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Monetary Policy and Capital-Based Macroeconomics: An Empirical Examination for the United States (1963–2012)

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ABSTRACT: This paper provides an empirical investigation of the role of monetary policy in the determination of interest rates and consumption as developed by capital-based macroeconomics and Austrian business cycle theory, where monetary dislocations caused by central bank action are key to boom and bust business cycles. By way of a vector error correction model (VECM), an econometric method considered a tractable model for Austrian-inspired research in earlier work, we ponder the long-run relationships between monetary aggregates, interest rates and real consumption, and their implied effects over the short run.

Results suggest that the Federal Reserve's intervention in the loanable funds market, which affects short-term rates directly via the federal funds rate and long interest rates indirectly, dislocates long-run relationships around a central tendency that seeks to match both rates. Furthermore, we also analyze the volatility of this long-run cointegrated relationship, and find that the dislocation of policy action by the Fed, although muted

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between the mid-eighties and the late-nineties, resumed since the dot-com boom-bust cycle, with far-from-clear effects in the medium and long run, especially in the wake of the 2008 financial crisis.

KEYWORDS: capital-based macroeconomics, monetary policy and interest rates, Federal Reserve policy, Austrian business cycle theory

JEL CLASSIFICATION: B53, E43, E44, E52, E58

1. INTRODUCTION

This paper is an empirical investigation on the role of monetary policy in the determination of interest rates and consumption within the capital-based macroeconomics tradition. As developed by Austrian business cycle theory (ABCT), monetary considerations play a key role in business cycles. For this literature, booms and busts are driven by changes in interest rates below natural, sustainable levels through increases in the money supply. As interest rates simultaneously set the bar for entrepreneurial calculations of costs and benefits, and personal decisions about saving and consumption, lower interest rates dislocate decision-making towards less productive and harder-to-justify investment projects that can easily turn sour, or conversely, by mopping currency from the system, a tight-money policy could induce a recession by rationing funds for profitable investment opportunities. However, if changes in time preferences drive the change in the rates, no boom or bust cycle would occur, as decisions would be fully absorbed and internalized by agents in the economy.

Despite their intuitive clarity, it is very difficult to study these interlinkages empirically, as numerous frictions are at play in the workings of the market mechanism's natural tendencies towards equilibrium. For this reason, most econometric methodologies run the risk of offering muddled results as they pick up wide varieties of noise which tend to falsify Austrian explanations. Nonetheless, this paper employs a vector error correction model (VECM), already considered an adequate model for Austrian-inspired research questions in past work (Keeler, 2001; Mulligan, 2002, 2006), to help ponder the long-run relationships between monetary policy, interest rates and real consumption and their influence over the short run. As with all econometric analysis, our results need to be taken with a pinch of salt, although they provide persuasive evidence in favor of the Austrian critique of the monetarist theory at the core of modern central bank stabilization policy.

Results indicate that the Federal Reserve's intervention in the loanable funds market affects short-term rates directly via the federal funds rate, and long-term interest rates indirectly. The Fed's actions dislocates long-run policy relationships that seek to match and clear both the long and short interest rates intertemporally. A similar phenomenon is also hinted at with respect to real personal consumption expenditures.

This article is structured as follows: After this short introduction, the second section presents a short review and discussion of the literature around capital-based macroeconomics and Austrian business cycles. The third section presents some stylized facts about the cointegration relationship used for our VECM and a description of the econometric model and the data used for estimation. The fourth section presents our test and model results, with some analysis of the findings. The fifth and final section concludes.

2. CAPITAL-BASED MACROECONOMICS AND THE AUSTRIAN BUSINESS CYCLE: THEORY AND EMPIRICS

Capital-based macroeconomics stresses the role of capital and time in production, and indicates that the time preference of individuals is the most important factor in the determination of the interest rate (Garrison, 2001), in contrast to other macroeconomic approaches that focus on inflation expectations, animal spirits and risk. By highlighting the role of subjective time preferences for a large numbers of agents, capital-based macroeconomics emphasizes the inherent roundaboutness of production processes. As coined by Eugen Bohm-Bawerk (1891), roundaboutness describes the inherent time dimension at the core of the savings and investment identity—as presented by Jean-Baptiste Say (1855) decades earlier.

According to Bohm-Bawerk, if an individual wished to consume a good not offered in nature, he had to first find a way to collect the raw materials from his environment and process them through indirect, lengthy and roundabout methods. If he successfully abstained from consuming the tools to deliver the roundabout good with his invested time and effort, the new product would allow for increased enjoyment or advantages over the raw or less developed substitutes he used to attend to those same needs. However, implicit in this narrative is a theory of capital production born out of the time preferences of the individual's choice to consume immediately or abstain from producing the capital good, a logic which applied to the behavior of a plurality of agents, leads to a theory of business cycles as developed by Mises (1980 [1912], 2007 [1949]) and Hayek (1941, 1969, 2008).

For the above example, as the individual invests part of his time to find and trim a tree branch strong enough to reach the fruits of a tall tree, instead of climbing directly and risking life and limb, he will be rewarded with a safer and easier way to procure these goods. In this case, abstaining from consumption and investing time and effort in the creation of a tool increases his ability to get more fruit. Under these conditions, the individual will arrive at a new, improved state in which his human wants will be better satisfied. Nonetheless, in a modern economy, any roundabout process is incredibly complex as numerous agents, each endowed with subjective preferences, faces informational constraints and uncertain outcomes. For this reason, the interest rate exhibits numerous pressures in its determination, which tend to blur the equilibrium tendencies at the center of the loanable funds market.

