, and usually ignored in present days models. In terms of the quantity equation, $\beta i_t + \varepsilon_t$ represents the velocity of money; $\beta (i_t^* - i_t) + \varepsilon_t$ represents deviations from equilibrium velocity or short-term velocity movements, and $\beta (i_t^* - i_t)$ can be interpreted as money movements reflecting contemporaneous policy-induced interest rate movements[11]. I will refer to ε_t as the velocity residual.

We can then decompose the difference between the adjusted money level m^* and prices in three different parts,

$$m_t^* - p_t = (y_t - y_t^*) + \beta (i_t^* - i_t) + \varepsilon_t, \tag{8}$$

i.e. an output gap, an interest rate gap, and a velocity residual[12]. Thus, the difference $m_t^* - p_t$ represents the sum of output gaps and deviations from equilibrium velocity.

[11]Note that even when i_t represents the opportunity cost of money instead of the 3-month rate, $(i_t^* - i_t)$ can still be interpreted as policy-induced interest rate movements as own rates paid on deposits are sticky and vary only with persistent changes in market interest rates.

[12]It is standard in the P*-literature to decompose the difference between actual and equilibrium money balances, i.e. excess liquidity, in three gaps, and to interpret these gaps as causal factors for inflation. This interpretation is however problematic given the observed lead-lag relationship running from velocity to output gap movements, i.e. these different gaps do not seem to be independent from each others.

Let us further define

$$p_t^y \equiv p_t + (y_t - y_t^*) \,. \tag{9}$$

Therefore, short-term velocity movements can also be expressed as $m_t^* - p_t^y$.

Figures 10-12 plot the variable p^y (Py) together with $m^*$and p, for the US, the euro area (where the sample has been restricted to 1978-1992 for graphical clarity) and Switzerland, respectively. The information of output gaps for inflation is illustrated by the variable p^y, which can also be interpreted as the price level that would have prevailed in the absence of frictions that caused real quantity adjustments. We observe that output gap fluctuations sometimes provide slightly advanced information on price developments, sometimes move contemporaneously with prices, but sometimes prices start increasing before a positive output gap appears and keeps increasing after the positive output gap has vanished. This indicates that major price developments, even persistent ones, are not always associated with real quantity adjustments. However, short-term velocity movements, i.e. the spread between $m^*$and p^y, display a much more leading, quantitative, and thus more consistent relationship with price developments.

Inflation persistence, in the sense of substantial long-lasting inflation swings, thus reflects money growth persistence, which occurs much before output gap movements. We observe that there is first no effect on inflation, and then price increases reflect closely past money increases. This adjustment pattern does not seem to fit well with an optimal staggered price setting framework. The lag preceding real quantity adjustments could be understood in terms of a liquidity effect or a money demand framework as in Alvarez et al. (2003). However, as discussed below, not only interest rate induced velocity movements but also velocity residuals are responsible for the lag. This means that a framework where velocity is driven by interest rates only is incomplete.

Figures 13-15 display interest rate gaps, i.e. $\beta(i_t^* - i_t)$, velocity residuals, i.e. ε_t, and excess liquidity, i.e. $m_t^* - p_t$. The correlation between velocity residuals and excess liquidity is 0.77 for US data, 0.91 for euro area data, and 0.78 for Swiss data. Correlations between interest rate gaps and excess liquidity are positive but lower, i.e. 0.39 for the US, 0.01 for the euro area, and 0.42 for Switzerland, and correlations between interest gaps and velocity residuals are negative, i.e. -0.14 for the US, -0.30 for the euro area, and -0.21 in the Swiss case.

What is usually labelled as velocity “shock” and omitted from monetary policy models thus represents an important part of monetary movements and, as show above, these movements have useful quantitative information for price movements, with a substantial lead relative to output gap movements. A plausible interpretation of these velocity residuals could be that, contrary to what is usually modeled, the effects of monetary policy cannot be summarized by short-term interest rates only, and these persistent residuals could reflect propagation mechanisms induced by financial frictions.

Nelson (2003) argues that monetary aggregates could act as proxy for various yields not considered in standard macroeconomic models. Figure 16 display the negative of the US velocity residual, i.e. an abnormally low money level not associated with 3-month interest rate or output movements corresponds to the line being above zero and vice versa, together with bonds average (across 2 to 5-year maturity) ex-post excess returns from Cochrane and Piazzesi (2005). The latter variable represents one-year excess returns, i.e. borrowing at the one-year rate, buying a long-term bond, and selling it in one year. The evolution of both series display interesting similarities, and velocity residuals often lead excess returns; this of course does not say anything about causality. Correlation coefficients are 0.25 for contemporaneous movements and 0.4 when velocity residuals are lagged by 3 quarters.

A relationship between these variables could be interpreted in the sense that restrictive/expansive monetary policy, in terms of money supply or money as a quantitative measure of monetary conditions, affects various yields and increases/decreases risk premia, i.e. induces higher/lower longer-term yields that are however followed by relatively lower/higher inflation. Another interpretation could be that money demand reacts to additional yields than short-term yields. Both interpretations would provide an information role for money with respect to the monetary policy transmission mechanism.

The evidence presented above on the behavior of velocity and velocity residuals allows us to address two points raised by critiques of the usefulness of considering monetary aggregates in monetary policy. First, it is generally argued that velocity shocks weaken the information content of money for price developments. This views is related to Poole's (1970) insight that in the presence of relatively large money demand shocks, monetary policy should accommodate these shocks. This accommodation should reduce output and price fluctuations as these shocks are assumed to have no influence on inflation or economic activity in contrast to the interest rate movements the shocks would generate if not accommodated. As a result, the link between money and prices, it is argued, should weaken given large velocity residuals. The misconception underlying this critique is due to the assumption that monetary policy is transmitted via short-term interest rates only. Offsetting the velocity movements, i.e. holding interest rates fixed and letting money fluctuate, would in that world lead to less price (and maybe output) fluctuations. The analysis above has shown that, on the contrary, velocity residuals contain important information for subsequent price and potentially real activity developments, and major price developments are associated with previous monetary movements.

