VELOCITY AS AN INDICATOR FOR ECONOMIC POLICY

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ABSTRACT

The velocity of income (*V1)* is considered for the United States over the past century, and more thoroughly examined within the current context of the financial crisis. With all inference based on 1 percent significance testing, a Granger Causality relationship from velocity growth to real income growth formalizes velocity's importance. Its long- and short-run behavior is estimated reserving a role for previous empirical literature and current extraordinary stimulating packages. Fiscal policy in terms of public debt accumulation appears to be substantially negatively influencing velocity behavior. A negative Granger Causality linkage from public debt growth to velocity growth makes a case for a gradual run-down in public debt.

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I INTRODUCTION

For a large part of the twentieth century there was debate in the field of macroeconomics concerning the effectiveness of stimulating policy, between on the one side Keynes with his followers, and on the other monetarists conducted by Friedman. As from the 1980s on, most western governments took a Keynesian stance of little inflation and pursuing stimulating policy whenever needed. As a result of the formidable track record of stable economic growth ever since, it seems the dispute has been settled convincingly in favor of the Keynesians. However it’s equally possible to reason the other way around by stating there hasn’t been much challenge during a recent considerable period of time – with substantial economic growth resulting from inventions mainly in information technology, there might haven’t been much space for economic crises. Which version of inference is right, may well become clear after dealing with the aftermath of the economic downturn that currently is still hitting our western economies. In combating the economic severity, western countries respect their common view of intervening immediately and massively in order to bring their economies back on track. Recently the Federal Reserve decided to inject another $600bn high-powered money into the world’s largest economy, while the United States’ public debt is noting the highest level since WWII. Both fiscal and monetary policy are reaching upper limits: the fiscal policy part is currently played out, as even more of it would only raise further doubts on the credibility of the United States being able to repay their debts; and with respect to the monetary policy part, the Fed is pushing its limit for a long time now, since interest rates had already reached lower bound levels of zero. Despite historic stimulating packages, economic prosperity remains forthcoming. For economists of course it’s now interesting to investigate why this happens, as it doesn’t seem to be caused solely by lagged responses of stimulating policy. The effectiveness of government’s single remaining credible instrument – monetary policy – is being obstructed because of a stagnating money multiplier on the one side, and a weakening velocity on the other. Uncertainty and lack of confidence in the economy leading agents rather to sit on their money than spending it. A likewise situation in the United States during the Great Depression was later characterized by Friedman (1971) as:

> ‘’The holders of money are in metastable equilibrium, like a tumbler on its side on a flat surface; they will be satisfied with whatever the amount of money happens to be’’ – Milton Friedman, 1971

The velocity of income – as determined using the quantity equation – can be regarded as an approximation of economic activity, and its low current value appears to be partly causing the disappointing results of the stimulating packages so far. The concept has got a long history in economic thinking, with William Petty (1664) being the first to touch upon it in his ‘’Verbum Sapienti.’’ During this extended period of scrutiny, quite varying views on velocity passed by: once it was just interpreted as being a constant variable within the quantity of money framework, whereas vis-à-vis it also served as the basis for Fed’s monetary policy for a certain period until the 1980s. The reason why the Fed abandoned velocity based monetary targeting at that time, was the apparent break in its generally assumed upward trending path. This unexpected and unexplained break in the velocity of income on the one hand significantly reduced its usefulness for economic policymaking, whereas on the other hand it has attracted many researchers to the subject, trying to explain the breakdown. In this empirical literature, velocity is most conventionally defined using the quantity equation with *M1* as the relevant money stock. Since *M1* is generally being held for transactional purposes it seems like the most appropriate money stock to define velocity upon in this study as well, as velocity is about to be interpreted as a measure of economic activity. This study aims at contributing the body of research in order to get better insight in the behavior of velocity, hopefully leading to a better understanding of its current low values. For that matter, the starting point will be a basic money demand function, conventionally rewritten into a velocity function. With broad attention to the field’s empirical literature, this velocity function will subsequently be extended by implementing in it, main empirical findings of past decades. Together with policy related variables as put forward by this study, the specification will be used to estimate long- and short-run velocity behavior with a sample covering economic data of nearly a century. The estimation results finally serve as a foundation for velocity-based recommendations regarding the policymaker’s choice between monetary or fiscal policy.

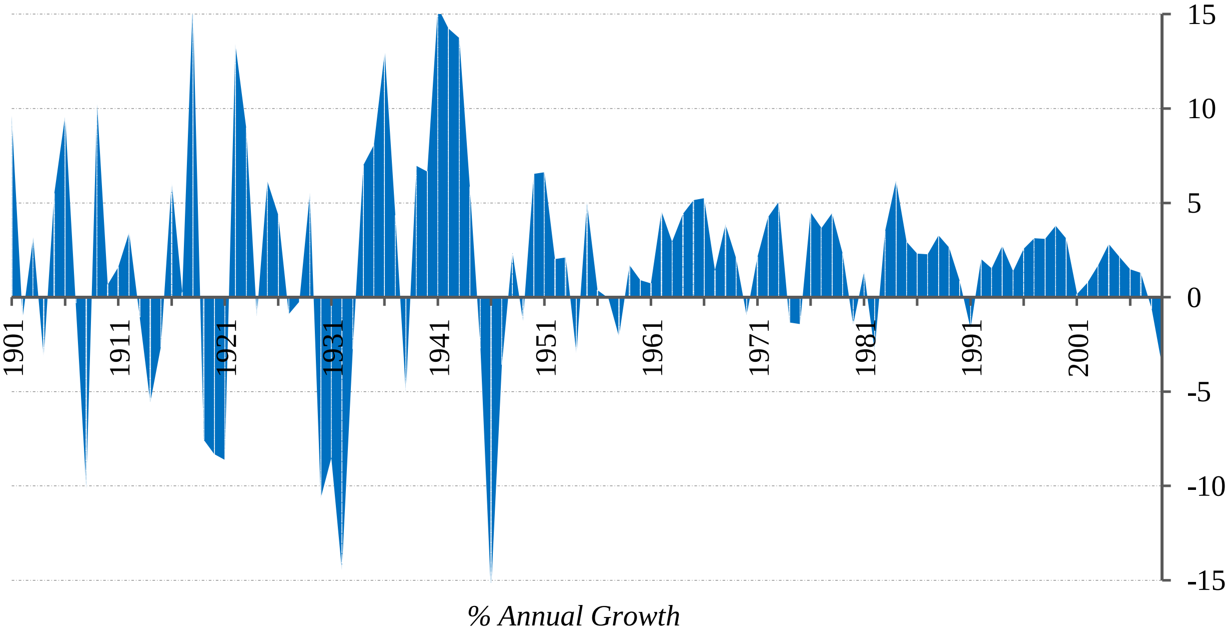
With the economic crisis hitting severely into all western world economies, a lot of interesting cases for studying velocity are provided. Nonetheless opposed to the differentiated stabilization packages within the European Union, the relevant policy in the United States is characterized by a more uniform approach due to the presence of one Federal Government next to the Fed. Together with a long-standing US dollar contrary to only a short-lived euro, it seems that there have been fewer major interfering factors affecting United States’ data. On behalf of these circumstances, the United States will be the focus of work.

The study will take off quite basically in section II, with general remarks about stimulating policy and US Government stimulating behavior during the current economic downturn. The velocity concept will be introduced in section III, where its importance within the previously sketched context will be explained. Section IV extensively discusses the main results of previous empirical literature, whereas section V presents the methodology accompanied by the final velocity estimation. All data related questions are properly documented in the appendix, to ease potential further research on the topic. The final section concludes with policy implications and furthermore provides opportunities and recommendations for further research.

II . I US GROWTH PERFORMANCE 1901-2009

A noble ambition for macroeconomic policymaking would be optimizing economic growth. Slight differences in growth performance over considerable time periods, show off vigorous influences on standards of living, since sustained growth operates like compound interest. Figure 2.1 shows the growth performance of the United States during the past century – with economic growth most conventionally defined as per capita real output growth.

Figure 2.1: Per Capita Real GNP Growth 1901-2009



Source: own computations based on NBER US historical data & US Department of Commerce: Bureau of Economic Analysis (real GNP); and US Census Bureau (population statistics)

Frankly, the impact of economic growth can be best illustrated through periods with negative growth. As can be told from the graph, the most pronounced period of negative growth last century was the Great Depression, with growth rates of about minus ten percentage points during a couple of years. These days of extreme poverty are sure to be remembered and illustrate the impact of growth differences on our society. Only after the WWII-related productivity boom, the US economy could be considered definitely back on track. The post WWII period appears a lot more tranquil in growth terms, with sustained periods of moderate positive growth, and recessions paling into insignificance when compared to the Great

Depression. Once again the impact of growth rates is illustrated here, as post-war recessions were everything but easygoing, with as most appealing example the actual economic severity. Graphically the current economic downturn could already pass for the most intense one since WWII – thus letting aside the question whether we are already on top of things. The final interpretation of the current crisis will entirely depend on the amount of traction the unprecedented stimulating packages are about to receive.

II . II GENERALS ABOUT ECONOMIC POLICYMAKING

Concerning stimulative economic policy, there has to be distinguished between expansionary fiscal policy on the one hand, and expansionary monetary policy on the other. In case of expansionary fiscal policy government is essentially raising public debt by either lowering taxes, or increasing expenses. Monetary policy is called expansionary, when the monetary authorities are basically expanding the capital market.

With respect to the effectiveness of pursuing either kind of policy, quite differing views dominated the field of economics during the past century. First there was Keynes proposing an active role for the government in achieving economic prosperity, through eliminating output gaps. In times of inadequate spending government need to be expansionary, and when the economy is about to get overheated a contractionary policy serves best. In the view of Keynes, fiscal policy was one of the most effective tools for short-run stabilization with governments directly able to address inadequate spending by simply raising government's purchases. The income-expenditure multiplier in turn guaranteed efficiency, as spending changes would be exceeded by output changes. As a result of Keynes' focus on the short-run, monetary policy could be pursued equally well in fighting recessions. With sticky prices, a change in the quantity of money affects interest rates which in turn would generate changes in investment spending. Eventually, these changes in investment spending are to be magnified into aggregate spending through the Keynesian multiplier.

Contrary to Keynes, Friedman supported a government being reserved with economic policy. Underscored by experience with the Great Depression, he regarded government intervention as rather being a reason for instability or aggravating unstable economic conditions. Based upon a more rigid distinction between real and nominal values, his theory went particularly into long-run economic behavior. Friedman was skeptical to pursuing fiscal policy, as there wasn't much evidence for its effectiveness; although he believed Keynes' analysis to be possible, he did not consider the way of reasoning as unquestionable. Especially Friedman's theories regarding monetary policy made noise in economic thinking, as he advocated a fixed money growth rule to be optimal monetary policy. Using monetary policy as a short-term fine tuning instrument ought to be everything but recommended, since the unpredictability in the short-run relationship between money and nominal income implies long and variable lags of policy effects. In addition – contrary to Keynes – Friedman believed the dichotomy between nominal and real variables to hold to a larger extent in the short-run. As a consequence, much of the short-run variation in the quantity of money will be transformed into price changes rather than real income changes. With a complete dichotomy in the long-run, long-term monetary policy effects are to be strictly inflationary. Friedman's view upon the effectiveness of monetary policy made him conclude public's interest is best served instead with a fixed money growth rule. By consequence, both absence of inflation and government intervention would favorably lead to economies being less disrupted.