When roundabout goods exchange in the market, the time dimension of their production faces the discount of consumers as given by their preferences. Sellers will lower their prices given their desire to use the proceeds of these goods for other merchandise they desire for consumption. However, in a monetary economy, if the good they offer is in excess supply, they will accept goods in exchange for immediate consumption, or discount their ask price sufficiently to sell the good:

> When a superabundant article can find no vent, the scarcity of money has so little to do with the obstruction of its sale, that the sellers would gladly receive its value in goods for their own consumption at the current price of the day: they would not ask for money, or have any occasion for that product, since the only use they could make of it would be to convert it forthwith into articles of their own consumption (Say, 1855).

The converse of this argument is that if the superabundant article is money, both sellers and buyers will discount its value with respect to goods. Implicit in Say's statement is the power of time preferences involved in market exchange in the differentiation of economic activity as defined by the interest rate:

> At the outset of every step forward on the road to a more plentiful existence is saving the provisionment of products that makes it possible to prolong the average period of time elapsing between the beginning of the production process and its turning out of a product ready for use and consumption. The products accumulated for this purpose are either intermediary stages in the technological process, or goods ready for consumption that make it possible for man to substitute, without suffering want during the waiting period, a more time-absorbing process for another absorbing a shorter time. These goods are called capital goods [or produced factors of production]. (Mises, 2007 [1949])

Indeed, Austrian business cycle theory (ABCT) seeks to gauge "how the relative values of goods as sources of income or as means of satisfactions of wants are affected by money" (Hayek, 2008), and how monetary institutions and considerations lead to cycles. Indeed, Hayek took up the problem of how changes in the rate of interest and the quantity of money differentially affected the prices and the proportions between consumer and producer goods, through the use of his now-famous triangles. Through Wicksell (1936) and his concept of a natural rate of interest (whereby the supply and demand of loanable funds clear when the time preferences of agents "match" under normal conditions), Hayek argued that manipulations of realized market interest rates below or above that natural rate would favor one type of good over the other, and in doing so, skew the differential returns on investments in each of these sectors.

However, this *matching* process, rather than an equilibration between different discount rates, is more akin to a marginal *tâtonnement* process. As low time preference savers lend to high time preference borrowers, the last marginal transaction will shrink the time preference spreads. However, other considerations may weigh on the interest term structure, especially as argued by Hicks's term premium theory, (Hicks, 1946) which lends support to the fact that interest rates are generally far higher for longer-term loans, as lenders charge more to depart from liquid assets for a longer period of time.

Barring liquidity preferences, under a neutral monetary regime, changes in the time preferences of consumers would be a factor in the inter-temporal allocation of consumer and producer goods. Under this scenario, for example, a savings-oriented adjustment would increase the supply of loanable funds (which would be fully absorbed as credit put towards investment), lower the rate of interest and derivatively, the desire for investment goods and more consumption to be realized over the long run. In contrast, a policy-driven decision by a monetary authority to lower the market rate of interest below the natural rate (via a monetary expansion not fully absorbed by the needs of the loanable funds market) to stabilize swings in business activity would continue to dislocate entrepreneurial decisions. A lower-than-natural rate of interest would make investment projects attractive as returns on lending accumulated savings decrease. However, unlike the aforementioned neutral monetary regime, lower market rates would also affect consumer decisions regarding the division between saving and consumption, with a bias towards consumption.

In the above case, forced saving would occur. Unlike in a savings-oriented adjustment, the "increase in capital creation [comes] at the cost of consumption, through the granting of additional credit, without voluntary action on the part of the individuals who forgo consumption, and without their deriving any immediate benefit" (Hayek, 2008). As the lower than natural rate of interest comes as a result of a monetary expansion not fully absorbed by credit granted towards long-run investment, consumption becomes more expensive and decreases, despite lower rates of interest. As Hayek noted, as the accumulation of capital is not due to a change in time preferences, "it is probably more proper to regard forced saving as the cause of economic crisis than to expect it to restore a balanced structure of production." (Hayek, 2008). Indeed, forced saving can be considered synonymous with overinvestment (or malinvestment) which comes next to overconsumption due to low interest rates produced by expansionary monetary (or fiscal) policy.

For Hayek, forced capital accumulation had real yet unintended consequences. Whereas other authors argued that forced saving improved capital supply and pulled down the natural rate towards the new market rate (as capital goods would be made readily available), Hayek suggested that these artificially low interest rates would favor investments that would be unable to cover yields and depreciation costs sustainably. As projects cannot be easily undone, and banks cannot keep monetary inflation forever to keep down the rates, these investments would need to be liquidated at a deep discount. In the end, any monetary- (or fiscally-) induced stabilization would only delay the day of reckoning and require a deeper correction rather than adequately correct for the initial swing in production and/or demand. Furthermore, the increase in the interest rate would elbow consumption successfully towards the future, while higher rates would prompt consumer saving, ironically when a large contingent of capital goods undergoes a process of liquidation.

Key to ABCT are the costs of capital adjustment and the dislocations brought upon policy-induced, monetarily-driven (or fiscally-induced) changes in interest rates to mitigate or entirely avoid the costs of liquidation, although similar adjustment processes do occur with respect to the reallocation of other factors of production (like labor and other raw resources). However, ABCT points to installed capital goods as the least adaptable input. Under these circumstances, capital is the binding constraint of entrepreneurial plans of production, given its multispecificity (Lachmann, 1947), the complex relationship of complementarity and substitutability with alternative plans of production. For this reason, according to Mulligan:

> In the Austrian view, the business cycle cannot be caused by changes in interest rates resulting from changes in actors time preferences, but only through policy-induced credit or monetary expansion. The prosperity which precedes a recession is marked by a lowering of the nominal interest rate below an appropriate, sustainable, equilibrium interest rate which would prevail in the absence of monetary expansion. While the interest rate is artificially depressed during the expansion phase, firms invest intensively in physical capital. Since the interest rate is so low, the production process can take more time to produce the same amount of real consumable output, so the production process becomes more drawn out, or more roundabout... (Mulligan, 2006)