The other criticism is that if money is used to offset other fundamental economic shocks with respect to price developments, the observed relationship between money and prices would vanish. Velocity residuals would this time be interpreted as money offsetting other fundamental shocks. However, if these other fundamental shocks would have been important for price developments in the samples considered, we would have observed either significant price movements not related to monetary movements if central banks had not used monetary aggregates to offset them, or we would have observed significant money movements not followed by inflation, in case central banks had used money to offset these shocks. Accounting for price behavior asymmetry, we have however observed neither fact, thus these other fundamental shocks seems relatively small. The fact that downward money level movements are not followed by downward price movements could be interpreted as money offsetting positive price shocks; this interpretation is however less plausible than downward nominal rigidities, especially given that monetary contractions occurred usually in disinflationary policy periods. There is thus no empirical reason, at least in the economies considered and subject to similar shocks, to think that the information of money for a central bank that perfectly meets its inflation target would vanish.

The monetary regularities presented above also help to understand why many empirical studies have not found a significant relationship between money growth and subsequent inflation, and point to several issues in modeling money. First, there is a long lag between money developments and corresponding subsequent price movements and output fluctuations. It is thus not surprising that researchers who have included only a few quarterly lags of money growth have claimed that money does not help in explaining or forecasting inflation relative to output gaps or other real variables moving more or less contemporaneously with inflation, although the latter variables provide only with a delayed and incomplete signal. The P* approach, which has usually found supporting evidence for money, suffers from a similar problem, as it assumes that excess liquidity triggers an inflation adjustment as a function of contemporaneous excess liquidity as long as this liquidity, or money demand disequilibrium, persists. In fact, given the lags, we observe that the price adjustment often occurs well after the money demand disequilibrium has vanished and even as excess liquidity has changed sign[13], and that peak inflation does not correspond to peak excess liquidity; moreover, the price level adjustment eventually matches the previous money level increase. Focusing on such an error-correction mechanism has another drawback in that ad hoc assumptions on inflation trends have to be made. Inflation adjustment specifications are usually of the accelerationist type, like e.g. in Hallman, Porter and Small (1991), where a higher money level generates an increase in trend inflation rather than an increase in the price level, inducing a price level overshooting and oscillating inflation behavior, or the analysis focuses on inflation deviations around an exogenously specified trend, like e.g. in Gerlach and Svensson (2003) where a downward

[13] This is, for example, one element that lead Christiano (1989) to criticize P*-models, based on their prediction regarding the late 1970s US episode, as inflation increased despite an excess liquidity that was small and even turned negative. Moreover, using M2 does not display as a clear monetary impulse as with M2- preceding the inflation peak around 1980; M2 is less useful than M2- in general as a measure of policy stance, as the amount of some assets included in M2, like e.g. certificates of deposits, usually increases with policy rate increases, and vice versa, given that the own rate is above the 3-month rate.

inflation trend reflecting central banks assumed objective is modeled. An additional complication, which affects models including or not money, comes from the asymmetric price behavior, which might bias standard linear estimates. Finally, monetary movements due to equilibrium velocity changes and upward monetary movements in disinflation periods reflecting real balances adjustments need to be accounted for and not interpreted as a signal of subsequent corresponding price increases.

3.2. MONEY AND POLICY STANCE

A useful measure of monetary policy stance should give qualitative and quantitative information on subsequent inflation trends as well as on fluctuations around these trends. I have argued in section 2 that interest rate stance measures do not provide such information. The analysis above shows that monetary movements precede and validate changes in inflationary environments, on the upside as well as on the downside, as well as transitory inflation fluctuations, and provide quantitative information on subsequent price levels. Monetary developments preceded, validated and provided with the successive impulses of the “great inflation” of the 1970s in the US and in the euro area, with quantitative information on inflation average and fluctuations. Monetary developments can similarly explain the disinflation and the lower inflation average of the 1980s and 1990s, as well as provide qualitative and quantitative information on the late 1980s inflation increases. Money developments thus allow us to think in terms of inflation steady-states, transitions from/to a different steady-state, and temporary fluctuations around steady-states; the notion of steady-state inflation in fact becomes useless.

The danger of persistently deviating or drifting away from low inflation thus arises when monetary policy allows money to accommodate price increases following an initial monetary expansion, with a persistently relatively steep money slope as in the 1970s in the US and euro area for example, rather than restricting liquidity until inflation drops. The fundamental observation is that the high inflation environment of the 1970s in the US and euro area is characterized by relatively steeper money level trends, with money leading inflation. In Switzerland in contrast, monetary policy has not accommodated price increases, i.e. it has reacted restrictively to relatively faster increases in prices, thus average inflation has remained low relative to other countries[14]. If only the level of money is or has been higher, but is not increasing faster, the subsequent relatively faster price level increase is temporary. The rate of price increase in this latter case should depend on time-varying frictions and expectations, and has been higher in high inflation environments.

In the samples considered, we do not observe a significant increase in inflation that has not been preceded by a corresponding increase in money growth, and we do not observe a significant relatively higher money level not followed by corresponding price level increases. Given the substantial information provided by short-term velocity movements, the implied low quantitative effects of other fundamental shocks, and the fact that velocity movements provide leading information for subsequent price developments not always associated with interest rate or real output measures, using monetary aggregates to measure policy stance and to guide policy decisions should reduce inflation volatility and still result in a clear proportional relationship between money growth and inflation.

[14] The Swiss National Bank had money growth targets from 1973 to 1999, although it was targeting the monetary base or M1, but not M2, which is presented here.