II . III US GOVERNMENT POLICY TARGETS AND TOOLS

> ''Macroeconomic policymaking is a difficult and inexact science. Policymakers do not know the precise state of the economy, the future path of the economy if no policy changes are implemented, or the precise level of potential output. They also have imperfect control over policy instruments and imprecise knowledge of the effects of any policy changes. Consequently, macroeconomic policymaking is an art as well as a science'' – Ben Bernanke, 2007

Economic policy in the United States is nowadays obviously pursued from a Keynesian perspective, with government intervening whenever needed in order to retain stable economic growth. Formally the United States Congress constitutes the authority uniquely entrusted with fiscal policy powers. Borrowing or lending, raising or cutting federal taxes are namely determined to be acts that require continuous democratic accountability. Among political pressures, the extent of fiscal policy proclaimed by Congress is determined with close attention to macroeconomic indicators like the output gap, the unemployment level, the annual government deficit, and – not unimportant – the level of public debt.

The monetary policy powers have – once also democratically – been entrusted with the Federal Reserve. With the Fed being unilaterally in charge of the money stock within the US economy, it can be held primarily responsible for sustained inflation. Keeping inflation within bounds is crucial for a properly functioning economy, as both too high and too low inflation disturb agents considerably in their natural profit-maximizing behavior. In this regard the Fed doesn’t publicly announce an explicit numerical inflation target, but instead just got the reputation of favoring low inflation. This reputation is extremely important to the Fed’s capability of controlling inflation, since actual inflation is largely dependent upon public’s inflationary expectations.

In striving for mid-term price stability, Fed’s principal tool is the open-market operation as directed by the Federal Open Market Committee (FOMC). This essentially concerns the buying or selling of Treasury securities from the public in exchange for money balances. Formally the open-market operation can be executed through both the money supply or the interest rate – with de facto the one implying the other as simply two sides of the same coin. Most conventionally Fed sets its policy in terms of the federal funds rate, that represents the rate that commercial banks charge each other for overnight loans. The federal funds rate is closely watched in financial markets, it being an anchor for all sorts of interest rates across the term structure. As a guide to Fed’s short-term interest rate policy, the Taylor-rule can build intuition by relating the federal funds rate to core inflation and the output gap.

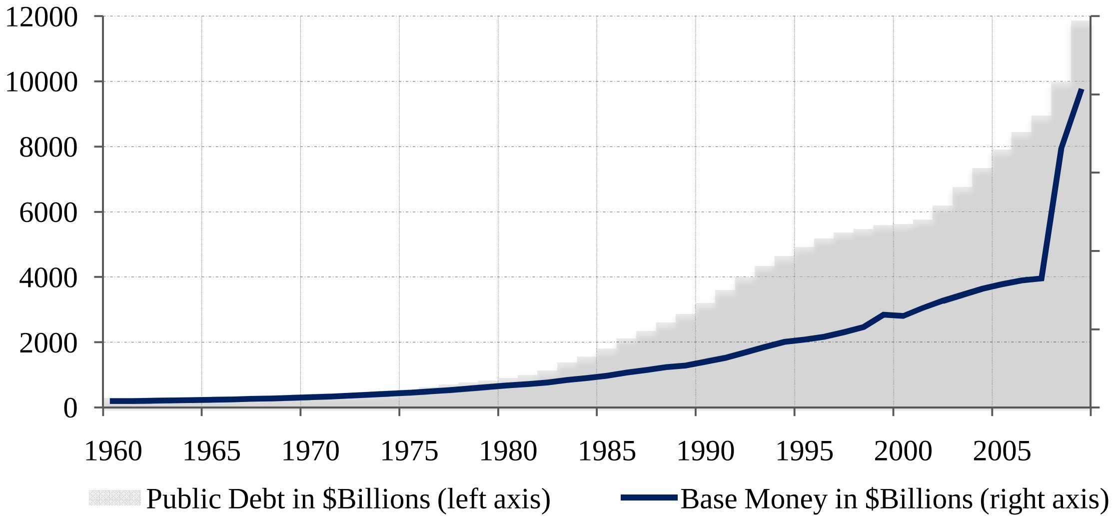
Over the past decades the Federal Reserve has generally been praised for its monetary policy. With stable inflation and relatively mild infrequent recessions, this extended period has already been characterized strikingly as ‘’the Great Moderation’’. Goodfriend (2007) among others, relates this decreased volatility to improved communication, as the Fed gradually shifted from secrecy into transparency. As a result markets would have become better able to predict monetary policy, and thus are confronted with less uncertainty. Conversely, Stock and Watson (2003) attribute Fed’s impressive track record predominantly to good luck in the form of unusually quiescent macroeconomic shocks. According to their econometric modeling, improved monetary policy can only be credited for a small fraction of the decline in volatility.

II . IV US STIMULATING POLICY DURING THE CURRENT FINANCIAL CRISIS

''Why was I invited to this party? Because you're the one with the deep pockets'' – derived from James Hamilton, 2009

With respect to both fiscal and monetary policy, government has been acting quite remarkable during the current crisis. Not only the absolute size of stimulating measures are unprecedented, but also the way they are executed. Next to Congress, the Federal Reserve namely performed some fiscal policy actions too. Goodfriend (2009) illustrates in this respect, that contrary to pure monetary actions when there is an exchange of high-powered money for Fed's Treasury securities, the Fed pursued pure credit policy by issuing private sector loans with funds raised by the sale of its Treasury securities. Commonly Treasury securities on the Fed's balance sheet are called ''retired'', since the Fed directly returns the Treasury most of the received interest. However when the Fed instead sells these securities while holding the economy's stock of money constant, the Fed is essentially raising public debt. Besides this, a combination of monetary and credit policy is executed when the Fed issued large amounts of high-powered money in exchange for risky private financial assets. Although these Fed credit policy initiatives are definitely caused by the turmoil in credit markets and the particular urgency for quick action, central bank's independence in the monetary system has been eroded partly as well. According this independence the Fed should not be involved in fiscal policy matters where to allocate public funds, simply to keep politicians at safe distance from money-printing powers. Government's extensive fiscal policy measures created an awful lot of public debt last years. Figure 2.2 shows the evolution of public debt over the past fifty years, together with the amount of high-powered money outstanding in the economy – both expressed in billions of US dollars.

Figure 2.2: Policy Evaluation 1960-2009



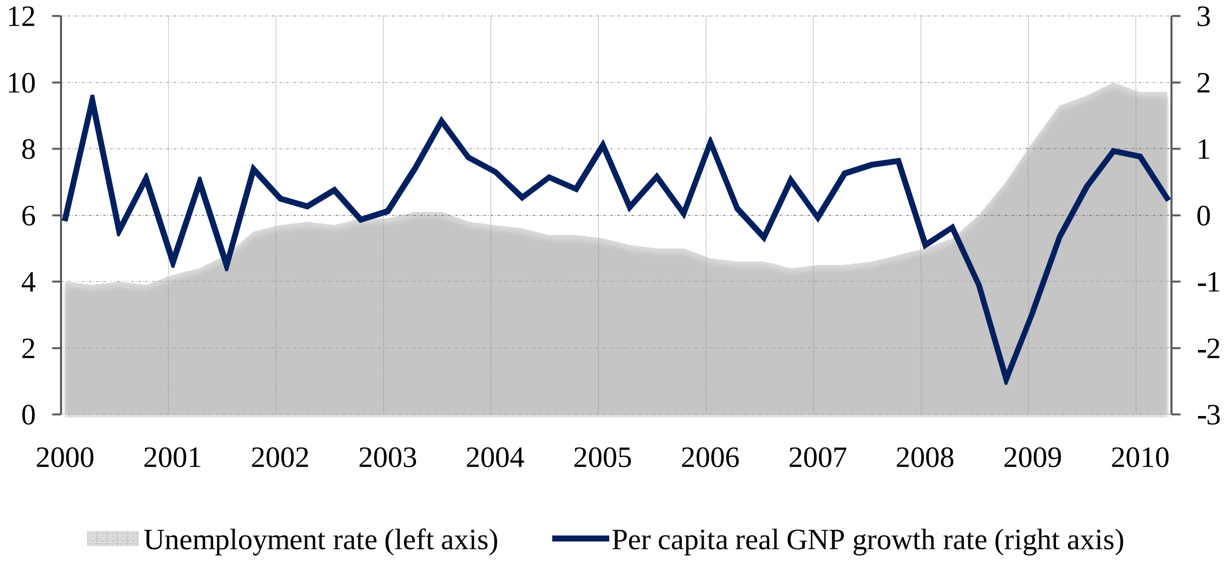
Source: The White House: Council of Economic Advisers (public debt) and IMF international financial statistics (base money)

Figure 2.2 clearly shows the immense magnitude of government's stimulating packages – with public debt increasing at a rapid pace and base money reaching all-time heights. Although the federal funds rate is hitting the lower bound of zero for quite an extended period now, the Fed has still been capable to pour money into the economy as a result of its ''interest-on-reserves regime''. By paying interest on excess reserves the Fed got better able to control the federal funds rate, that normally would have been exposed to unmanageable downward pressure due to the ongoing quantitative easing. Furthermore because of this new regime financial institutions are no longer confronted with the so called ''tax-on-reserves'' – so it has become less burdensome for these institutions to hold that amount of reserves by which they can safely make loans to the public again. Most importantly, this unconventional regime opened the possibility for the Fed to pursue its monetary policy independently of interest rate policy. On that account the Fed can continue its quantitative easing practices in order to spur US recovery, aiming at a higher inflation level that is particularly favorable since high debt loads are being reduced.

> ''Simply stated, the bright new financial system – for all its talented participants, for all its rich rewards – has failed the test of the market place. To meet the challenge, the Federal Reserve judged it necessary to take actions that extend to the very edge of its lawful and implied powers, transcending certain long embedded central banking principles and practices'' – Paul Volcker, 2008

As Volcker put it aptly, the extreme circumstances at the beginning of this crisis with a lot of events threatening the stability of the global financial system have pushed the Fed into creative policymaking, away from its long embedded central banking practices. Obviously the Fed has taken away market's biggest fears and for the most part succeeded in returning consumer confidence in the financial system. But in spite of this achievement, the results of government's stimulating policy on the US economy are only to be called moderate so far. As Figure 2.3 shows, unemployment is still balancing at a 10% level while economic growth effects already appear to be over the hill.

