

Nicolini, Juan Pablo

Article

Money demand: A simple look at some data

Aussenwirtschaft

Provided in Cooperation with:

University of St.Gallen, School of Economics and Political Science, Swiss Institute for International Economics and Applied Economics Research

Suggested Citation: Nicolini, Juan Pablo (2017) : Money demand: A simple look at some data, Aussenwirtschaft, ISSN 0004-8216, Universität St.Gallen, Schweizerisches Institut für Aussenwirtschaft und Angewandte Wirtschaftsforschung (SIAW-HSG), St.Gallen, Vol. 68, Iss. 1, pp. 29-49

This Version is available at:

<https://hdl.handle.net/10419/231245>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Money demand: A simple look at some data

Juan Pablo Nicolini¹

Federal Reserve Bank of Minneapolis and Universidad Di Tella

In this paper, I offer a non-technical summary of recent research that focuses on the stability properties of real money demand. I first describe a simple workhorse model that serves as a conceptual framework for organizing the data and guiding the empirical analysis. Then, by using simple plots, I argue that the implications of the simple theory are remarkably robust over time. I do this for some developed economies with a history of relatively low inflation and for two developing economies that experienced severe hyper- inflation. Finally, we point toward several failures in this research and discuss avenues for future work.

JEL codes: E40, E41, E42

Key words: inflation, monetary aggregates, money demand

1 Introduction

Up until the international financial crisis of 2008, most economists and central bankers in developed economies had come to doubt the usefulness of the measures of monetary aggregates in the conduct of monetary policy. Thus, over the last decades, there was a surge in the number of central banks that explicitly or implicitly followed inflation-targeting policies with a short-term market-determined interest rate as the monetary policy instrument, paying essentially no attention to the evolution of monetary aggregates. The result has clearly been remarkable: inflation, as we understood it in the 1970s and 1980s, has been defeated. This has been the case both for developed economies that saw double-digit inflation rates for a few years in the late 1970s and early 1980s, and for emerging economies that experienced hyperinflation – and everything in between – during the same years.

But 2008 changed that perception. By the end of that year, most central banks in developed economies lowered their policy rates to their effective lower bound, and most believed that move was not accommodative enough. Faced with that dilemma, a (seemingly) new idea emerged: additional accommodation could be achieved by actively changing the central bank balance sheet. And thus a new term – quantitative easing – was coined.

The idea of quantitative easing was not new, of course; it was just out of fashion. We (meaning macroeconomists who are old enough) were trained in monetary theory using money rules rather than interest rate rules, and were also exposed to

¹ I thank my coauthors Luca Benati, Robert E. Lucas Jr., and Warren Weber, as well as participants at the conference “What can monetary economics say about long-run developments?”, organized by the Swiss National Bank and *Aussenwirtschaft* on 7 July 2017 in Zurich. All remaining errors are my own. The views expressed herein are those of the authors and not necessarily those of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.

the dimensions along which both are equivalent. Money rules describe how the balance sheet of a central bank evolves over time. Those old-fashioned, simple theories emphasized the size of the balance sheet rather than its components – a feature of some of the programs actually implemented after 2008. And that policy action not only had a name (“changes in the money supply”) but also a nickname (“helicopter drops”). Paradoxically, the single case in which the effect of balance sheet changes on the equilibrium was ambiguous was precisely when the interest rate was at the lower bound – hence the term “liquidity trap.”

The decision to change the focus from the policy rate to the balance sheet had no theoretical justification within the main theoretical paradigm that was dominant at the time, since monetary aggregates (no matter how narrow or broad) conveyed no useful information, much less information about their composition. Ben Bernanke, then Chair of the Federal Reserve System, justified the quantitative easing policies he implemented by arguing, “[t]he problem with QE is it works in practice, but it doesn’t work in theory.”²

One of the reasons behind the move away from monetary aggregates was the breakdown, starting around the 1980s, of the previously identified stable relationship between monetary aggregates, GDP, and interest rates in the United States. Indeed, remarkably stable relationships that had stood the test of time since 1900 (MELTZER, 1963; LUCAS, 1988) broke down after eight decades (FRIEDMAN and KUTTNER, 1992). In this paper, I review recent research that aims at explaining that breakdown in the United States (LUCAS and NICOLINI, 2015) as well as research that shows that breakdown to be specific to the United States.