4. MONETARY ANALYSIS AND APPARENT CHANGES IN INFLATION DYNAMICS

Several issues have recently emerged regarding inflation dynamics. On one hand, inflation is perceived to have been less persistent and less volatile since the mid-1980s than in the 1970s. On the other hand, it has been argued that inflation has become more difficult to predict, in the sense that estimated coefficients on unemployment or real activity in inflation equations have declined in absolute value and Phillips curves do not seem to provide additional forecasting information relative to univariate inflation equations. In other words, the Phillips curve has flattened and the relationship seems less precise. This section tries to shed light on these issues using the monetary analysis presented above.

The standard Phillips curve can be represented as

$$\pi_t = \alpha + \rho\pi_{t-1} + \sum_i \delta_i \Delta\pi_{t-i} + \sum_j \gamma_j \left(y_{t-j} - y^*_{t-j}\right) + s_t, \tag{10}$$

where π is inflation and $\left(y_{t-j} - y^*_{t-j}\right)$ represent output gaps, forward looking in standard New-Keynesian models but mostly estimated in its backward looking form, and s_t represents what is usually referred to as a supply shock.

A first issue in using equation (10) to describe and forecast inflation dynamics is that monetary aggregates and velocity developments provide leading information relative to output gaps for price developments. This means that forecasts generated with Phillips curves signal inflation increases only with a delay. The estimation problem can however not be solved by adding a few quarterly lags of money growth. Money can lead price developments by several years and there is no reason to expect a fixed lag structure, thus estimates would be unprecise and unstable. Moreover, monetary and output gap movements may not be independent from each other, as the information value of output gaps for price movements appears to be already included in previous monetary movements, thus estimates would be biased.

The observation that the Phillips curve has flattened and inflation has become more difficult to forecast, or in other terms that the coefficients γ's have become smaller and less precisely estimated, could be related to the fact that, as discussed above, we observe both downward price rigidity in general and money levels that have been mostly below price levels in the 1990s, which as a stylized fact has been associated with a decline in inflation regardless of the direction of monetary and output gaps movements. Thus the fewer and less persistent positive monetary impulses, i.e. excess liquidity episodes, of the 1980s and 1990s relative to the 1970s could explain the lower output gap coefficients and the decline in inflation volatility of the post-1980 period, as well as the fact that inflation has been below Phillips curves forecasts since the late 1990s.

The decline in inflation persistence could be related to other facts discussed above, which should also affect the estimated coefficients of equation (10). The fact that monetary developments seem to feed into prices without always being associated with corresponding output gap movements suggests that Phillips curves estimates might be biased and sample-dependant as different monetary experiences could affect the error term s_t differently. For example, the 1970s in the US was characterized by several strong and persistent positive monetary impulses leading to higher inflation. In the 1980s and 1990s in contrast, we have observed only one period of moderate excess liquidity, i.e. in the late 1980s, followed by a small increase in inflation. As some monetary impulses feed into prices without corresponding output gaps movements, using equation (10) the high inflationary environment of the 1970s can be characterized by an estimated higher inflation persistence that the 1980s and 1990s, i.e. the inflation persistence of the 1970s can get attributed to some intrinsic inflation persistence instead of policy persistence reflected by monetary movements. The apparent higher inflation persistence of the 1970s could thus be due to both more positive monetary impulses and a higher inflationary environment, as a less credible monetary policy might induce fewer real quantity adjustments and feed more directly through prices.

The monetary analysis above also implies that, as $\sum_j \gamma_j \left(y_{t-j} - y^*_{t-j}\right)$ should average at zero over business cycles, α equals average money growth over the estimation period divided by $(1-\rho)$, or equals the average change in inflation divided by $\left(1 - \sum_i \delta_i\right)$ if $\rho = 1$, which is the specification generally used to model US inflation dynamics. This raises another estimation issue; as inflation average or inflation average rate of change depends on the sample considered, so does the estimated α. In other words, adding a business cycle with a lower average inflation can change inflation dynamics, i.e. the average rate of change in inflation α, thus affecting γ's coefficients on output gaps as well as inflation (or its rate of change) implied convergence value in forecasting exercises. This would be the case, for example, when adding the US post-1980 period to a post-war sample if the Phillips curve has indeed flattened recently, i.e. if similar output gap fluctuations are associated with a lower inflation average.

5. CONCLUSIONS

Recently, theoretical as well as empirical models have been based on steady-state normalization or detrended data, disregarding the only variable clearly related to major movements of the general price level, i.e. money. This focus on relative price analysis has had a strong influence on recent arguments and debates regarding inflation developments and prospects. One example is the discussion on global factors, like international competitiveness and energy prices, as explanations of inflation developments. The increased global importance of the Chinese economy has often been mentioned as a cause of holding inflation down in the early 2000s, and a few years later as a cause of rising inflationary pressures.

In order to reconcile current models with major inflation fluctuations, research has been focusing on indeterminacy issues. However, significant price movements can always be related to previous corresponding monetary developments, and significant monetary movements are always followed by corresponding price movements.

Using monetary aggregates is not straightforward and requires careful analysis, as aggregate money demand instability can occur, and it is certainly wise to base monetary policy decisions on a broad source of indicators and models and to communicate in terms of an inflation objective. However, given the evidence presented, neglecting money, i.e. relegating it to models backgrounds, and opposing using the evidence to improve models and policy making is certainly not the best way of making the best use of all available information, nor of improving our understanding of inflation dynamics and avoiding major policy mistakes.