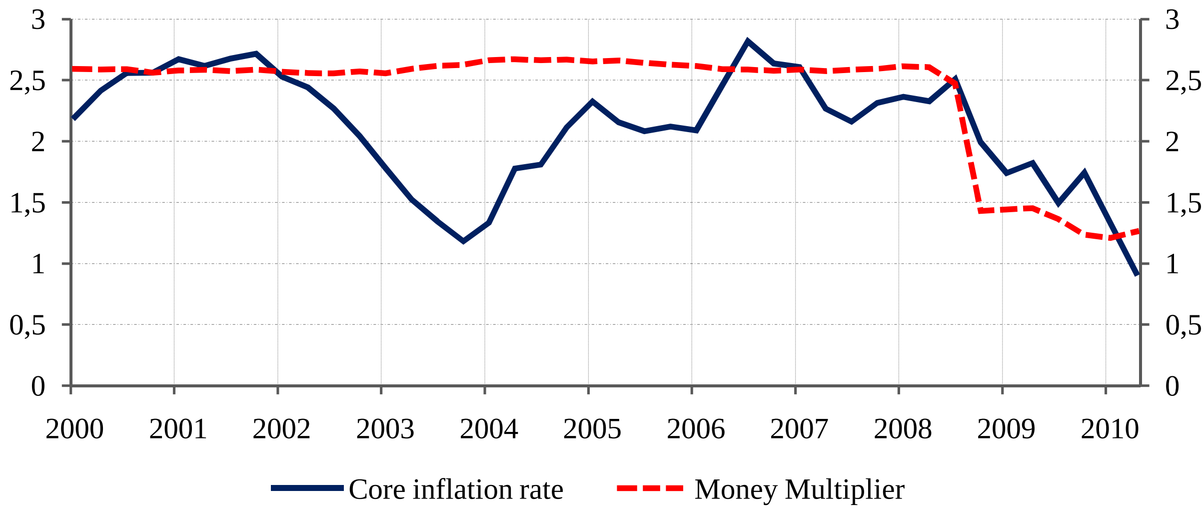
Figure 2.3: Economic Conditions 2000-2010



Source: US Department of Commerce: Bureau of Economic Analysis (quarterly real gnp data); and US Department of Labor: Bureau of Labor Statistics (quarterly data on unemployment rate)

To keep the US economy going, government still feels a need for further stimulating packages with a predominant focus on monetary policy, as the swelling public debt made it drop the exorbitant fiscal policy. Notwithstanding the considerable expansion of base money the past years, Fed will keep travelling the same path – at least for the coming months.[1] Despite an impressive tripling of the pre-crisis monetary base, Fed's intentions to expand the capital markets are of limited effect so far. In Figure 2.4 this is illustrated by the development of the core inflation rate, that remains well below Fed's temporarily higher-than-normal target.

Figure 2.4: Inflation Rate[a] & Money Multiplier[b] 2000-2010



Notes: (a) rate of change CPI, all items less food & energy (b) defined as M1/M0
Source: US Department of Labor: Bureau of Labor Statistics (quarterly CPI data); and IMF international financial statistics (quarterly data on monetary aggregates)

As already pointed out by many economists, Fed's unconventional and untested policy of flooding the market with cash involves the risk of uncontrollable inflation. In this respect Hamilton (2009) emphasizes the need for a credible exit-strategy of Fed's policy, noting that every hyper-inflation in history had the two ingredients of an enormous amount of public debt and a central bank that has acquired the taste of creating money. However currently the Fed is still dealing with a lack of traction of its record stimulus. The economy's effective money supply is only being loosely affected, due to a stagnated money multiplier and a low-valued velocity; both related to uncertainty and rooted fears remaining from the credit crunch. Figure 2.4 shows the current low money multiplier values, indicating commercial banks are just stockpiling reserves instead of making new loans in the marketplace. Low values for the velocity of income are furthermore implying that money that has actually made it to the public, circulates only slowly thereby demonstrating public's ongoing preference for saving over spending.

[1] As of November 3, 2010, the Fed announced to expand the stock of high-powered money by another $600 billion.

In Keynesian thinking a rather extreme economic situation is described where monetary policy is ought to be ineffective. According to Keynes, monetary policy primarily worked through the interest rate as an increase in the money stock would lower interest rates, hence affecting output positively. Though a strictly theoretical case is distinguished by Keynes, where monetary policy would be of no effect to aggregate spending. In this case of *absolute liquidity preference*, a change in the economy's money stock will not influence the interest rate because of ultrasensitive money demand; an implied lowering of the interest rate through central bank's purchase of treasury securities, leads money holders to absorb all the extra money balances as they hold firm expectations with respect to the interest rate level. The highly elastic demand for money makes sure for the increase in the money supply to be of no effect on both the interest rate and aggregate spending since the increase is only being passively transformed into low velocity values. Notwithstanding Keynes was only pointing at a strictly theoretical situation, there are some remarkable parallels with the current US economic situation. Monetary policy initiatives haven't appeared to be really output enhancing so far and could equally well have been transformed into low velocity values, all the more since the interest rate mechanism is disabled at the zero lower bound. To improve insight into the velocity of income as one of the obstacles to Fed's monetary policy, the next section will specify this variable more formally, investigate its behavior during the past century and illustrate its importance to our economy.

SECTION III MAIN CHARACTERISTICS OF THE VELOCITY OF INCOME

III . I DETERMINATION OF INCOME VELOCITY

Essentially income velocity embodies the speed at which money changes hands, which may clarify its other customary name being ‘’velocity of circulation’’. It is not only a measure for economic activity intuitively, but also by definition. Conventionally velocity of income is defined by means of the quantity equation, through the division of nominal output by a specific monetary aggregate.

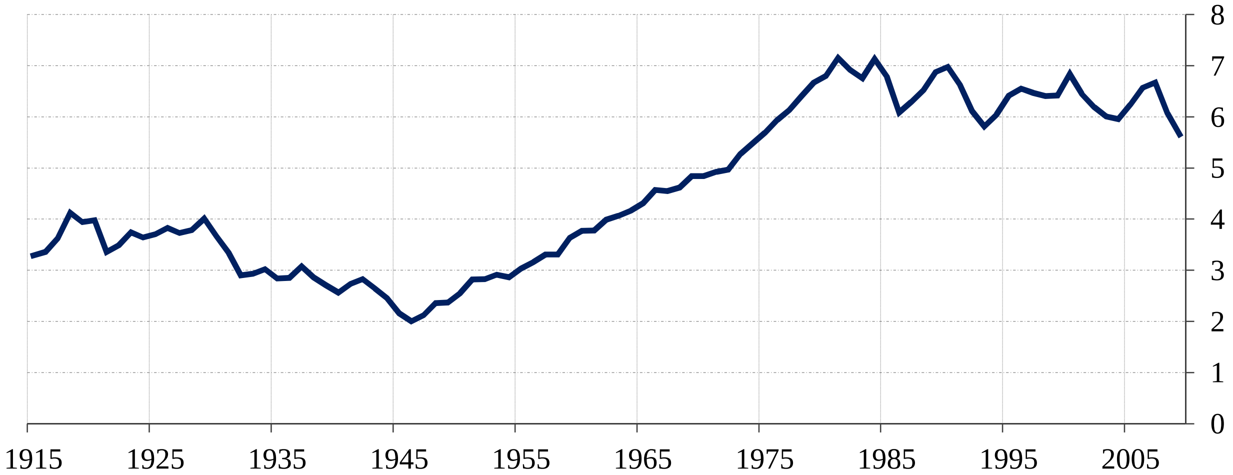
$$V = P\,Y/\,M \tag{3.1}$$

Hence the monetary aggregate of interest determines what kind of velocity values will exactly turn up. In this respect, Lucas (2000) makes a case for *M1* by arguing this money aggregate is basically being held to execute final good transactions and so would incorporate most accurately money’s role as a medium of exchange. Thus a velocity measure based on *M1* – henceforth denoted as *V1* – would make sense in approximating economic activity, as it indicates the speed at which this ‘’transaction money’’ actually is being used in performing final good transactions. However using *M1* entails the rub of the aggregate being disturbed ever since 1994, when the Federal Reserve agreed upon the use of so-called ‘’retail sweep programs’’ by depository institutions. Anderson and Rasche (2001) describe this type of computer software as creating the opportunity for commercial banks to sweep money balances from consumer’s transaction balances – that are subject to Fed’s reserve requirements – into money market deposit funds – that entail a zero reserve requirement. In effect this computer software on the one hand reduced the ‘’tax-on-reserves’’ largely, but on the other implied downward-biased *M1* estimates. Nevertheless, in order to produce reliable velocity estimates, in this study *M1* values are corrected with Fed’s estimations on the impact of sweep programs.

A major result in long-run velocity analysis has shown to be the institutional approach pioneered by Wicksell (1935), and further developed in a series of papers by Bordo and Jonung during the 1980s. This approach provides explanation for the U-shape in long-run velocity behavior which is generally being observed across countries through history. For the

US, the downward trend already commenced prior to 1900 and persisted until the post-WWII increase in velocity took off, that finally expired in the 1980s.

Figure 3.1: Long-run behavior of *V1*[a]: 1915-2009

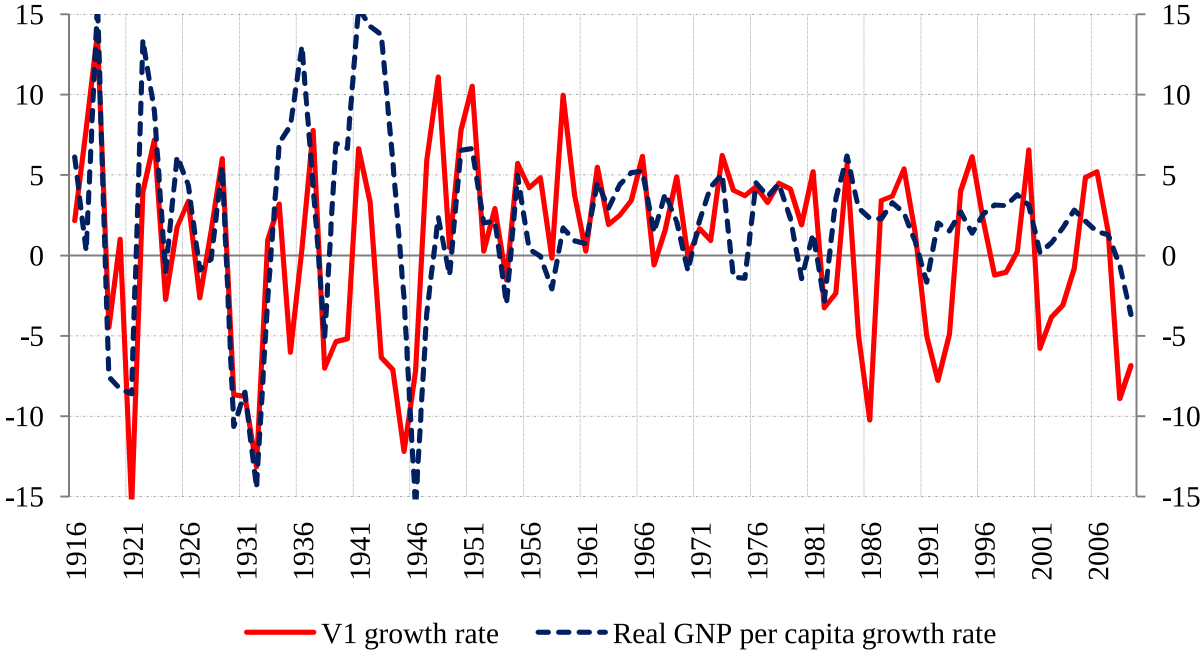


Note: (a) *V1* is defined as nominal GNP divided by *M1*
Source: own computations based on NBER US historical data & IMF international financial statistics

The institutional approach related velocity's downward trend to monetization because of both, increased importance of money in settling transactions and the spread of commercial banking. With more and more money being offered, the necessity of circulation declined. The post-WWII increase in turn, is supposedly related to the introduction of alternative financial instruments that together with increased economic stability made agents economize upon their cash balances.