For the most part, ABCT has put forth some persuasive explanations about the monetary drivers of boom and bust cycles, mostly ignored by the mainstream. The definitive work in the ABC tradition remains Rothbard’s book about the Great Depression. (Rothbard, 2000) Indeed, Rothbard claims that the severity of the Great Depression was due to government policy which at first tried to extend the boom via accommodative monetary policy during the 1920s, and later sought to impede capital adjustment and liquidation through fiscal policy and direct government action under the New Deal. Empirically, Keeler (2001) pinpointed the tendencies toward convergence between short- and long-term interest rates that would work unfettered in a neutral policy regime (and which is hampered under the current system of monetary interventions), with income providing part of that adjustment through error correction models. However, it was Mulligan (2002, 2006) who sought to explain the finer details of the boom and bust backdrop with details on the interlinkages between interest rates, labor markets and capital goods allocation using US data for the latter half of the 20th century via econometric cointegration methods.

In his first paper, Mulligan (2002) signaled the influence of interest rates in sectoral employment demand depending on the stage of production, where low interest rates positively increased demand in early stages of production (and decreased demand in later stages of production). The second paper, which is more relevant to our present study, sought to analyze a stable long-term relationship between real consumption and the term spread between 3-month and 10-year yields, through a clever construction of a real rate of return of assets borrowed from Keeler (2006). That ECM model centered around one cointegrating relationship between consumption (in terms of real consumable output) and the cumulative real interest yield, or the compound real log return over time of the spread between 3-month and 10-year government bond yields, often used as a measure of the real interest rate (Keeler, 2001). Unlike the spot spread, which is I(0), the cumulative spread is a I(1) process, and in log first differences yields the same information content as the yield spread but with the proviso that it can be used for cointegration analysis. However, unlike Keeler, Mulligan did not include a monetary variable in his analysis between consumption and interest rates.

At the core of Keeler and Mulligan's contributions is the justification of cointegration analysis as an empirically tractable way to test ABCT for capital-based macroeconomic analysis. Indeed, cointegrating vectors could be considered as dynamical equilibrium tendencies of entrepreneurial plans for given observation periods, which do not need to be realized to constitute a natural (although irregular) tendency of the system, as argued separately by Wicksell, Mises and Hayek. As Mulligan explains, the error correction methodology (ECM) is especially amenable to ABCT as it "provide[s] estimates of both a structural or equilibrium process toward which adjustment is generally effected, and the error-correction or disequilibrium adjustment process through which adjustment is made toward the hypothesized equilibrium" (Mulligan, 2006). With this in mind, we propose an extension that seeks to integrate and assess the role of currency policy in the determination of interest rates and consumption. To this we turn next.

3. ECONOMETRIC MODEL AND DATA DESCRIPTION

Our extension seeks to include monetary considerations to extend Mulligan's analysis and assess the inter-linkages between monetary factors, real rates of return over the long run, and short-run real consumption preferences. In this section, we employ a cointegration function to describe long-run relationships for monetary policy to replicate and extend the insights in Mulligan's work, in the spirit of Garrison's neo-Austrian diagrammatic synthesis (Garrison, 2001) for empirical purposes.

With respect to monetary policy, Garrison (2001) explains that the Federal Reserve (Fed) prompts changes in the loanable funds market via three channels: (1) the reserve ratio imposed on commercial banks, (2) the discount rate on short-term lending and (3) open market operations where the Fed lends to the government by acquiring securities issued by the US Treasury. Although there is considerable research on monetary policy rules (for brief reviews see Woodford [2007] and Taylor [2000]), despite the theoretical consensus in the mainstream, monetary policy under the Fed is subject to multiple political and institutional pressures.

For the most part, the Fed manipulates credit money via the discount rate. The Federal Reserve system charges this overnight rate to member banks (or other favored entities) to borrow needed balances to meet legal minimum reserve regulations. However, the federal funds rate (FFR) is a target market rate of interest used by the Federal Open Market Committee (FOMC) for its open market operations, a rate which acts as a benchmark for transactions between participants in the banking system. In many cases, no direct intervention of the Fed is needed to open the vent for changes in credit money, as banks take the FFR as the given rate for negotiations. Nonetheless, at all times the Fed is ready to back this rate via open market operations that directly increase (or decrease) the money supply to lower (or increase) the FFR—indeed this has been the case since 2006, as both the discount rate and the FFR have been informally linked since then. And while many consider the Fed's action reactive to current economic conditions and expectations of financial activity, it remains problematic to fully ground the Fed's actions as following the lead of the economy when in many cases, and especially in the aftermath of the 2008 crisis, the Fed's behavior has been as proactive and unorthodox.

Nonetheless, the fact that the Fed is able to target both the short and longer-term interest rates simultaneously, and directly fuels the complexity of any empirical endeavor. Interventions like QE2, QE3 and "Operation Twist" (which sought to lower longer term yields through the purchase of government longer-dated instruments to extend the maturity of the Fed's portfolio) flattened the yield curve and lowered rates across the board. Furthermore, the Treasury also has a pre-eminent role in determining (and manipulating) long-term interest rates through new debt issues. However, it remains to be seen how successful the Fed's efforts will be in manipulating the long rate directly, as any policy action of this sort must balance concerns regarding the credibility of the action, its sheer effectiveness in fulfilling the task, the relative strength of other considerations in setting the rate (like time preferences and expectations on growth, inflation and risk) and last but certainly not least, the indeterminacy of future outcomes (for a discussion see McGough, Rudebusch and Williams [2005]).