The evolution of monetary policy in the next few years seems to be heterogeneous across countries. Although the Federal Reserve seems to be engaged in a process to move away from the lower bound on policy rates and to start normalizing its balance sheets (see the July 2017 Federal Open Market Committee statement), other central banks, such as the European Central Bank and the Bank of Japan, seem to maintain the hope that their quantitative easing policies are still effective. The view we take in this research agenda is that the starting point for understanding the effect of changes in the outside supply of liquid assets is to understand the demand coming from the private sector. In what follows, we summarize recent efforts in this direction. By reviewing recent work on this topic, we argue that long-run demand is alive and well.

Section 2 summarizes a simple inventory theoretical model of money demand. In Section 3, we briefly summarize the evidence for the United States in the last

2 ROBIN HARDING, “US quantitative measures worked in defiance of theory,” *Financial Times*, 13 October 2014 (<https://www.ft.com/content/3b164d2e-4f03-11e4-9c88-00144feab7de>).

decades and explain the key role of regulation in explaining the evolution of monetary aggregates, following LUCAS and NICOLINI (2015). In Section 4 we review the evidence for other four developed economies, and in Section 5, two other cases that exhibited hyperinflation, following BENATI, LUCAS, NICOLINI and WEBER (2017), as well as some failures. The evidence we provide shows the remarkable stability of real money demand. A final section concludes, pointing to several caveats to be addressed in future research.

2 The model

A representative household has preferences over final consumption,

$$E_0 \sum_{t=0}^{\infty} \beta^t U(x_t),$$

with standard properties and has an endowment every period of one unit of time. The technology to produce final consumption is given by

$$y_t = x_t = z_t l_t,$$

where l_t is time devoted to production and z_t the exogenous stochastic process. The remaining amount of time $1 - l_t$ will be used to carry out transactions. As in the models of BAUMOL (1952) and TOBIN (1956), the representative agent chooses the number n_t of “trips to the bank” in every period.

Transactions require the use of money, so we impose the following cash-in-advance constraint to the agent:

$$\kappa P_t x_t \leq M_t n_t, \tag{1}$$

where κ is a constant. The cost of making trips to the bank is given by a differentiable and increasing function,

$$\theta(n_t, v_t).$$

Then, equilibrium output is given by

$$x_t = z_t (1 - \theta(n_t, v_t)). \tag{2}$$

At the beginning of each period, an agent begins with nominal wealth W_t , which can be allocated to M_t , interest-bearing bonds, B_t , or state-contingent assets $Q_t(s_t + 1)$. Let $P_t^Q(s_t + 1)$ be the price of an Arrow-Debreu security, bought at t , that pays off one unit of money in state $s_t + 1$. The agent's allocation of these assets is then restricted by

$$M_t + B_t + \sum_{s_{t+1}} Q_t(s_{t+1}) P_t^Q(s_{t+1}) \leq W_t. \quad (3)$$

We treat the gross nominal return on short-term bonds, $(1 + i_t)$, as an exogenous process determined by monetary policy.³ The assumption that the short-term interest rate is determined by policy implies restrictions on the behavior of the growth rate of the money supply, as is well known.

We can now determine the agent's wealth next period, contingent on the actions taken in the current period and the realization of the exogenous shock s_{t+1} . In nominal units, this is

$$\begin{aligned} W(s_{t+1}) \leq & M_t + B_t(1 + i_t) + Q_t(s_{t+1}) \\ & + [1 - \phi(n_t, \nu_t)] z_t P_t + \tau_t(s_{t+1}) P_t(s^{t+1}) - P_t x_t, \end{aligned} \quad (4)$$

where $\tau_t(s_t + 1)$ is the real value of the monetary transfer the government makes to the representative agent in state $s_t + 1$.