As a measure of economic activity, velocity generally rises during expansions and falls during downturns. This pro-cyclical behavior of velocity can clearly be observed in Figure 3.2 by the co-movement of velocity growth and real GNP per capita growth:

Figure 3.2: Procyclicality of *V1*: 1916-2009



Source: own computations based on NBER US historical data & IMF international financial statistics

III . II VELOCITY'S RELEVANCE

> ''The importance of the concept [of monetary velocity] can scarcely be denied. A given change in the quantity of money will have widely varying effects on the level of prices and incomes, depending on the behavior of monetary velocity'' – Richard Selden, 1956

Within the original quantity theory of money framework, effectiveness of expansionary monetary policy was unquestioned. With velocity treated as a constant – simply reflecting payment technologies – increases in monetary aggregates certainly would affect nominal output levels. Variability in velocity values proved this theory to be erroneous and by consequence reduced the economic basis for monetarist thinking. A little later Friedman (1956) restated the quantity theory and retrieved the importance of money to nominal output by pointing at the relevance of velocity behavior. Successful estimation of velocity again would imply monetary changes to be generating predictable changes in aggregate spending.

> ''You can lead a horse to water, but you can't make him drink'' – Paul Samuelson, 1948

In my opinion velocity is not only important in determining to which extent monetary policy is about to be effective, but rather is crucial in determining whether short term monetary policy is effective at all. When an increase in *M* is matched by an equal decrease in *V*, monetary policy is ineffective as nominal output will remain unaffected; velocity's pro-cyclical nature in turn, assures we are not just assessing a strictly theoretical case here. Diving velocity values historically have been related to eroded confidence about the state of the economy, like Selden (1956) attributed the sharp decline in velocity during the Great Depression to the threat of reduced incomes and unemployment. With agents rather building contingency reserves than letting their money flow, the effectiveness of short-term monetary policy comes at danger. Thus instead of simply taking velocity behavior for granted, monetary authorities should strive for high velocity values in order to safeguard monetary policy effects.

When turned to long-run economic behavior, the relevance of high velocity values just seems to be intensified. Straightforward interpretation of the quantity equation suggests a long-run change in the economy's money stock to be entirely transformed into price changes, which consequently implies long-run velocity changes to be fully affecting real output growth. However – in fact – this way of reasoning would only make sense when velocity growth would actually cause output growth, instead of velocity just being one of the results of output growth.

III . III WHAT CAUSES WHAT: A FORMAL ANALYSIS

To evaluate this theoretical reasoning more formally, the concept of *Granger Causality* can be applied to investigate the direction of causality between real income and velocity growth. This concept of causality originates from Granger (1969) and identifies a one-way causal relationship as soon as a lagged value of variable *x* statistically improves an estimated relationship for *y* based on its own history, whereas the lagged value for *y* hasn't got similar predictive value in a likewise estimation for *x*. With respect to the econometric investigation of Granger Causality this study complies with Wen (2007), who has applied this causality concept to evaluate causal linkages among consumption, output and investment growth.

To start with an indication of the causal relationships between the variables, first the simplified Granger Causality test can be applied. With quarterly real GNP and *V1* data covering the period 1915-2010, equations (3.2) and (3.3) are set up to estimate both growth rates on their own history and the lagged other variable. Growth rates are conventionally defined as the first derivative of the variable in logarithmic terms, with Δy_t denoting the growth rate of real output, and Δv_t denoting velocity's growth rate; *t*-values are reported in parentheses with the 1% significance level (denoted throughout by an asterisk) being ± 2.58:

$$\Delta y_t = \underset{(2.79)^*}{0.003} + \underset{(9.21)^*}{0.63}\Delta y_{t-1} - \underset{(-2.83)^*}{0.15}\Delta y_{t-2} + \underset{(4.86)^*}{0.26}\Delta y_{t-3} - \underset{(-2.45)}{0.12}\Delta y_{t-4} - \underset{(-4.19)^*}{0.22}\Delta v_{t-1} \quad (3.2)$$

$$\Delta v_t = \underset{(0.24)}{0.0004} + \underset{(4.01)^*}{0.29}\Delta v_{t-1} - \underset{(-3.36)^*}{0.18}\Delta v_{t-2} + \underset{(3.31)^*}{0.18}\Delta v_{t-3} - \underset{(-1.02)}{0.05}\Delta v_{t-4} + \underset{(1.12)}{0.10}\Delta y_{t-1} \quad (3.3)$$

The estimation of real output growth is clearly augmented by including past velocity growth, whereas past output growth doesn't seem to have explanatory power with respect to velocity growth. These results imply a one-way causal relationship of velocity growth onto real income growth.

Further econometric evaluation however is required to deal with potential non-invertible moving average components within one of the growth rates. Invertible moving average processes contain the property to be reformulated into a stationary autoregressive model with converging parameters. Non-invertible moving average models on the other hand, cannot be rewritten into a finite autoregressive representation as its coefficients will not converge – implying the variable's finite history won't be sufficient for adequate estimation of its current value. When in this case of a non-invertible moving average model, subsequently other variables are added to the estimation of the concerned variable on its own finite history, these added other variables may render erroneously significant results leading to biased conclusions with respect to Granger Causality. To eliminate this potential biased inference, Wen (2007) used a two-stage regression procedure of primarily estimating an optimal ARMA(*p*,*q*) model, after which the residuals of this model are dedicated to be the dependent variable in the second step of the procedure. This second step finally evaluates – like an extended form of Granger Causality – the significance of another lagged variable in predicting the estimated residual series. The ARMA(*p*,*q*) model has been set up in accordance with a *Box-Jenkins* procedure that first requires a stationarity check[2] of both variables, after which the number of autoregressive terms *p*, and moving average terms *q* can be determined with the help of the autocorrelation function (ACF) and the partial autocorrelation function (PACF). Lastly, misspecification has to be ruled out by verifying absence of residual autocorrelation.

[2] Stationarity issues are discussed in section V in more detail.

After a satisfactory stationarity check for both series, an ARMA(3,2) model turned out to be optimal for modeling real output growth, whereas an MA(1) model has shown up being the best fit for velocity growth. Both models are specified below:

$$\underset{(4.10)^*}{\Delta y_t = 0.007} - \underset{(-2.10)^a}{0.28\Delta y_{t-1}} - \underset{(-4.36)^*}{0.39\Delta y_{t-2}} + \underset{(7.13)^*}{0.39\Delta y_{t-3}} + \varepsilon_t + \underset{(5.28)^*}{0.72\varepsilon_{t-1}} + \underset{(4.79)^*}{0.59\varepsilon_{t-2}} \tag{3.4}$$

$$\Delta v_t = \underset{(0.80)}{0.001} + \eta_t + \underset{(7.79)^*}{0.37\eta_{t-1}} \tag{3.5}$$

Note: (a) *t*-value is significant at 5% with critical values being ± 1.96

With a minimized number of significant terms and absence of residual autocorrelation, both models show up satisfactory. The estimated residuals are now to be used as the dependent variables in both second-stage regressions. Equation (3.6) examines the predictive value of the lagged growth rate of velocity on the estimated residuals of real output growth, whereas equation (3.7) considers the predictive value of the lagged growth rate of real output growth on the estimated residuals of velocity growth:

$$\varepsilon_t = \underset{(0.13)}{0.0001} - \underset{(-2.85)^*}{0.10\Delta v_{t-1}} \tag{3.6}$$

$$\eta_t = \underset{(0.00)}{-0.000002} + \underset{(0.06)}{0.004\Delta y_{t-1}} \tag{3.7}$$

Again highly significant values for velocity growth in equation (3.6) are pointing at Granger Causality from velocity growth to real output growth, while equation (3.7) confirms earlier results of a merely one-way linkage as the lagged growth rate of real GNP doesn’t contain explanatory power for velocity growth.

After applying the two-stage regression procedure that is able to cope with bias from non-invertible moving average components, the conclusions are still pointing in the same direction with a one-way Granger Causality linkage between velocity growth and real output growth. By means of this formal testing, velocity growth has appeared to cause output growth, thereby making a strong case for investigating velocity specifications in more detail.

SECTION IV LITERATURE REVIEW

> ‘’In the developed quantity theory of money (...) there has always been a weak spot, namely, the velocity of circulation. The Quantity of Money is an observable phenomenon, and the proximate causes, at least, which govern it, may be specified (…) Velocity is also observable, but the causes which govern it are less easy to distinguish’’ – Roy Harrod, 1936

IV . I SPECIFICATION REMARKS

To approximate velocity econometrically, the general approach has been to combine a conventional money demand function with the quantity equation. Formally the money demand function is then stated as:

$$\frac{M_t}{P_t} = L(y_t, R_t) \tag{4.1}$$

where the quantity of real money demanded is depending positively upon real transactions volume y_t and negatively upon the interest rate R_t, a measure of opportunity costs. After subsequently approximating $L(y_t, R_t)$ in the following form $e^{\gamma_0}\, y_t^{\gamma_1}\, e^{-\gamma_2 R_t}$ (thereby assuming the parameters, γ_1 and γ_2, to have positive values), a logarithmic transformation yields the conventional money demand function:

$$\log(M_t/P_t) = \gamma_0 + \gamma_1 \log y_t - \gamma_2 R_t \tag{4.2}$$

By means of the quantity equation this can be rewritten into a velocity function V_t:

$$\log V_t = (1 - \gamma_1) \log y_t - \gamma_0 + \gamma_2 R_t \tag{4.3}$$

Because this last rewriting into the velocity function just uses the quantity equation – which holds by definition – the link between money demand and velocity becomes clear as it shows up that estimation augmentations concerning the velocity of income are apparently to be made in the context of the money demand specification of (4.2).