This can be better understood by contrasting the current regime and a neutral monetary system, famously publicized by Milton Friedman (Friedman, 1948, 1983). Under a neutral policy regime, there would not be such a thing as a short or long interest rate as all information on expectations and time-discount preferences would be factored into a single rate attuned to the long-run sustainable rate of real GDP growth, given Hicksian liquidity considerations—this counterfactual scenario constitutes the equilibrium tendency of the system under no constraints. To maintain interest rate stability, the monetary stock would have to grow at a constant rate given by the needs of the domestic economic stability (reliant, for the most part, on automatic government action whose surpluses or deficits would increase or decrease depending on the current state of business activity).

If we ignore liquidity considerations for simplicity, at its barest form, this neutral regime would imply that:

$$(1) \quad r^l = r^s = r^* = E(g^y) = f(g^m)$$

where f is a function. Equation (1) states that under a neutral policy regime, both the "long" r^l and "short" run r^s interest rates would be at the equilibrium rate at r^*. At this rate, r^* will be dependent on the expectations of future income growth $E(g^y)$. However, to keep the loanable funds market in equilibrium, the money supply would have to grow at rate g^m (via function f).

However, the Fed manipulates the short-run interest rate (through injections in the monetary supply) with the hopes of influencing consumer behavior over the long run as the real return of assets increase. If we define the real return as:

$$(2) \quad r^* = r^l_0 - r^s$$

where r^t is log real rate of return, r^s is the *short* rate (which is directly influenced by the Fed's actions), and r^l_0 is the *long* rate (which is mostly exogenous to the Fed policy, given expectations on growth, income, risk and inflation). Unlike the stronger forms of rational expectations which rely on a set of restrictive optimization and instrumental assumptions about the future, we base this simple formulation on a simple rule of thumb, namely that a decrease in the short rate increases the real rate of return on assets: as short run rates decrease, projects that would otherwise be deemed too costly to undertake become feasible.

Under monetarism, over the long run, nominal variables (like the money supply) do not affect real variables (like real personal consumption expenditures). Conversely, ABCT argues that nominal variables can indeed have permanent effects on output, especially if they are changed regularly. Indeed, we claim that it is impossible to isolate the effects of central bank intervention on either long- or short-run interest rates under continuous and persistent central bank intervention. In setting rates, the actions of the Fed disrupt the formation of long-term expectations and sets in motion a chain of investment decisions which affects the economy's production possibilities and consequently, its overall multispecificity.

In the light of the above considerations, we offer a simple representation of the Fed's monetary policy function that directly targets the short-run interest rate via liquidity injections to clear the loanable funds market, but also factors in the need to keep long-run rates aligned to allow for growth. For the most part, the Fed sets the FFR to govern short-term bank lending, with the assurance that the new discount rate would normally be set 50 basis points higher (after 2006). As issuer of currency and holder of easily tradable government securities in a deep market, the Fed has great powers of discretion to set the FFR at a given rate. The Fed will try to keep an uneasy relationship between the amount of money it requires to inject (or absorb) to lower (or raise) the FFR, but at the cost of disrupting long run expectations. Moreover, although the central bank tracks real consumption expenditures as a gauge of economic activity, in the long run real consumption expenditures do not factor in the Fed's decision (a restriction we include in our cointegrating relationship). In this case, the Fed's actions act as a wedge between long and short interest rates over the long run, as Keeler suggested in his paper. [8] Therefore:

$$(3) \quad r^* = r_0^l - r^s = \alpha_1 + \beta_1 m_t + \beta_2 c_t + \epsilon_1$$

where r^* is the log real rate of return over the long run, α_1 is a constant (which represents policy drift and other non-monetary considerations in setting the rate), m_t is the log money stock level, c_t is real personal consumption expenditures) and ε_1 is an error term. With the restrictions $\beta_1 > 0$ and $\beta_2 = 0$ (as time breaks the links between real and nominal variables), Equation (3) states that the Fed will issue enough monetary stock through its short-run FFR operations to affect the interest rate (where the Fed will issue increased currency to lower the short-run rate) but with an eye to facilitate the needs of a *prospective* long-run rate as in the neutral regime—with all the difficulties that accompany pursuing both policies simultaneously. Solving for the error correction term, we have:

$$(4) \quad \epsilon_1 = r^* - \beta_1 m_t - \alpha_1 = r_0^l - r^s - \beta_1 m_t - \alpha_1$$

where in (4), the countervailing forces of the short-run rate, the money stock and policy aims try to match the long-run rate. If the error correction term produces a positive effect on the variables, we can consider the Fed's action as destabilizing over short-run variables in their efforts to keep these long-run interlinkages. In that sense, the Fed would be subject to errors and omissions in aiming for that long-run rate and stabilizing the economy over the short run, via monetary interventions that sought to lower interest rates and prospectively, spur growth. On the contrary, a negative effect would register a stabilizing influence of the Fed's actions on short-run behavior and the system as a whole.

Toward this purpose, we estimate a linear vector error correction model (VECM) for m_t, c_t, and r_t of the following form:

$$(5) \quad \Delta m_t = \gamma_{10} + \gamma_{11}\epsilon_{1,t-1} + \sum_{i=1}^{n} \gamma_{12}(n)\Delta m_{t-n} + \sum_{i=1}^{n} \gamma_{13}(n)\Delta c_{t-n} + \sum_{i=1}^{n} \gamma_{14}(n)\Delta r_{t-n} + v_1$$

$$(6) \quad \Delta c_t = \gamma_{20} + \gamma_{21}\epsilon_{1,t-1} + \sum_{i=1}^{n} \gamma_{22}(n)\Delta m_{t-n} + \sum_{i=1}^{n} \gamma_{23}(n)\Delta c_{t-n} + \sum_{i=1}^{n} \gamma_{24}(n)\Delta r_{t-n} + v_1$$

$$(7) \quad \Delta r_t = \gamma_{30} + \gamma_{31}\epsilon_{1,t-1} + \sum_{i=1}^{n} \gamma_{32}(n)\Delta m_{t-n} + \sum_{i=1}^{n} \gamma_{33}(n)\Delta c_{t-n} + \sum_{i=1}^{n} \gamma_{34}(n)\Delta r_{t-n} + v_3$$

where γ_{10}, γ_{20}, γ_{30} are constants, γ_{11}, γ_{21}, γ_{31} are the loading (adjustment) coefficients, n are the lagged variables and the v's are the error terms of the regressions.