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APPENDIX: MONEY DEMAND

Figures 17-19 display velocity and opportunity cost for the US, the euro area and Switzerland, respectively. As presented in Reynard (2006), using dynamic least squares (Stock and Watson, 1993), an income elasticity not significantly different from unity is found with US and euro area data, once changes in US financial market participation in the 1970s and checking accounts substitutes introduced in the early 1980s are accounted for, and when the euro area sample includes the 1970s, and Swiss data can be characterized by a unitary income elasticity as well; this elasticity is thus imposed in the three (groups of) economies[15]. Table 1 shows the corresponding interest rate semi-elasticity, β, estimated by OLS. Similar results are obtained with dynamic least squares regressions. The resulting error term is not used for inference, but as a measure of money movements not associated with contemporaneous interest rate or output fluctuations, referred to as "velocity residuals" in the text. Table 1 also includes the euro area M3 adjusted by portfolio shifts. Sample periods are chosen according to data availability.

	β	Sample
US M2-	3.08	1959Q1-2006Q2
Euro Area M2	1.22	1973Q1-2005Q4
Euro Area adjusted M3	3.66	1980Q1-2005Q4
Swiss M2	3.89	1975Q1-2006Q2

Table 1. Interest Rate Semi-Elasticity Estimates

In the US case, two broken trends in real money demand are estimated and used to adjust the monetary variable m^* in order to account for two distinct aggregate

[15] Reynard (2006) presents money demand results using a log-log instead of a semi-log specification. The analysis is not significantly affected by this specification choice. However, a semi-log specification seems more appropriate, given recent US money demand developments.

instability episodes. One trend covers the period 1965Q1-1977Q1 to account for the change in money demand extensive margins due to the increase in financial market participation, i.e. an increase in the fraction of US households holding non-monetary assets like e.g. stocks and bonds, that occurred during that period, as documented in Reynard (2004). The other trend covers the period 2001Q1-2003Q1, where another apparent aggregate instability occurred, also related to extensive margins. Between the 2001 and 2004 Surveys of Consumer Finances[16], financial market participation decrease from over 40 percent to about 35 percent; this is the first time such a significant decrease in financial market participation happens since these surveys started in 1962, and this could be related to the decline in equity markets prices. While these trend adjustments are relatively ad hoc, they yield plausible outcomes. However, more work is needed to quantify these changes in extensive margins in real time. Practical examples of dealing with velocity shifts in real-time include Orphanides and Porter (2000), who suggest using regression trees to account for real time velocity shifts, and the analysis presented by ECB staff to account for the 2001-2003 episode, adjusting the monetary aggregate M3 with measured portfolio shifts[17]; this latter adjusted monetary aggregate is displayed in Figure 7.

[16] These surveys are available on the Federal Reserve Board internet site.
[17] See ECB, 2004.

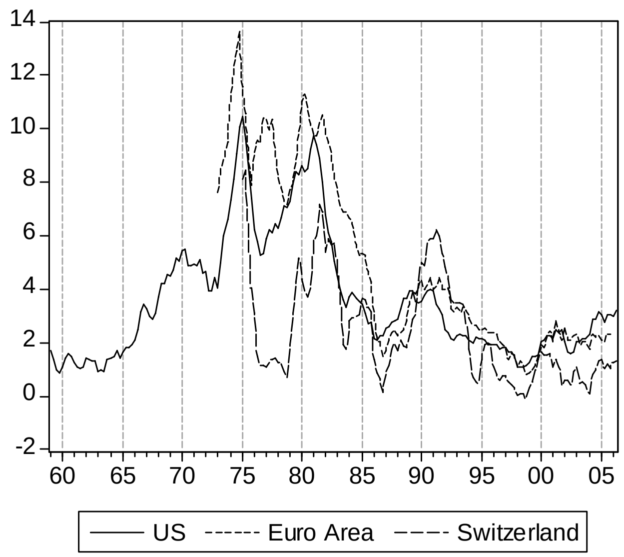

Fig. 1. Inflation (percent)

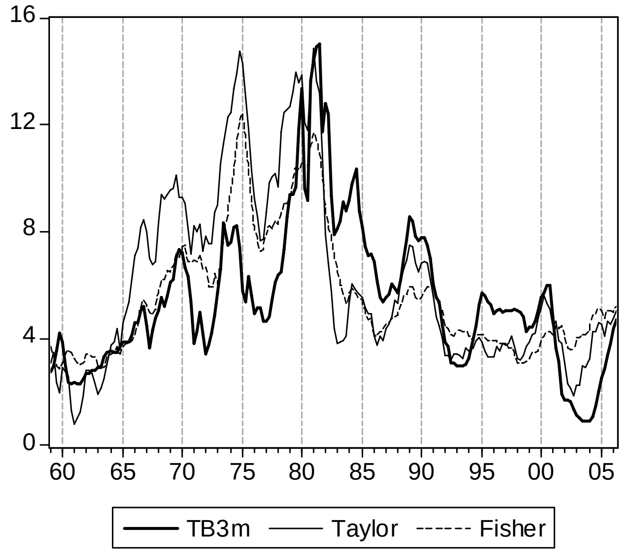

Fig. 2. US Interest Rates (percent)

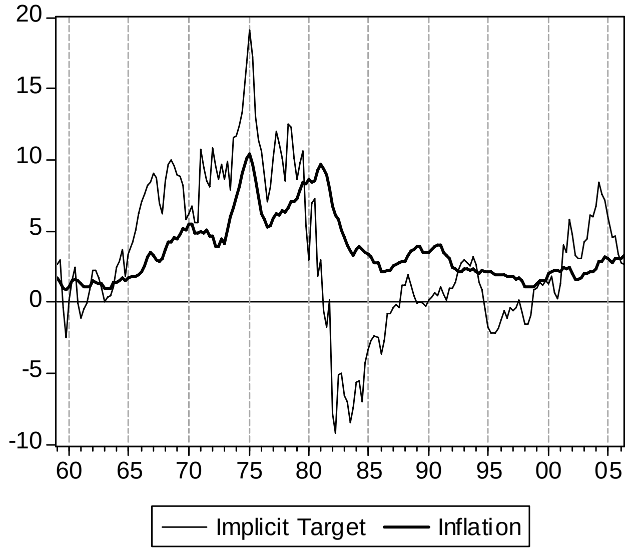

Fig. 3. US Inflation and Taylor Rule Implicit Target (percent)