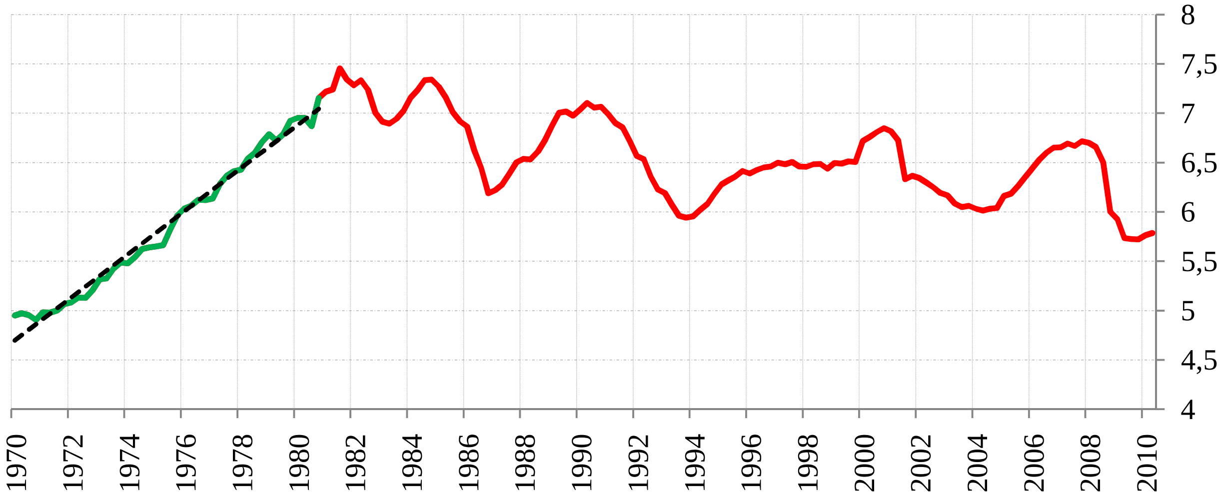
After this formal derivation of our velocity function, below mentioned velocity function (4.4) will be used as a base for further econometric analysis:

$$\log V_t = \beta_0 + \beta_1 \log y_t + \beta_2 R_t \tag{4.4}$$

where economic theory suggests the elasticity β_2 to be positive, since higher opportunity costs would imply money to switch hands at a faster pace; the elasticity β_1 theoretically can be both positive or negative, however intuitively we would expect a positive value with a heating economy calling for higher money circulation.

Because of the close linkage between money demand and velocity, both concepts are interchangeably used in economic literature. Estimating in velocity terms entails an interpretational advantage since it can be effectively related to the economy's nominal output level by means of the quantity equation. Until the 1980s there was considerable stability in money demand, as can be told from the clear upward trend in velocity in Figure 4.1:

Figure 4.1: Breakdown *V1* trend (1970Q1-2010Q2)



Source: own computations based on NBER US historical data & IMF international financial statistics

The apparent stability in short-run money demand these days, gave the Federal Reserve the ability to pursue monetary targeting accurately. With the Fed relying on the upward velocity trend, the subsequent break initially caused a misallocation of the economy's stock of money. Velocity was being overestimated, leading to underestimation of money demand and so a temporary shortage of money. After this break, Poole (1988) among others considered it unwise just to rely on a thirty year old velocity trend, instead of carefully examining the underlying determinants. With respect to a monetary policy rule in general, Feldstein and Stock (1996) quite strikingly observe a trade-off between controllability of monetary aggregates and the corresponding strength of the linkage to nominal output. The initial accurateness of Fed's respective well controllable monetary policy rule was outstanding, however got eclipsed by the break and ended finally as the most pronounced confirmation of *Goodhart's Law* (1975). This Law predicts any observed statistical regularity to collapse sooner or later, pre-eminently when pressure is placed upon it as a result of it being used for control purposes. Closely related to the *Lucas Critique*, the Law is founded on the recurrent inadequacy in econometric modeling not to properly account for estimation deviations that stem from different policy making behavior – so in fact, the estimated model is solely applicable in an unchanged policy environment. An implication of the Law for central banks now is, to resist the temptation of using a simple statistical regularity instead of dealing with the total complex of macroeconomic factors and their internal relationships. Compatible with Goodhart's Law, this study aims at improving central bank's information provision rather than deriving an indisputable monetary policy rule.

IV . II RELATED LITERATURE

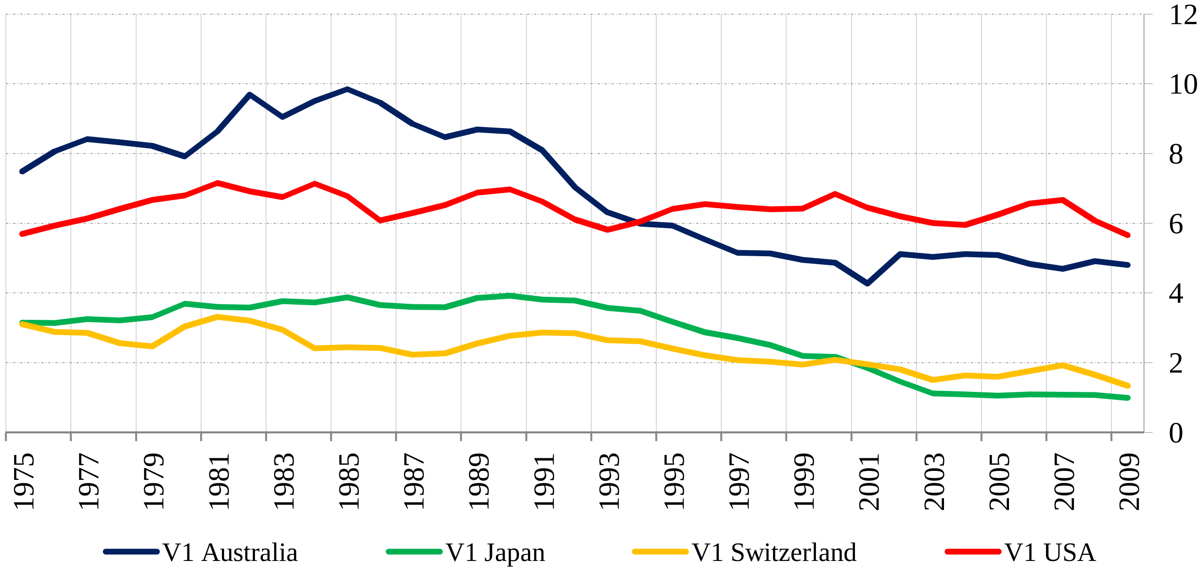
The break and subsequent substantial and unpredictable shifts in money demand are to a considerable extent related to innovations in the financial system. Nonetheless an interesting body of research emerged ever since with varying success, trying to explain the break more specifically in order to restore stability in the velocity function. The most important contributions of past decades with respect to the velocity function are summarized below.

As already touched upon in section III, Bordo and Jonung (1981) made an attempt to explain and model velocity's long-run behavior in an influential series of papers during the 1980s, where they gave the Wicksellian institutional variable approach a personal interpretation. Although the U-shape is generally observable for *V1* as well as *V2*, they explicitly chose throughout to work with *M2*; not only on account of it being the sole monetary aggregate available for their extensive time-span, but also because they reasoned *M2* to be less disturbed by financial innovation and hence better comparable across countries. Founded upon institutional factors that would bring about substitutions between monetary assets, they attributed velocity's downward trend to the process of monetization whereas the upward trend was related to agents economizing upon their cash holdings. To model these aspects, they distinguished four institutional variables. With respect to the downward trend they considered both the spread of commercial banking – approximated by the currency money ratio – and the gradual decline of barter, that was ought to be translated into the share of the labor force active in the non-agricultural sector. They expected the currency money ratio to be negatively correlated with the spread of commercial banking and thus positively related with velocity, whereas the share of non-agricultural labor in total labor ought to be correlated positively with the spread of the money economy, and hence negatively with velocity. Regarding the upward trend of economizing upon cash holdings, they distinguished between both financial sophistication – approximated by the share of non-bank financial assets in total financial assets – and economic stability, as indicated by a six year moving standard deviation of the annual percentage change in real per capita income. The former variable was expected to be positively correlated with financial sophistication and hence ought to be positively related with velocity, whereas the latter is considered to be negatively related with economic stability and hence should enter the velocity function with a negative sign.

Since Bordo and Jonung's initial paper didn't account properly for possible unit root behavior in time series data – as correctly noted by Raj and Siklos (1988) – a revised version with an extended sample was published in 1989. This revised version investigates annual *V2* behavior in the United States, United Kingdom, Canada, Sweden and Norway for the period 1880 to 1986. Together with the four mentioned institutional variables, the benchmark velocity equation (4.4) was further modified by entering both real per capita permanent income as a proxy for transaction balances, and another variable ''cycle'' that was about to incorporate the effect of transitory income on velocity behavior. In order to deal with unit root behavior a rates-of-change specification was used, with all variables in logarithms except the interest rate – henceforth a ''semi-log specification''. In their estimation of *V2* behavior, they only found two out of the four institutional variables significant at the 5% level, in addition to the more basic determinants as the interest rate and real per capita permanent income. With significance of the currency money ratio and the financial sophistication variable, the U-shape appears to be modeled successfully as the former variable represented the downward trend whereas the latter concerned the upward. Financial deregulation in the 1980s has been put forward as to be causing both a renewed spread of commercial banking, and an increasing share of non-bank financial assets. The importance of the labor share in non-agricultural pursuits in the estimation is logically weakening through time, as the transition away from barter doesn't play a part anymore. Finally Bordo and Jonung interpreted the significance of their variable ''cycle'' across countries, as confirming *V2*'s pro-cyclical nature.

A remarkable aspect of an extended international post-WWII velocity study by Bordo and Jonung (1987a), are the considerable absolute level differences in *V1* as well as in *V2* across the 84 countries investigated. Primarily they attribute these differences to countries being at different stages of financial development; with some already being on the upward velocity trend, while others are still hitting downwards. Nonetheless when considering solely high-income OECD countries, there still are substantial *V1* differences to be found. For Australia, Japan, Switzerland and the United States this is illustrated in Figure 4.2, where these countries exhibit absolute *V1* differences up to a factor 5 during the past decades.

Figure 4.2: *V1* in Australia, Japan, Switzerland[a] & the US: 1975-2009



Note: (a) V1 has been calculated by means of GDP instead of GNP values
Source: own computations based on NBER US historical data & IMF international financial statistics

Among the many factors influencing velocity values across countries, at first definitional disturbances might arise due to measurement inconsistencies with respect to *M1* aggregates. Standards for compiling monetary aggregates are published by the IMF only for a decade now.[3] Nonetheless, countries still can be faced with measurement issues like the already in section III mentioned sweep accounts for the US. Apart from this, the striking differences in absolute *V1* levels for Australia and the US vis-à-vis Japan and Switzerland might be related to historical differences in interest and inflation rates; with higher opportunity costs in the former countries causing higher money circulation. Overall stagnation of the Japanese economy during the past decades might have caused a further Japanese drop in *V1* values,

[3] As of 2000 the IMF has published its ''Monetary and Financial Statistics Manual'' with guidelines for the computation of monetary aggregates.

whereas Swiss floor values in turn are indisputably related to its nature of being a banking country with relatively high *M1* composites.