All data were collected from the Federal Reserve Economic Data (FRED) database at the Federal Reserve Bank of St. Louis[1] —descriptive statistics are presented in Table 1 below. For m_t we

[1] http://research.stlouisfed.org/.

used log quarterly data for M1 between 1963:1 and 2012:3.[2] For c_t, we used real personal consumer expenditures for the same period.

Table 1. Descriptive statistics

Variable	Mean	Median	Minimum	Maximum
log M1 stock	6.3649	6.6110	4.9857	7.7214
log Real PCE	8.4598	8.4876	7.5504	9.1677
log Real RR	1.2649	1.1801	0.0115	3.0223
Variable	**Std. Dev.**	**C.V.**	**Skewness**	**Ex. Kurtosis**
log M1 stock	0.8017	0.1260	-0.2655	-1.3208
log Real PCE	0.4757	0.0562	-0.1210	-1.1550
log Real RR	0.9270	0.7328	0.2492	-1.3172

PCE stands for Personal Consumer Expenditures and RR for Rate of Return. M1 currency stock is comprised of funds readily accessible for spending—it consists of currency outside the U.S. Treasury, Federal Reserve banks, and the vaults of depository institutions, traveler's checks of non-bank issuers, demand deposits and other checkable deposits, primarily negotiable order of withdrawal accounts at depository institutions and credit unions. Source: Federal Reserve Bank of St. Louis Database; no. of observations: 187.

Finally, we used the spread between the 10-year Treasury bond and the 3-month Treasury bill rate for our real rate of return on assets. After we calculated the spread, we added and compounded the yield to produce the total real log return on assets over the period. Although integrated, this construction maintains the information of the series with respect to quarterly returns, as log-differencing will recover the I(0) series. Another way to represent the above is to assume the investment of a dollar in an account which yields and accumulates the spread as a return on assets, hence at time t after n quarters the total return will be:

[2] Fed programs like Operation Twist in 2011, QE2 in 2010 and QE3 in 2012 have all tried to lower longer- and shorter-term interest rates *simultaneously* through direct action on government bonds. In contrast, for QE1 in 2009, the radius of operation was ring-fenced to mortgage-backed assets in private markets. For this reason we will use these observation markers to test the statistical robustness of the model, ascertain cleaner results, and provide comparisons between theoretical *forecasts* and current scenarios.

$$(8) \quad R_t = \sum_{i=1963:1}^{n} R_{t-n}(1+s_t)$$

where R_t is the return at time t, $\sum_{i=1963:1}^{n} R_{t-n}$ is the accumulated returns and s_t the current spread.

4. RESULTS AND ANALYSIS

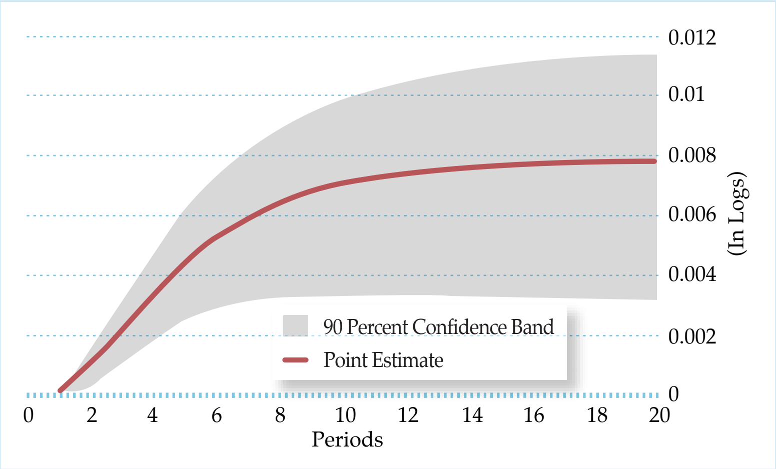
Our results are divided into three parts: the first provides a summary of the results, with other graphical analyses and in-sample forecasts to compare the path-dependent dynamics of the model and current economic contexts. The second section presents the unit root Augmented Dickey-Fuller (ADF) tests and Johansen tests for cointegrating relationships, while the third and fourth sections present raw results related to the VECM model estimation, with robustness checks subsampled from the data series for different periods respectively.

4.1 Analyses of the Results and Forecasts

Tables 4 through 9 present the VECM models and test for robustness. As presented below, there is some change in the significance levels for the subsampled models, as short-run relationships are mutable depending on the subsample. However, the parameter estimates and the standard errors of the long-run relationship (for the cointegrating vectors, the adjustment parameters and the variables in general) remain significant for the cointegrating equation and fairly constant across the board.

Results mimic Mulligan's results with respect to the reaction of real personal consumer expenditures to innovations in the real rate of return. A decrease in the short-run rate causes a non-linear reaction in real consumption, which increases at first and then levels off, as in the impulse reaction function in Figure 1 below—a result that validates the inclusion of a drift term in our estimation. The symmetrical result is seen in the response of real rates of return, as a percentage point increase in real personal consumption expenditures prompts the Fed to decrease the short run real rate of return (via raises in the overnight rate) by 0.12 percentage point.