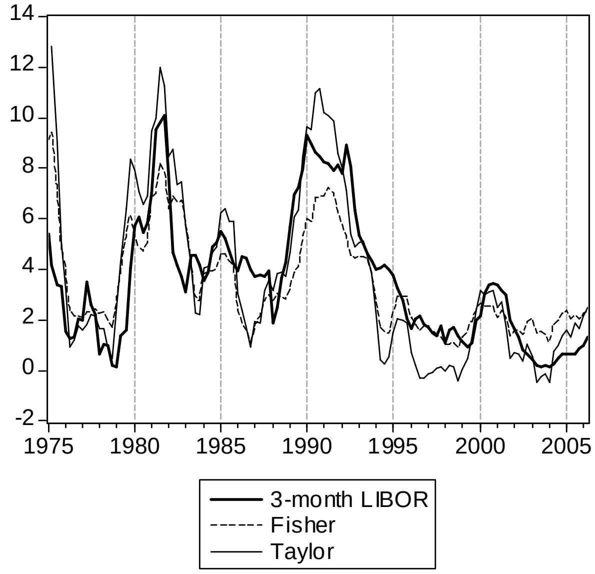

Fig. 4. Swiss Interest Rates (percent)

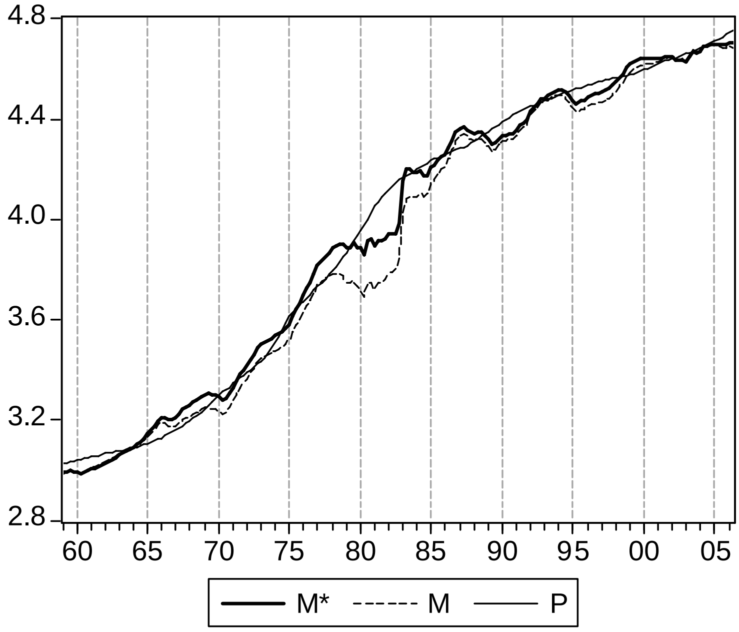

Fig. 5. US Money and Prices (log)

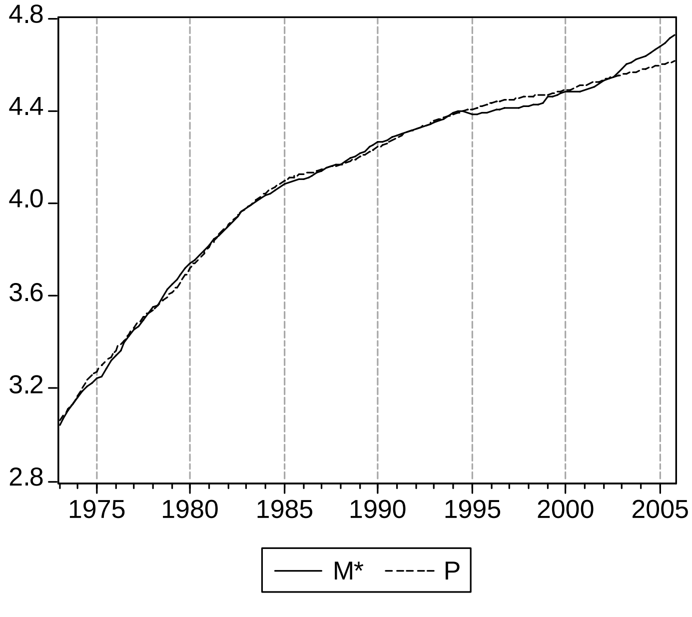

Fig. 6. Euro Area Money (M2) and Prices (log)

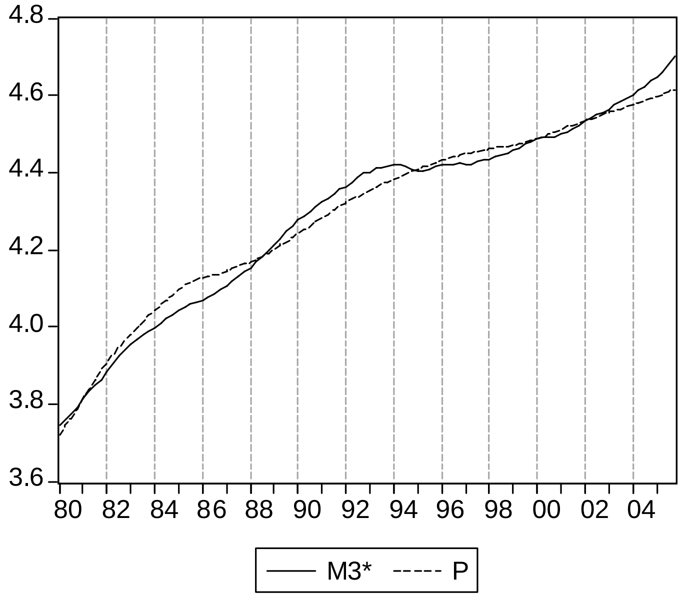

Fig. 7. Euro Area Money (adjusted M3) and Prices (log)