Research by Stock and Watson (1993) pointed at the importance of extensive data samples when studying long-run money demand. With a simple semi-log specification for money (*M1*) demand using annual data, they found a stable money demand relationship over the period 1900-1989 with an income elasticity near one and an interest semi-elasticity near -0.1. However when their sample was divided into a pre-war and a post-war sample, the latter turned out to generate an unstable *M1* demand function in the sense of the income and interest rate elasticities being both highly dependent on the exact estimation specification and greatly varying across their different proposed estimators. When instead monthly post-war data are used at first there appeared to be less disagreement among the different estimators of the income elasticity and interest semi-elasticity, however these results had shown to be misleading with estimates being highly sensitive to the sampling termination date. Stock and Watson relate unstable money demand after WWII to the absence of growth in real balances until 1982, by which the post-war data wouldn't tell much about the parameters of the cointegrating relationship and merely generates a kind of ratio between the elasticities of income and the interest rate. Nonetheless when the last years of their sample were included as well, multicollinearity between income and the interest rate declined leading to considerable changes in point estimates that gradually became more reliable

In a Ramsey-Cass-Koopmans model Gordon *et al*. (1997) investigate *V0* trends with quarterly data covering the period 1960-1997. Although the authors recognized their choice for *M0* to be quite unconventional, they made an attempt to justify it by pointing at comparable time patterns of *M1* and *M0*. However in my opinion *V0* values contain considerably less valuable information for monetary authorities, with the central bank essentially being perfectly in charge of *V0* through its full command of the monetary base. Gordon *et al.* convert in their general equilibrium model effects of monetary and fiscal policy expectations into the expected returns of nominal vis-à-vis real assets – thus the policy expectations would finally influence agents' portfolio decisions. These portfolio decisions regarding substitution between nominal and real assets in turn would produce velocity movements. They argued expansive fiscal policy in the sense of nominal liability creation to pull agents into real assets that are to become relatively less taxed, whereas contractionary policy would increase real taxes and consequently induce agents to shift into nominal assets, including money. In this respect a shift into real assets generates lower short-term money demand, and hence would imply higher velocity values. Expansive monetary policy on the other side produces increases in real money balances, thereby heightening the opportunity costs of holding money, leading agents to substitute out of money into real assets that finally got the effect of higher short-term velocity values as well. Applying various simulations for the conversion of past economic information into agents' expectations, they found expectations simulated by means of *Bayesian updating* to produce reasonable results in estimating velocity trends – which made them emphasize the importance of policy expectations to *V0* behavior. With portfolio decisions based on the valuation of money as an asset, Gordon *et al.* gave a rather Keynesian touch to the interpretation of velocity, whereas in the underlying study on the contrary velocity is interpreted as a measure of activity being dependent upon agents' assessment of the current general economic situation with merely the nominal interest rate showing money's relative value as an asset.

In order to measure opportunity costs for holding *M1* adequately in studying money demand, Ball (2002) pointed at the importance of looking at its closest substitutes. As the closest substitute for *M1* he defined ''near-monies'', essentially consisting of zero maturity bank-accounts not included in *M1*. More specifically this concerned money market deposit accounts, retail money market mutual funds, and savings accounts – all representing liquid parts of *M2*. The interest rate on these individual parts in turn are weighted by their shares in *M2*, in order to construct the final interest rate on near-monies. With 1960 as the first year with data on the interest rate on near monies and 1993 as the termination date – related to measurement complications arising from sweep accounts – the investigated sample of quarterly data is rather short. Nonetheless a stable long-run money demand function showed up, with an income elasticity of 0.47 and an interest rate semi-elasticity of -0.082. In order to estimate the short-run dynamics of money demand, Ball used a Partial Adjustment Model. Estimation results pointed at faster adjustment when using the interest rate on near monies instead of the Treasury Bill rate. In addition, this short-run specification again implied stable parameter values. Ball attributed the apparent stability to the circumstance that his interest rate on near monies is being comparably – like velocity – influenced by financial innovation.

An alternative explanation for velocity's pro-cyclical behavior is provided by a study of Leão (2005) where he proposed the pro-cyclicality to be caused by the varying compilation of total expenditures during crises and business expansions. In this respect, Leão distinguished between expenditures related to durable consumption, export, and investment goods on the one hand (DGEI), and expenditures related to nondurable goods and services (NDGS) on the other. Money involved in expenditures of DGEI generally displays higher velocity values than expenditures related to NDGS, as agents usually synchronize their expenditures of the former category with the moment that liquid capital has become available. With the share of DGEI in total expenditures increasing during expansions and decreasing during downturns, the pro-cyclical movement of velocity is hence being alternatively interpreted. In this regard Leão used in his quarterly *V1* specification over the period 1982-2003 the explanatory variable ''Weight'', representing the share of DGEI in aggregate expenditures. Furthermore he specified the volatility of *M1* – as indicated by the standard deviation of *M1* – as an explanatory variable with an expected negative sign, based on reasoning by Friedman (1984) that volatility in *M1* would imply uncertainty that pushes agents into money balances thereby lowering velocity values. To include the impact of non-real GDP transactions on velocity behavior,[4] Leão used the ratio of the money stock *M3* and *M1* as one of the explanatory variables. An increase in non-GDP transactions would led agents out of *M3* into demand for *M1*, implying lower values of this ratio that are consequently accompanied by lower *V1* values. In order to investigate the influence of specified variables on velocity behavior, Leão used a long-run semi-log specification accompanied by a short-run Error Correction Model. In the long-run cointegrating relationship all just mentioned variables turned out to be significant with expected signs, whereas in the short run specification only the *M1* volatility variable dropped out being insignificant.

In order to determine whether a basic log-log or semi-log specification fits best long-run demand for *M1*, Ireland (2008) used merely the interest rate as explanatory variable since he imposed the restriction of a unitary income elasticity. He illustrated the relevance of his study by pointing at the differences between the one and the other specification in terms of the costs of inflation as indicated by a percentage of real GDP; these inflation costs are subsequently compared to optimal monetary policy as proposed by Friedman (1969a) based upon a zero nominal interest rate. Following Lucas (2000) on the determination of inflation costs implied by the money demand distortion of a positive nominal interest rate, the costs of inflation appear to be significantly higher when money demand fits a log-log specification. Related to financial deregulation of the 1980s, Ireland discovers a log-log specification to better fit his pre-1980 annual data, whereas the semi-log specification outstands on the 1980-2006 period

[4] E.g. the purchase of real estate.

with quarterly data. According Ireland's analysis, this functional shift in money demand reduces the welfare costs of inflation, making a stronger case for Fed's current policy of low but positive inflation rates instead of Friedman's zero nominal interest rate rule.

A recent study by Rao and Kumar (2009) investigated annual long-run *M1* demand over the period 1960-2008. A semi-log specification with unit income elasticity was augmented by including variables for the inflation rate and the real exchange rate next to a trend variable. The inflation and real exchange rate variables are included to better proxy the opportunity costs of holding money and were expected to enter the money demand equation with a negative sign, whereas the trend variable should be capturing advances in payment technologies, and hence would also be expected to enter negatively. In the subsequent estimated long-run model all introduced variables showed up significantly and correctly signed. Using single structural break tests, the stability of this long-run cointegrating relationship was largely confirmed, with only weak evidence for a break in 1998. Yet the break was accounted for in their short-run money demand model, that yielded rather unsatisfactory results in terms of a low R^2-value together with problematic misspecification test results.

SECTION V EMPIRICAL RESEARCH

> ''Velocity and its determinants lie at the center of long-running debates about the effects of macroeconomic policies'' – David Gordon, 1997

With derivation of the Granger Causality linkage in Section III, the importance of *V1* (henceforth ''velocity'') to output growth was formally established. In the current economic context with high public debts and extensive monetary policy, velocity should be brought even more to the fore. As an indication for confidence and a solution to ineffective monetary policy, high velocity values are currently desirable. To this matter, a proper insight in velocity and hence a good estimation of its behavior could be valuable. As already shown in the previous section, several attempts have been made in estimating velocity behavior adequately – whether in the context of money demand or not. The purpose of this study is to contribute to this literature, making an attempt to incorporate the extraordinary economic circumstances in terms of stimulating policy.

V . I METHODOLOGY

To provide adequate insight into velocity behavior the *Engle-Granger two step procedure* (1987, EG-procedure) will be applied. This procedure provides the opportunity of specifying both long-run and short-run behavior for variables that may contain unit root properties. In order to derive a non-misspecified long-run relationship between variables that behave like random walks, the first step obliges to verify all variables to be integrated of equal order. The order of integration can be determined by means of an Augmented Dickey-Fuller test (ADF-test); unit root behavior in levels, and subsequent stationarity in first differences imply a variable to be integrated of order one, I(1). After satisfactory test results regarding the order of integration, a cointegrating relationship between these variables might be present. In general, cointegration can be assumed if residuals of the cointegrating relationship are stationary in levels. Critical values reported in statistical software are generally unreliable for performing an ADF-test on residuals, because these values are derived conditional on the actual existence of the cointegrating relationship. With these critical values functioning merely as an indication, existence of cointegration will be verified at the second step of the EG-procedure according the *Engle Representation Theorem*.

The static long-run equation will take the form of the benchmark velocity equation (4.4), extended with variables of interest (x_t):

$$v_t = \widehat{\beta_1} + \widehat{\beta_2} y_t + \widehat{\beta_3} R_t + \widehat{\beta_4} x_t + \varepsilon_t \qquad (5.1)$$

where lower case letters indicate logarithmic values. The second step of the EG-procedure considers estimation of an Error Correction Model, to investigate velocity's short-run dynamics. The model is built upon the dynamics of v_t, as depending on the dynamics of specified explanatory variables in addition to an error correction term (ε_{t-1}) and lagged dependent variables. A significant t-value on the coefficient of the error-correction term in turn can verify existence of a cointegrating relationship; thereby relying upon Ericsson & Mackinnon (2002) critical values. Modeling from general to specific subsequently should yield an optimal Error Correction model resembling the following form:

$$\widehat{\Delta v_t} = \widehat{\beta_0} + \widehat{\gamma_0} \Delta x_t + \sum \widehat{\gamma_i}\, \Delta x_{t-i} + \sum \widehat{\alpha_j}\, \Delta v_{t-j} + \hat{\gamma} \varepsilon_{t-1} \qquad (5.2)$$

where (ε_{t-1}) represents the lagged value of the estimated residuals of equation (5.1). The short-run dynamics of velocity are now being explained assuming the estimated cointegrating relationship (5.1) to be representing long-run equilibrium; the error correction term in turn indicates the speed of dynamic adjustment towards imposed long-run equilibrium values. In estimating short-run dynamics, all OLS assumptions with respect to the behavior of the residuals will be met and will be documented in Appendix III.

V . II VARIABLE DESCRIPTION

While a considerable part of quoted empirical literature is merely fixated upon own contributions in estimating velocity behavior – to a certain extent overlooking previous major findings – this study aims at including previous notable contributions as much as possible. In order to answer the call of Stock and Watson (1993) a rather long sample of annual data will be investigated concerning the period 1917-2009. The focus will be on annual data, because of both availability and reliability matters. With respect to the latter, Romer (1988) noted quarterly pre-WWII observations of especially GNP to be suffering from inaccurateness. To qualify for insertion in the long-run estimation, variables need to be I(1), whereas the short-run specification requires variables to be in first differences form. Elaboration on data sources and specification of unit root tests on variables is postponed respectively to Appendix I and II.

The variable R_t I(1) denotes the interest rate in percentage points. To capture opportunity costs properly, the interest rate on near monies will be included as of the year 1959 – the first year of availability. In fact, the interest rate on near monies as proposed by Ball (2002) will be proxied by means of the ''*M2*-minus'' rate – representing the interest rate on a weighted average of *M2* components less small time deposits. Other than that, the corporate bond yield will be included. Expectedly, this variable enters the velocity function with a positive sign, as higher opportunity costs should imply faster money circulation.