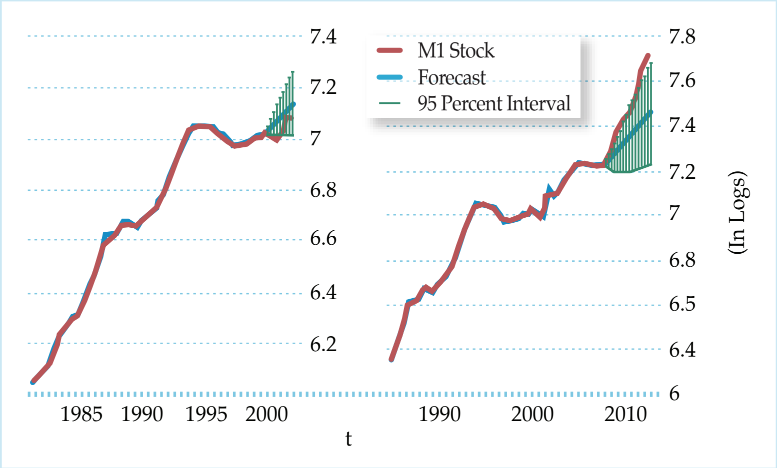
Figure 1. Impulse response function (red line) of real personal consumption expenditures with respect to an increase in the real rate of return (gray shading demonstrates a 90% confidence band)



More importantly, we see that the Fed's intervention in long rates via the short-term market (through its manipulation of the real rate of return) is destabilizing, although the effect is small (perhaps as it is bounded by the institutional constraints of its decision-making process and by today's economic realities and political implications). A positive percentage point deviation in the long-run error correction term (through an increase in the monetary stock to pull down the short-run interest rate) increases the supply of currency in the economy over the short run by 0.016 percentage point. In other words: a short-run action dislocates long-run expectations, which in turn, signal the policy decision to increase the money stock even more; this represents a tendency of the Fed to overshoot (or undershoot) prescribed policy targets.

We can see this tendency in Figure 2 below. The left panel forecast shows the real and the expected "equilibrium" level of monetary stock according to the linear specification presented in (4) for the 2001 recession—although the Fed undershot the expected required level of monetary stock, it quickly reverted close to the forecast line. However, the right panel shows the Fed's actions in light of the 2008 downturn, in which the Fed overshot the expected equilibrium rate well above the equilibrium tendency and unlike the 2001 case, its actions seem farther away from that warranted level.

Figure 2. Actual (red line) and expected (blue line, forecast) levels of M1 for the US economy for 1963:1 -2002:1 (left) and 1963:1 -2012:3 (right) with 95% confidence interval (in green bars)



Reasons abound for the contrast in policy reactions during these two episodes. Aside from the obvious pressures "to do something" (to paraphrase Keynes' famous dictum on why government action is done first, and only later pondered on its merits), deeper factors seem to be in operation. For one, unlike the 2001 recession, the fate of the 2008 "Great Recession" seems to be intimately tied to a deeper malaise at the core of the US economy. The Fed's intervention in 2001 was smaller in scale and deviated little from the expected forecast path. Although destabilizing, the relative magnitude was bounded by the strength of the effect, which is small. Today, however, in trying to manipulate the short-term rate aggressively to spur growth, the Fed may be overstating prospects for long-term expansion. Already in a liquidity trap, the Fed was forced to undertake other types of monetary policies (like direct injections of liquidity in asset markets via the quantitative easing programs) at the cost of disrupting the relationships at the two ends of the equation. Under increasingly uncertain outcomes, these measures may heighten the risk of future inflationary pressures, especially if economic growth continues to sputter.

A similar phenomenon also seems to be operational with respect to real personal consumption expenditures: a positive percentage point deviation in the long-run monetary policy function will cause a small, yet significant, destabilizing increase of 0.0014 percentage points in short-run real personal consumption expenditures. Nonetheless, as the Fed overshoots or undershoots long-run targets, this dislocation will cause short-term effects to fizzle over time.

The reason for these dislocations can be found in Figure 3 below, which plots the dynamic stability of the error correction term, as measured by its rolling two-year standard deviation. Another way to understand this measure is to consider it as the volatility between short and long interest rates brought upon by the Fed's intent to manipulate short-interest rates—the figure also plots the federal funds rate.

Figure 3. Stability of the error correction term, as measured by a rolling two-year standard deviation estimate (blue bars, left axis) against the effective Federal Funds Rate for 1964:3–2012:3 (orange line, right axis)

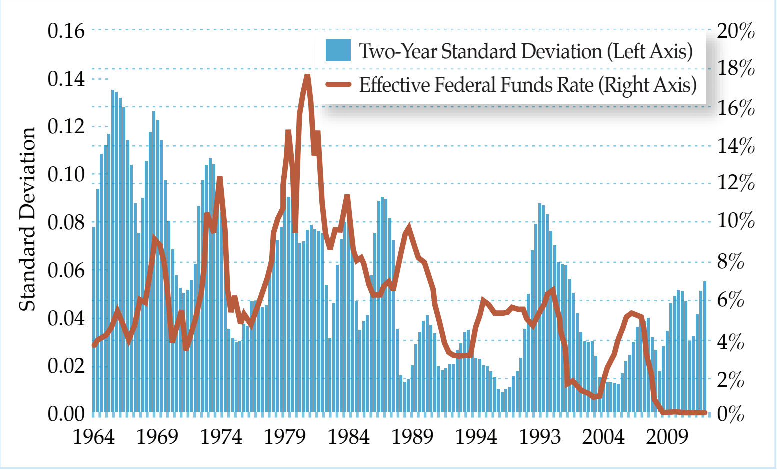


Figure 3 tracks well known episodes in macroeconomic history: We see a lot of policy volatility until the mid eighties, until the onset of the first leg of the so-called "Great Moderation"—the period that roughly spanned the mid-eighties to 2007 when economic indicators like aggregate output and unemployment in the US experienced relative calm. However, contrary to the accepted lore (as famously put by Robert Lucas in his 2003 American Economic Association Presidential Address when he asserted that the macroeconomic problem had been "solved"), the late nineties did experience policy volatility, and today, that trend seems to be on the rise (as seen in the far right corners of the graph).