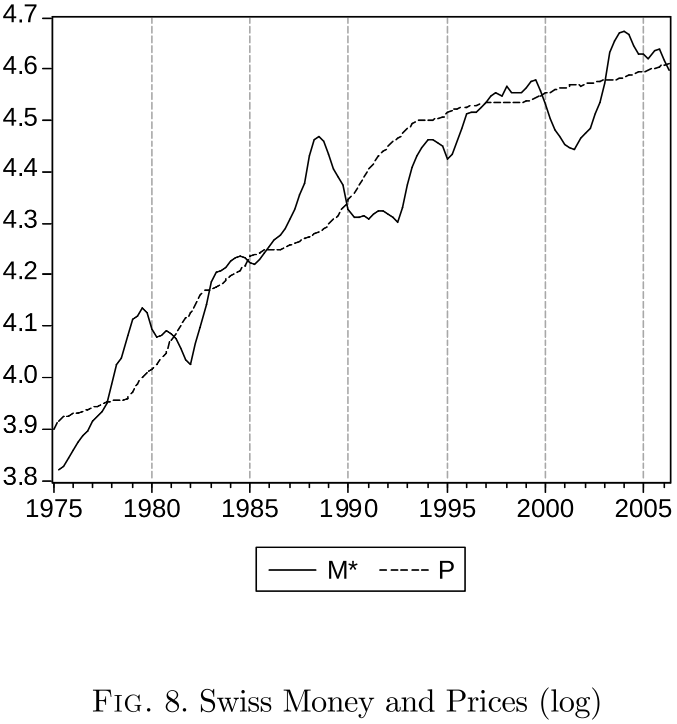

Fig. 8. Swiss Money and Prices (log)

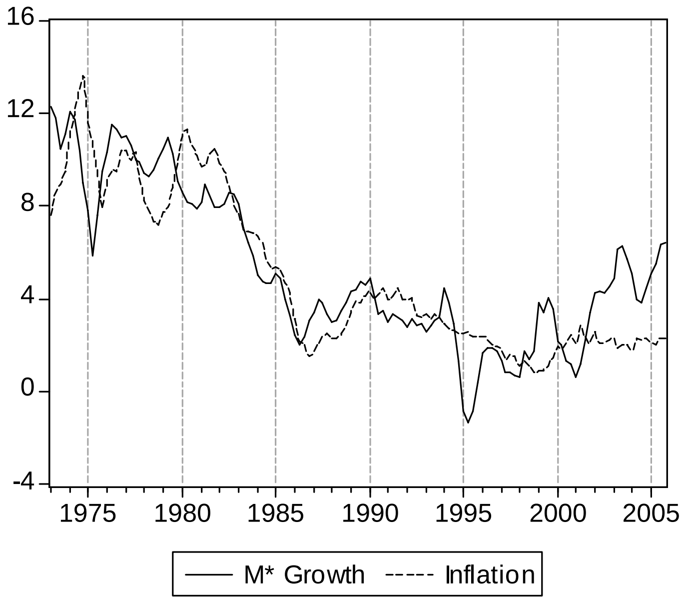

FIG. 9. Euro Area Inflation and Money Growth (percent)