The variable y_t I(1) represents the logarithm of real GNP. With de facto the interest rate already including inflationary expectations, real GNP appeared purest in measuring transactions volume. We would expect a heating economy to require higher money circulation, and so this variable should enter positively.

Variables $bank_t$ I(1) and $soph_t$ I(1) are derived from Bordo and Jonung (1990) being their most prominent variables to address the U-shape in long-run velocity behavior. The downward trend is captured by $bank_t$ denoting the spread of commercial banking as proxied by the currency money ratio – this ratio will be determined as the logarithm of the percentage of currency and notes in *M2*. Assumed that $bank_t$ is negatively related to the spread of commercial banking, we would expect it to be positively related to velocity. The upward trend in long-run velocity behavior is related to financial sophistication and has been captured by the variable $soph_t$. This variable proxies financial sophistication by the ratio of total non-bank financial assets over total financial assets. With respect to the pre 1960s period, I used data available in Bordo and Jonung's study. As of the 1960s I proxied this variable by the ratio of credit market assets over currency and checkable deposits – all in amounts held by non-financial institutions. In order to match Bordo and Jonung's original variable adequately, the constructed variable has been transformed into comparable magnitudes and is finally turned into a logarithm of percentage points. Following Bordo and Jonung, the variable should be positively related to financial sophistication and hence is expected to enter the velocity function with a positive sign.

The variables $base_t$ I(1) and $debt_t$ I(1) are newly constructed and included to examine monetary and fiscal policy effects on the behavior of velocity. With respect to monetary policy, this will be the stock of high-powered money outstanding as a logarithmic percentage of nominal GNP. The intensity of fiscal policy will be captured by the logarithm of the amount of public debt per capita. Intuitively – and to a certain extent underscored by Gordon *et al.* (1997) – we would expect both variables to enter the velocity function negatively signed, with agents' interpretation of the economic situation negatively influenced by government's apparent need to apply stimulating policy.

As a measure of confidence, $gold_t$ I(1) will be included in the long-run estimation of velocity behavior – denoted as the logarithm of the annual average real per ounce price in US $. With agents generally taking refuge into gold during times of economic instability, an increasing price per ounce would in this sense point at economic turbulence. Hence the expectation for this variable is to enter the velocity function negatively signed.

In order to model velocity's short-run dynamics, primarily the significant long-run variables will be included, after which the following two stationary variables will be added – both based on previous empirical research by Leão (2005).

The variable $\Delta WEIGHT_t$ is included to capture Leão's alternative explanation for the pro-cyclicality in velocity behavior. This variable represents the difference in the share of high velocity expenditures in total expenditures and is expected to be positively related to velocity. In order to construct the variable of interest I used the following conventional notation for GDP:

$$Y = C + I + G + X - Z \tag{5.3}$$

where Y represents aggregate expenditures on products originated in the United States. To derive aggregate expenditures in the way Leão proposed, the value of imports should first be added to this GDP figure. Subsequently the value of government expenditures and the consumption of nondurable goods and services are subtracted, resulting in the part of expenditures for which velocity is likely to be high. The relative share of this part in aggregate expenditures finally represents the variable $WEIGHT_t$ that is constructed for the period 1929-2009.

The short-run variable $\Delta M1VOL_t$ denotes annual differences in the volatility of *M1*. In this regard, volatility has been calculated as the standard deviation of the logrelative returns in *M1*. According Friedman (1984) $\Delta M1VOL_t$ should be negatively related to velocity, since increased volatility in *M1* would point at uncertainty that pushes agents into money balances thereby lowering velocity values. However, because of mixed results upon this variable in previous literature, the variable will be regarded as exerting ambiguous influence on velocity.[5]

V. III ESTIMATION RESULTS

The composition of variables yielded a satisfactory long-run relationship with an adjusted R^2 of 0.97, and all included variables being significant with the expected sign – the logarithm of the real gold price ($gold_t$) excepted. The measure for financial sophistication ($soph_t$) turned out to be redundant by means of a standard F-test with a probability of 0.85. The estimated long-run static relationship took below specified form:

$$v_t = \underset{(-0.08)}{-0.011} + \underset{(4.00)^*}{0.018R_t} + \underset{(12.21)^*}{0.40y_t} + \underset{(2.33)^a}{0.12bank_t} - \underset{(-8.81)^*}{0.36base_t} - \underset{(-6.95)^*}{0.20debt_t} + \underset{(2.71)^*}{0.062gold_t} + \varepsilon_t \quad (5.4)$$

Note: (a) *t*-value is significant at 5% with critical values being ± 1.96

where *t*-values are reported in parentheses with the 1% significance level (denoted throughout by an asterisk) being ± 2.58. With respect to the interest rate R_t it has to be mentioned that this rate is solely based on the corporate bond yield, since the rate on near monies turned out to be insignificant. The interest rate semi-elasticity of 0.018 is roughly conform more recent findings in empirical literature, however is substantially lower than the 1900-1989 semi-elasticity of 0.1 as reported by Stock and Watson (1993). This discrepancy might be due to the generally higher absolute values of the corporate bond yield, as compared to the commercial paper rate used by Stock and Watson. When considering the income elasticity, the value of 0.4 is somewhat high compared to Stock and Watson's income elasticity near one in the context of money demand. This inconsistency might be related to sampling differences as Stock and Watson internalized the early 1900s period with declining velocity values and rising real income, whereas this study instead internalized recent period with rising real income and stabilized velocity values. Consistent with Bordo and Jonung's view upon effects of the spread of commercial banking on velocity behavior, a positive relationship between $bank_t$ and v_t can be reported. Since Bordo and Jonung investigated *V2* behavior, our point estimates aren't one to one comparable. However, there is some consistency in the sense that

[5] E.g. Pollin and Schaberg (1998) put forward an *ad hoc* argument where velocity may be positively related to $\Delta M1VOL_t$, reasoning that uncertainty might instead lead agents into other monetary aggregates.

their point estimates are slightly less, which was to be expected since *V2* generally denotes lower values. With respect to the included policy variables, the results are as expected with long-run velocity behavior negatively influenced by both expansionary monetary and fiscal policy. Especially the negative coefficient for $base_t$ was to be expected, since normally an increase in the base indirectly leads – via an adequately functioning money multiplier – to a rise in *M1*, that in turn generates lower velocity values. However, because of the large elasticity with respect to monetary policy as indicated by $base_t$, you would expect the immense increase in the base to be reflected in a sharp decline in v_t. In this respect the effects on v_t have only been moderate so far – an observation that is certainly related to a disfunctioning money multiplier. Fiscal policy on the other side is also accompanied by a rather large elasticity, showing off the impact of rising public debt on velocity behavior. Realizing the United States per capita public debt has increased by roughly 30% in the period 2007-2009, the effects on velocity are about to be substantial. The results regarding the coefficient of $gold_t$ are surprising in the sense that this variable isn't accompanied by an expected sign. However, the value of the elasticity indicates the effects of real gold price fluctuations on long-run velocity behavior only to be relatively modest.

The short-run dynamics are satisfactorily represented by equation (5.5) yielding an adjusted R^2 of 0.85 with all included variables significant at 1% and moreover signed conform expectations:

$$\underset{(-2.57)}{\Delta v_t = -0.009} + \underset{(3.28)^*}{0.011\Delta R_t} + \underset{(6.04)^*}{0.52\Delta y_t} + \underset{(3.14)^*}{0.18\Delta bank_t} - \underset{(-5.20)^*}{0.16\Delta base_t} + \underset{(5.94)^*}{0.23\Delta base_{t-1}}$$

$$-\underset{(-4.76)^*}{0.21\Delta debt_t} + \underset{(3.19)^*}{0.60\Delta WEIGHT_t} + \underset{(3.78)^*}{0.32\Delta M1VOL_t} + \underset{(5.94)^*}{0.50\Delta v_{t-1}} - \underset{(-5.82)^*}{0.40\varepsilon_{t-1}} \qquad (5.5)^a$$

Note: (a) the 1% and 5% asymptotic critical values for the τ-Ecm test equal -5.17 and -4.56 respectively (see Ericsson & Mackinnon, 2002)

When compared to the critical values reported in Ericsson and Mackinnon (2002) the *t*-value associated with the error correction term ε_{t-1} convincingly confirms existence of a cointegrating relationship in equation (5.4). With the coefficient of the error correction term smaller than one and negatively signed, there appears to be adjustment towards implied long-run equilibrium values. The coefficient on the lagged dependent variable Δv_{t-1} indicates some degree of persistence in velocity movements. The newly included variable $\Delta WEIGHT_t$ is expectedly signed and hence strengthens Leão's (2005) alternative explanation for the pro-cyclicality in velocity behavior, whereas the other new variable $\Delta M1VOL_t$ appears to be positively signed contradicting Friedman's (1984) hypothesis in this respect. The policy variables $\Delta base_t$ and $\Delta debt_t$ are again negatively signed conform expectations; however the one period lagged value of $\Delta base_t$ appears to be positive, which may be related to both spurring growth effects of monetary policy and increased prices. To investigate policy effects on velocity behavior more thoroughly, henceforth the focus will be exclusively on the two policy related variables.

V . IV IMPLICATIONS OF MONETARY POLICY

As can be derived from a Wald-test on the coefficients of $\Delta base_t$ in equation (5.5), the downward effect of expansionary monetary policy on short-run velocity doesn't necessarily differ from the lagged upward effect, in the sense that both absolute point estimates do not statistically differ from each other. This result indicates that changes in monetary policy roughly show off ambiguous effects on short-run velocity behavior.

With long-run velocity negatively affected by expansionary monetary policy, and an insignificant directional effect of monetary policy on short-run velocity behavior, it would be informative to investigate whether there exists a causal linkage leading from monetary policy to velocity, or – alternatively – that both variables are just correlating. In this respect, the Granger Causality test – as already applied in section III – may well be used. In order to deal with possible non-invertible moving average components, the test will be applied in the form of a two-stage regression procedure of primarily estimating an optimal ARMA(*p*,*q*) model, after which the residuals of this model are dedicated to be the dependent variable in the second step of the procedure. Based on annual data over the period 1915-2009, it appears Δv_t fits best an MA(1) model, whereas $\Delta base_t$ is best fitted through an AR(1) model – these models are specified below:

$$\Delta v_t = \underset{(0.76)}{0.006} + \varepsilon_t + \underset{(3.09)^*}{0.31}\varepsilon_{t-1} \tag{5.6}$$

$$\Delta base_t = \underset{(0.59)}{0.009} + \underset{(3.41)^*}{0.34}\Delta base_{t-1} + \mu_t \tag{5.7}$$

The estimated residuals are subsequently used in the second step of the procedure, where the predictive value of a lagged variable of interest can be evaluated. In this respect, equation

(5.8) examines the predictive value of the lagged growth rate in the base on the estimated residuals of velocity growth, whereas equation (5.9) considers the predictive value of the lagged growth rate of velocity on the estimated residuals of monetary base growth:

$$\underset{}{\varepsilon_t} = \underset{(0.00)}{0.000004} - \underset{(-0.71)}{0.040}\Delta base_{t-1} \tag{5.8}$$

$$\mu_t = \underset{(-0.02)}{-0.0003} + \underset{(0.21)}{0.038}\Delta v_{t-1} \tag{5.9}$$

These results indicate neither causal relationship between Δv_t and $\Delta base_t$ and suggest there is merely a simple negative correlation between both variables.