For this reason, instead of focusing on the engineering aspects of economic management that led to this great moderation, another question that should be asked is whether this moderation was due to other factors—namely, a more natural alignment between long-run and short-run interest rates. A case in point appears during the so-called "Greenspan put" that took place during the so-called moderation and sought to put a floor on equity prices during the dot.com bubble by decreasing short-term rates with the hope of averting and mitigating a market correction. Indeed, the correction did occur, and in during the early phase of the put, we see that the error correction term grew unstable. Unlike the nineties where policy instability was subdued, this new bout of instability has persisted—although not to the extent exhibited during the sixties, seventies and early eighties. For this reason, it can be suggested that this moderation perhaps was not due to greater knowledge of monetarist management tools in the hands of increasingly wiser central bankers, but to endogenous factors in the formation of and alignment between short and long interest rates that accompany interest rate stability.

4.2 ADF and Johansen Tests

Table 2 presents test t-statistics (with p-values in brackets). The null hypothesis posits the existence of a unit root. As presented, we fail to reject the existence of unit roots in each of the variables.

Table 2. Augmented Dickey-Fuller test results (with constant)

ADF Test	log M1 stock	log Real PCE	log Real RR
t-statistic	-1.4227 [0.5728]	-1.4379 [0.5652]	1.7436 [0.9997]

The rank column in Table 3 shows the number of cointegrating relationships supported by the data, with t-statistic results for the trace and λ-max tests (with p-values in brackets). We can reject at the 5% (via the trace test) that the rank of the matrix is zero (and that there are no cointegrating relationships) against the alternative hypothesis that there exists at most two cointegrating relationships. Using the λ-max test (which has a sharper alternative hypothesis), we can reject at the 10% level the existence of zero cointegrating relationships, but both tests fail to reject the existence of more than and two cointegrating relationships for the three variables.

Table 3. Johansen test results (for unrestricted constant)

Rank	Eigenvalue	Trace test	λ-max test
0	0.1028	30.072 [0.0464]	20.292 [0.0644]
1	0.0437	9.7807 [0.3035]	8.3595 [0.3512]
2	0.0076	1.4212 [0.2332]	1.4212 [0.2332]

4.3 VECM Results

Table 4. VECM results for the full sample

Dependent Variable: Δ log M1

	γ	s.e.
const	0.0371	0.0149 **
Δ log M1 (-1)	0.1391	0.0700 **
Δ log M1 (-2)	0.2825	0.0696 ***
Δ log Real PCE (-1)	-0.2711	0.1586 *
Δ log Real PCE (-2)	-0.0811	0.1555
Δ log Real RR (-1)	0.3095	0.1798 *
Δ log Real RR (-2)	-0.0218	0.1891
ε	0.0018	0.0009 **
Adjusted R^2	0.2075	
Durbin Watson statistic	2.0341	

Dependent Variable: Δ log Real PCE

	γ	s.e.
const	0.0266	0.0067 ***
Δ log M1 (-1)	-0.0202	0.0313
Δ log M1 (-2)	-0.0562	0.0312 *
Δ log Real PCE (-1)	0.1905	0.0710 ***
Δ log Real PCE (-2)	0.1917	0.0696 ***
Δ log Real RR (-1)	0.1801	0.0805 **
Δ log Real RR (-2)	0.0092	0.0847
ε1	0.0014	0.0004 ***
Adjusted R^2	0.2312	
Durbin Watson statistic	2.0789	

Dependent Variable: Δ log Real RR

	γ	s.e.
const	-0.0043	0.0060
Δ log M1 (-1)	-0.0103	0.0279
Δ log M1 (-2)	0.0422	0.0278
Δ log Real PCE (-1)	-0.1195	0.0632 *
Δ log Real PCE (-2)	0.0015	0.0620
Δ log Real RR (-1)	1.0679	0.0717 ***
Δ log Real RR (-2)	-0.2271	0.0754 ***
ε	-0.0004	0.0003

Adjusted R^2	0.8080	
Durbin Watson statistic	1.9727	

γ are coefficient estimates, with standard errors (s.e.) (***) results significant at the 1% level, (**) at the 5% and (*) at the 10%; ε is the error correction term. The estimations were done on a lag order of 3, as the AIC and the HQ criterion were minimized for that specification.

Table 5. Cointegration and adjustment vectors for the full sample

	Cointegration vector	Adjustment vector
log M1 stock	-2.8353 [0.39258]	0.0018 [0.00087299]
log Real PCE	0.0000 [0.00000]	0.0014 [0.00039093]
log Real RR	1.0000 [0.00000]	-0.0004 [0.00034811]

Standard errors in parentheses.

Econometric results are in line with the theoretical error correction model presented in Equation (4).

4.4 Robustness Checks

Table 6. Cointegration and adjustment vectors for the sample for 1982:2–2012:2

	Cointegration vector	Adjustment vector
log M1 stock	-2.6024 [0.2989]	0.0090 [0.0044]
log Real PCE	0.0000 [0.0000]	0.0027 [0.0013]
log Real RR	1.0000 [0.0000]	0.0021 [0.00121]

Standard errors in parentheses.

Table 7. Cointegration and adjustment vectors for the sample for 1980:1–2009:1

	Cointegration vector	Adjustment vector
log M1 stock	-2.2063 [0.22690]	0.0160 [0.0054]
log Real PCE	0.0000 [0.00000]	0.0019 [0.0021]
log Real RR	1.0000 [0.00000]	-0.0012 [0.0021]

Standard errors in parentheses.