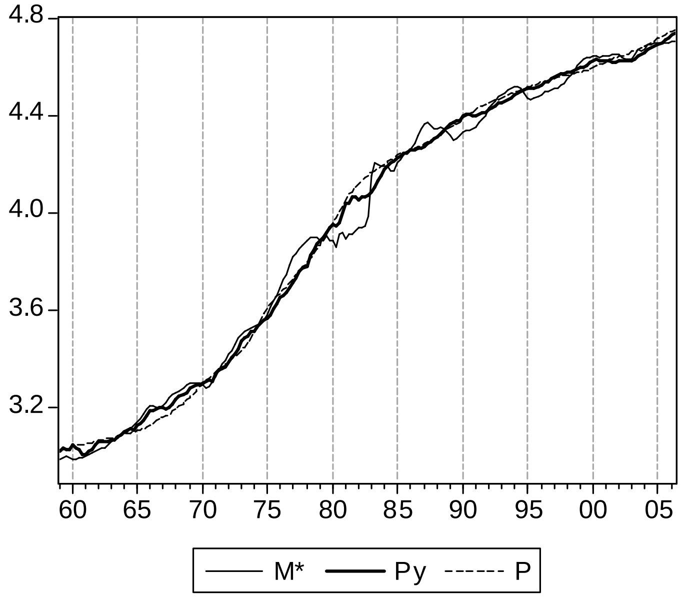

FIG. 10. US Velocity and Output Gap Information

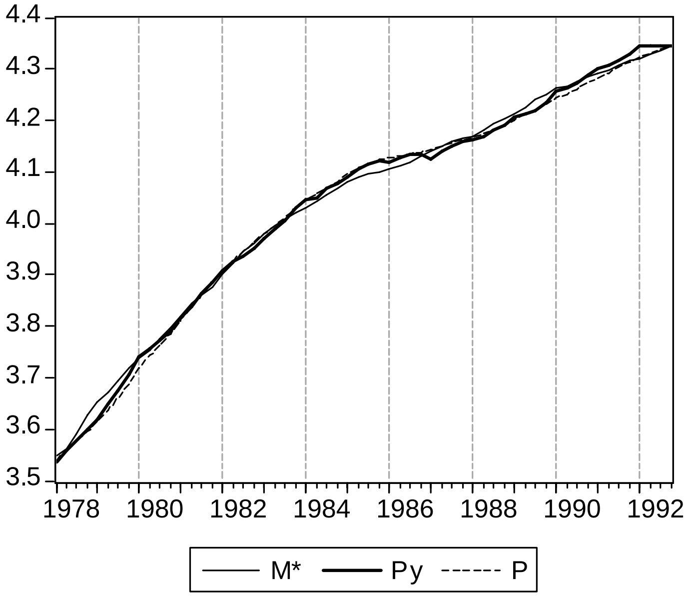

Fig. 11. Euro Area Velocity and Output Gap Information

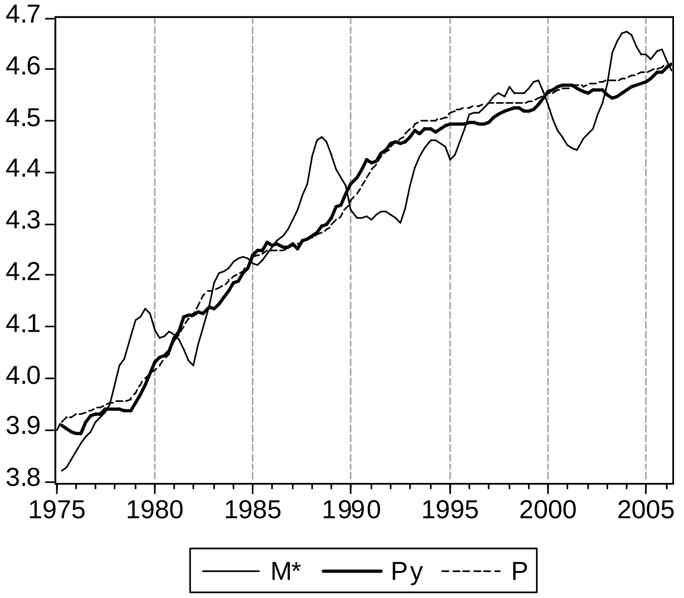

Fig. 12. Swiss Velocity and Output Gap Information

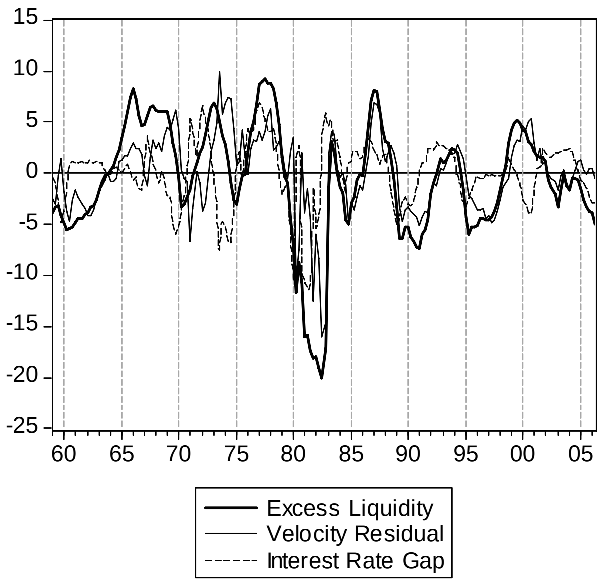

Fig. 13. US Velocity Residual and Interest Rate Gap (percent)

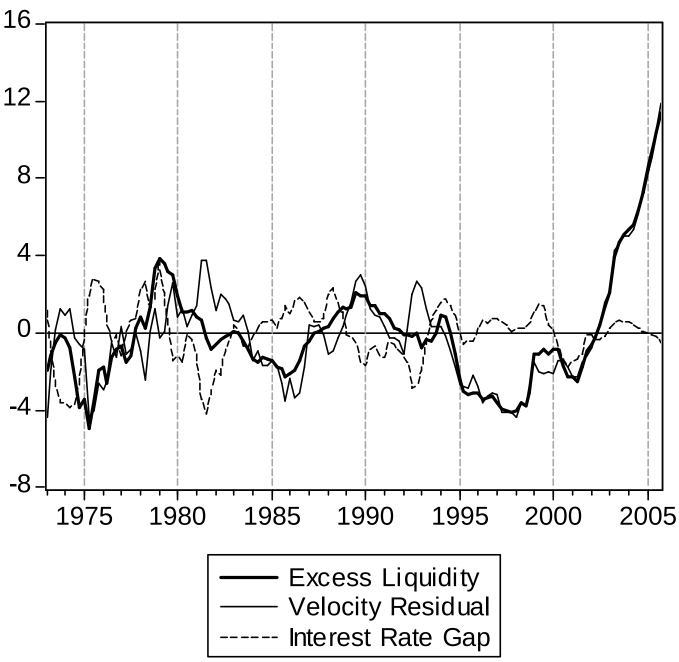

Fig. 14. Euro Area Velocity Residual and Interest Rate Gap (percent)

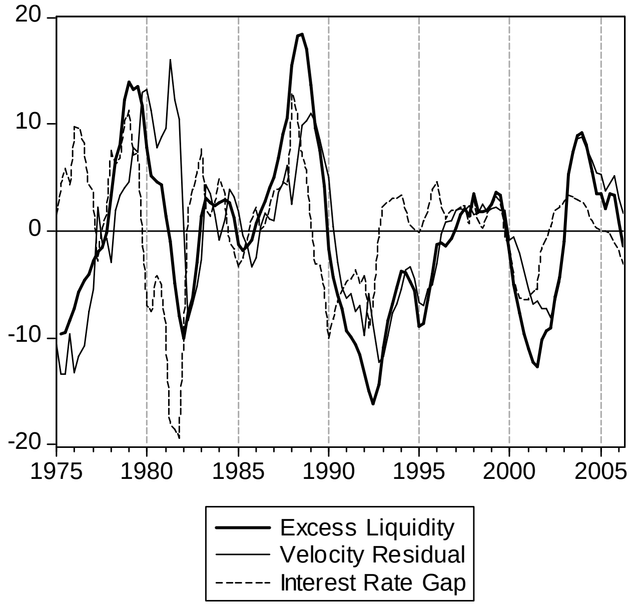

FIG. 15. Swiss Velocity Residual and Interest Rate Gap (percent)