V . V IMPLICATIONS OF FISCAL POLICY

When considering equation (5.4) and the dynamic equation of (5.5) in terms of expansionary fiscal policy, it shows up fiscal stimulation univocally has negative effects on short- as well as long-run behavior of velocity. Reconsidering the importance of velocity behavior to our economy, it would be rather interesting to investigate whether there exists a causal linkage from growth in per capita public debt to velocity growth.

Whereas the optimal specification for Δv_t over the period 1915-2009 has already been determined as MA(1), it turned out that an MA(1) specification fits best $\Delta debt_t$ as well:

$$\Delta debt_t = \underset{(2.13)}{0.045} + \eta_t + \underset{(27.52)^*}{0.95}\eta_{t-1} \tag{5.10}$$

The residual series are specified below in equation (5.11) and (5.12), where ε_t refers to the residuals from the MA(1) model for Δv_t, and η_t to the estimated residuals of growth in public debt per capita:

$$\varepsilon_t = \underset{(0.74)}{0.004} - \underset{(-2.88)^*}{0.15}\Delta debt_{t-1} \tag{5.11}$$

$$\eta_t = \underset{(-0.09)}{-0.001} + \underset{(0.75)}{0.14}\Delta v_{t-1} \tag{5.12}$$

According the Granger Causality concept, there is a one-way negative causal linkage detected from growth in public debt per capita to velocity growth.[6] This result implies a serious drawback for pursuing fiscal policy, as it negatively affects our economy in a direct and an indirect sense. Expansionary fiscal policy appears to lower velocity growth, and lower velocity growth in turn Granger causes lower real output growth – this is the direct negative effect. The indirect effect is to be found in the obstruction that low velocity values entail for pursuing effective monetary policy. In this sense, expansionary fiscal policy appears to be gradually undermining the effectiveness of monetary policy.

[6] To ascertain there is no disturbing causal linkage between expansionary fiscal and monetary policy, the Granger Causality concept has been applied to the mutual behavior of these variables and is readily documented in Appendix IV.

SECTION VI CONCLUSIONS AND POLICY IMPLICATIONS

US Government has been acting determinedly by heavily pursuing fiscal and monetary policy in order to sustain economic growth during the aftermath of the financial crisis. Except for the biggest fears that appear to have left the marketplace, the results so far aren't to be called satisfactory with unemployment still balancing at a 10% level and economic growth effects already being over the hill. Although government appeared to have changed its focus in fighting the crisis exclusively to monetary policy, recent remarks by the Fed are pointing at the need to accompany their efforts with additional fiscal policy. In the heyday of economic stimulation by US Government, this study makes a call for the velocity of income (*V1*). The pro-cyclicality of velocity together with straightforward reasoning within the context of the quantity equation, made a case for the pursuit of high velocity values. With a Granger causal linkage from velocity to real output growth, the importance of velocity behavior has been formally derived; whereas additional relevance can be extracted from its part in the effectiveness of monetary policy. A satisfactory long- and short-run equation estimated velocity behavior during the past century, yielding an important role for previous contributions in empirical literature. Most remarkable however is the apparent negative effect of public debt creation on the behavior of velocity, especially since public debt turned out to form a negative one-way causal relationship with velocity. Within the context of velocity behavior, this result implies a serious drawback for pursuing fiscal policy. Expansionary fiscal policy should be discouraged not only because it lowers velocity values that in turn are Granger causing real output losses, but also because it influences output growth indirectly in a negative sense by obstructing the effectiveness of monetary policy. Hence a policy implication now would be to gradually reverse fiscal policy in terms of public debt creation, since it negatively affects velocity behavior which in turn limits real output growth and hinders the effectiveness of government's latest trump of monetary policy.

Realizing inference merely based on velocity would be myopic, I propose velocity as an economic indicator in the sense of the information variable approach. Fed could consider it as one of the clues in assessing intermediate targets as well as long-run objectives, given its importance to both the effectiveness of short-term monetary policy as well as its implications for real output growth. Nonetheless statistical results based on a 1 percent significance level combined with the apparent implications of this study should encourage further research on the topic in order to examine robustness, *e.g.* in considering the relationship between public debt and velocity more carefully to determine whether the negative relationship is more outspoken in the case of excessive debt creation, or another interesting study would be to extend the scope to other countries.

VII APPENDICES

VII . I APPENDIX I – SOURCE OF VARIABLES

v_t The logarithm of *V1*. *V1* is calculated for the period 1915-1958 using annual nominal GNP and *M1* data as provided by Balke, N.S., and Gordon, R.J. (1986), ‘’Appendix B: Historical Data,’’ In: *The American Business Cycle: Continuity and Change, NBER Studies in Business Cycles*, ed. Gordon, R.J., Chicago: University of Chicago Press (henceforth ‘’NBER US historical data’’). For the period 1959-2009 both nominal GNP and *M1* data are originated from IMF international financial statistics, whereas *M1* data are adjusted for sweep accounts as of 1994 by using data from the Division of Monetary Affairs of the Board of Governors of the Federal Reserve System (online available).

R_t *M2* Minus Own Rate data – to proxy the interest rate on near monies – are online available at the Federal Reserve Bank of St. Louis. Corporate bond yield annual data over 1915-1983 are derived from NBER US historical data, supplemented by Moody's Seasoned Baa Corporate Bond Yield from the Board of Governors of the Federal Reserve System for the period 1984-2009.

y_t The logarithm of real GNP. Real GNP is derived from NBER US historical annual data for the period 1915-1958. Concerning the period 1959-2009, data are originated from the US Department of Commerce: Bureau of Economic Analysis.

$bank_t$ The logarithm of the annual percentage of currency and notes in *M2*. Currency in circulation is originated from the Board of Governors of the Federal Reserve System. *M2* over the period 1915-1958 is derived from NBER US historical data, whereas the period 1959-2009 is covered by data from IMF international financial statistics.

$soph_t$ The logarithm of the percentage of total non-bank financial assets over total financial assets. Annual data on this variable covering the period 1915-1960 are available via Bordo and Jonung (1990), whereas this variable is proxied over the period 1961-2009 by the logarithmic percentage of credit market assets in currency and checkable deposits – all in amounts held by non-financial institutions. Annual data regarding the constructed variable are originated from the Board of Governors of the Federal Reserve System.

$base_t$ The logarithm of the percentage of base money in nominal GNP. Base money over the period 1915-1958 is derived from NBER US historical annual data, whereas the period 1959-2009 is covered by annual data from IMF international financial statistics.

$debt_t$ The logarithm of per capita public debt. Gross federal debt annual data for the period 1915-1945 are online available at the US Treasury, whereas the annual 1946-2009 data are originated from The White House: Council of Economic Advisors. Annual population data over the period 1915-1952 are derived from the US Department of Commerce: Census Bureau, whereas 1953-2009 annual data are originated from the Federal Reserve Bank of St. Louis.

$gold_t$ The logarithm of the real per ounce gold price in US $. Annual data for the London PM fix are online available at The World Gold Council.

$WEIGHT_t$ This variable concerns the annual share of high velocity expenditures in total expenditures and is constructed over the period 1929-2009. Nominal GDP is derived from BEA, National Economic Accounts. Federal Government current expenditures, the value of imports of goods and services, personal consumption expenditures on nondurable goods, and personal consumption expenditures on services are all originated from the US Department of Commerce: Bureau of Economic Analysis.

$M1VOL_t$ This variable represents annual differences in the volatility of *M1*. In this regard, volatility has been calculated as the standard deviation of the logrelative returns in *M1*. *M1* over the period 1915-1958 is derived from NBER US historical data, whereas the period 1959-2009 is covered by data from IMF international financial statistics.

Variable	P-value unit root test in levels (ADF test statistic in parentheses)	P-value unit root test in first differences (ADF test statistic in parentheses)
v_t	0.76 (-0.99)	0.00 (-7.16)
R_t	0.31 (-1.95)	0.00 (-7.32)
y_t	0.90 (-0.43)	0.00 (-5.37)
$bank_t$	0.40 (-1.76)	0.00 (-6.53)
$soph_t$	0.67 (-1.20)	0.00 (-7.49)
$base_t$	0.56 (-1.45)	0.00 (-6.51)
$debt_t$	0.30 (-1.97)	0.00 (-5.75)
$gold_t$	0.34 (-1.88)	0.00 (-6.84)
$WEIGHT_t$	0.00 (-3.98)	0.00 (-7.14)
$M1VOL_t$	0.00 (-7.09)	0.00 (-10.52)

Test Results Regarding Stochastic Assumptions on the Disturbances of Equation (5.5):

Null Hypothesis	Test	P-value
Normality	Jarque-Bera	0.71
No autocorrelation	B-G Serial Correlation LM test	0.08
Constant variances	White test	0.11
No misspecification	Ramsey RESET test	0.29

$$\Delta v_t = \underset{(-2.57)}{-0.009} + \underset{(3.28)^*}{0.011\Delta R_t} + \underset{(6.04)^*}{0.52\Delta y_t} + \underset{(3.14)^*}{0.18\Delta bank_t} - \underset{(-5.20)^*}{0.16\Delta base_t} + \underset{(5.94)^*}{0.23\Delta base_{t-1}}$$

$$-\underset{(-4.76)^*}{0.21\Delta debt_t} + \underset{(3,19)^*}{0.60\Delta WEIGHT_t} + \underset{(3.78)^*}{0.32\Delta M1VOL_t} + \underset{(5.94)^*}{0.50\Delta v_{t-1}} - \underset{(-5.82)^*}{0.40\varepsilon_{t-1}} \qquad (5.5)$$

As already specified in the main text, the AR(1) model for $\Delta base_t$ and the MA(1) model for $\Delta debt_t$ are respectively:

$$\underset{}{\Delta base_t} = \underset{(0.59)}{0.009} + \underset{(3.41)^*}{0.34\Delta base_{t-1}} + \mu_t \tag{7.1}$$

$$\Delta debt_t = \underset{(2.13)}{0.045} + \eta_t + \underset{(27.52)^*}{0.95\eta_{t-1}} \tag{7.2}$$

The corrected residuals μ_t and η_t can subsequently be used to investigate Granger Causality linkages between these variables. The Granger Causality test results are specified in below mentioned equations (7.3) and (7.4):

$$\mu_t = \underset{(-0.18)}{-0.002} + \underset{(0.62)}{0.045\Delta debt_{t-1}} \tag{7.3}$$

$$\eta_t = \underset{(0.01)}{0.0001} - \underset{(-0.40)}{0.043\Delta base_{t-1}} \tag{7.4}$$

As indicated by highly insignificant *t*-values, lagged values of either variable don't contribute in predicting the other. These Granger Causality test results clearly indicate there is no causal relationship detectable between $\Delta base_t$ and $\Delta debt_t$ over the period 1915-2009.

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