Table 8. VECM results for the 1982:2–2012:2 sub-sample

Dependent Variable: Δ log Real M1

	γ	s.e.
const	0.1512	0.0721 **
Δ log M1 (-1)	0.1402	0.0905
Δ log M1 (-2)	0.2683	0.0912 ***
Δ log Real PCE (-1)	-0.5433	0.2995 *
Δ log Real PCE (-2)	-0.0915	0.2882
Δ log Real RR (-1)	0.3787	0.3204
Δ log Real RR (-2)	-0.0339	0.3144
ε	0.0090	0.0044 **

Adjusted R^2	0.2369
Durbin Watson statistic	2.0276

Dependent Variable: Δ log Real PCE

	γ	s.e.
const	0.0458	0.0216 **
Δ log M1 (-1)	0.0151	0.0271
Δ log M1 (-2)	-0.0359	0.0273
Δ log Real PCE (-1)	0.2625	0.0897 ***
Δ log Real PCE (-2)	0.2665	0.0863 ***
Δ log Real RR (-1)	-0.0439	0.0960
Δ log Real RR (-2)	0.0977	0.0942
ε	0.0027	0.0013 **

Adjusted R^2	0.2695
Durbin Watson statistic	2.1468

Dependent Variable: Δ log Real RR

	γ	s.e.
const	0.0384	0.0198 *
Δ log M1 (-1)	0.0288	0.0248
Δ log M1 (-2)	0.0346	0.0250
Δ log Real PCE (-1)	-0.0922	0.0822
Δ log Real PCE (-2)	-0.1266	0.0791
Δ log Real RR (-1)	1.0610	0.0879 ***
Δ log Real RR (-2)	-0.2348	0.0863 ***
ε	0.0021	0.0012 *

Adjusted R^2	0.8333
Durbin Watson statistic	2.1541

γ are coefficient estimates, with standard errors (s.e.) (***) results significant at the 1% level, (**) at the 5% and (*) at the 10%; is the error correction term. The estimations were done on a lag order of 3, as the AIC and the HQ criterion were minimized for that specification.

Table 9. VECM results for the 1980:1-2009:1 sub-sample

Dependent Variable: Δ log M1

	γ	s.e.
const	0.2182	0.0712 ***
Δ log M1 (-1)	0.1160	0.1017
Δ log M1 (-2)	0.2334	0.1133 **
Δ log Real PCE (-1)	-0.4236	0.2426 *
Δ log Real PCE (-2)	-0.0025	0.2513
Δ log Real RR (-1)	0.3585	0.2366
Δ log Real RR (-2)	0.0083	0.2442
ε	0.0160	0.0054 ***

Adjusted R^2	0.239387
Durbin Watson statistic	1.883626

Dependent Variable: Δ log Real PCE

	γ	s.e.
const	0.0271	0.0280
Δ log M1 (-1)	-0.0098	0.0400
Δ log M1 (-2)	-0.0521	0.0445
Δ log Real PCE (-1)	0.2787	0.0954 ***
Δ log Real PCE (-2)	0.2179	0.0988 **
Δ log Real RR (-1)	0.1652	0.0930 *
Δ log Real RR (-2)	-0.0079	0.0960
ε	0.0019	0.0021

Adjusted R^2 0.185729
Durbin Watson statistic 2.081856

Dependent Variable: Δ log Real RR

	γ	s.e.
const	-0.0124	0.0285
Δ log M1 (-1)	0.0159	0.0407
Δ log M1 (-2)	0.0825	0.0453 *
Δ log Real PCE (-1)	-0.1538	0.0971
Δ log Real PCE (-2)	0.1092	0.1006
Δ log Real RR (-1)	0.9690	0.0947 ***
Δ log Real RR (-2)	-0.1975	0.0978 **
ε	-0.0012	0.0021

Adjusted R^2 0.756324
Durbin Watson statistic 2.039785

γ are coefficient estimates, with standard errors (s.e.) (***) results significant at the 1% level, (**) at the 5% and (*) at the 10%; is the error correction term. The estimations were done on a lag order of 3, as the AIC and the HQ criterion were minimized for that specification.

5. CONCLUSION

This paper sought to extend earlier empirical work on capital-based macroeconomics, and especially Austrian business cycle theory (ABCT), to integrate and assess the role of currency policy in the determination of interest rates and consumption. We employed and estimated a cointegration function and error correction model, in line with Austrian-inspired empirical work penned by Keeler (2001) and Mulligan (2006), to describe long-run relationships for monetary policy, interest rates and real consumption.

Our extension includes monetary considerations in the loanable funds market and assesses the interlinkages between monetary factors, real consumption preferences, and long-run and short-run interest rates to determine the real return on assets. After presenting a standard battery of econometric and robustness results, results suggest that the Federal Reserve's intervention in the loanable funds market, which pulls down short-term rates directly via the federal funds rate (and indirectly pushes down long interest rates), dislocates long-run policy relationships between long and short rates. This prompts a small, yet positive feedback in the money stock level: a positive percentage point deviation in the long-run error correction term (through an increase in the monetary stock to decrease the short-run interest rate) increases the supply of currency in the economy in the short run by 0.016 percentage points. A similar phenomenon also seems to be operational with respect to real personal consumption expenditures: a positive percentage point deviation in the long-run monetary policy function will cause a small, yet significant, destabilizing increase of 0.0014 percentage points on short-run real personal consumption expenditures.

Although more empirical work is warranted, results hint that the short-run actions of the Fed affect and disrupt long-run expectations, which in turn, signal policy decisions that tend to overshoot (or undershoot) prescribed targets. Although there is considerable literature on the credibility of central bank action (King, 1995), the above results reflect poorly on whether credibility can serve as a binding constraint on central banks, as their boards and members may be swayed by adverse incentives (whether political or bureaucratic), stubborn fallacies and even a fatal conceit in their decision-making. And while long-run commitment is a powerful tool, it may be a self-defeating proposition if that commitment relies mainly on short-run instruments to be effective.

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