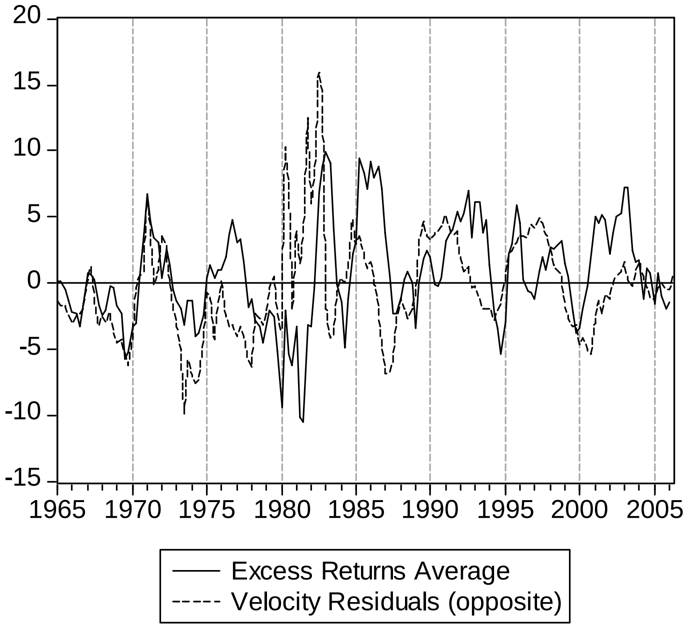

FIG. 16. Bonds Excess Returns and Velocity Residuals (percent)

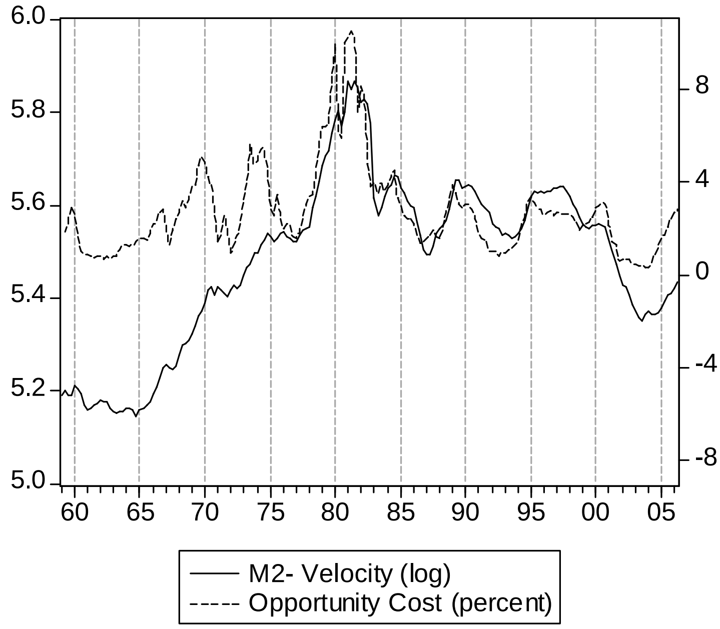

FIG. 17. US Money Demand

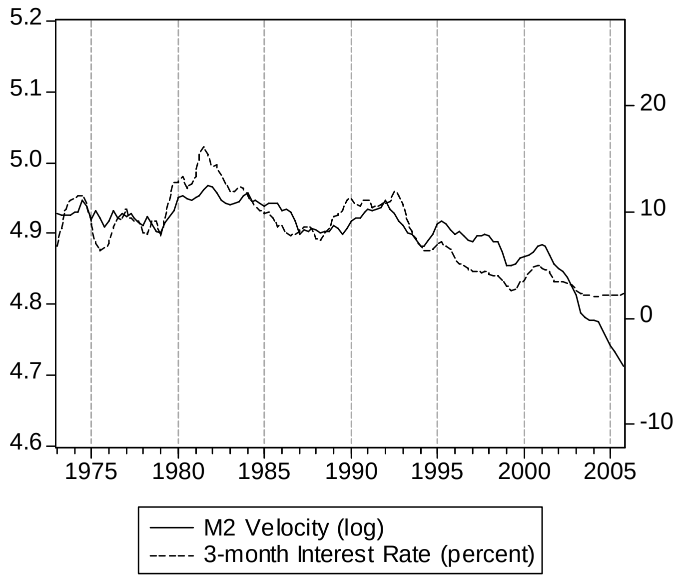

FIG. 18. Euro Area Money Demand

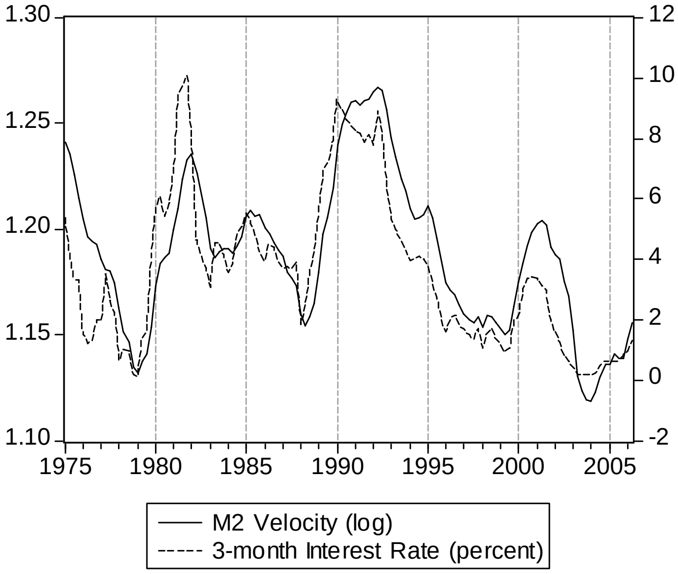

FIG. 19. Swiss Money Demand