Note that this budget constraint makes explicit that the nominal return on money is zero. This is not necessarily the case (as, for instance, in the United States since the early 1980s). It is precisely a change in regulation that is behind the apparent breakdown of real money demand in that country, precisely during those years, as Lucas and Nicolini (2015) argue. This discussion is futile in the abstract. It can only be given substantive content once we relate the objects in the theory to specific assets in the data. For the purposes of this paper, as we argue below, assuming that money pays no interest seems to be the reasonable thing to do.

The problem of the agent is to maximize utility subject to the cash-in-advance constraint (1) and the budget constraints (3) and (4). It is straightforward to show that the optimal conditions of this problem, combined with the equilibrium condition (2) imply a solution for n_t as a function of the nominal interest rate:⁴

³ When policy is described as a sequence of interest rates, there may be indeterminacy of the price level. Real money balances will, however, be unique. We ignore issues regarding the determination of the price level in this paper.

⁴ For details, see BENATI, LUCAS, NICOLINI and WEBER (2017).

$$i_t = n_t^2 \frac{\theta_n(n_t, \nu_t)}{1 - \theta(n_t, \nu_t)}.$$

Money demand is obtained by using (1) on the solution above:

$$\frac{M_t}{P_t x_t} = \frac{\kappa}{n_t(i_t, \nu_t)}. \quad (5)$$

The first feature of the solution we would like to emphasize is that $n_t(i_t, \nu_t)$, and therefore real money balances to output, are invariant to changes in total factor productivity, z_t . Thus, if productivity exhibits positive trend, as must be the case in order for the economy to grow, this trend is not inherited by the ratio of money to output. In other words, the theory implies that the income elasticity of real money demand is equal to 1. In what follows, we therefore look only at the ratio of money balances to output.⁵

The specific functional form of real money demand thus depends on the form of the cost function θ . For the purposes of this paper, we will assume the cost function to be⁶

$$\theta(n_t, \nu_t) = \gamma \nu_t n_t^\sigma.$$

In this case, the solution becomes

$$n_t^{\sigma+1} \frac{\sigma \gamma \nu_t}{1 - \gamma \nu_t n_t^\sigma} = i_t.$$

The term $\gamma \nu_t n_t^\sigma$ measures the cost, in terms of lost output, of nominal interest rates higher than zero. Estimates of this cost for relatively low interest rates are low – below 2% of output. Thus, if we use the approximation $1 - \gamma \nu_t n_t^\sigma \approx 1$ and take logs in the solution, we obtain

$$\ln \sigma \gamma + \ln \nu_t + (\sigma + 1) \ln n_t = \ln i_t,$$

which delivers the well-known log-log specification. The Baumol-Tobin particular case obtains when the cost is linear on the number of trips to the bank, so $\sigma = 1$, so the elasticity becomes 1/2. Replacing n_t using equation (5), we obtain

5 Below we argue that the relationship between money balances to output and the short-term interest rate is stable for periods that cover several decades. This stability is therefore evidence in support of the unit income elasticity.

6 For other specifications that deliver alternative functional forms, see BENATI, LUCAS, NICOLINI and WEBER (2017).

$$\frac{\ln \sigma \gamma}{\sigma + 1} + \ln \kappa + \ln \nu_t - \frac{1}{\sigma + 1} \ln i_t \simeq \ln \frac{M_t}{P_t x_t},$$

so if we let

$$m_t = \frac{M_t}{P_t x_t}, \quad \alpha = \frac{\ln \sigma \gamma}{\sigma + 1} + \ln \kappa \quad \text{and} \quad \eta = \frac{1}{\sigma + 1}$$

we obtain

$$\ln m_t \simeq \alpha - \eta \ln i_t + \ln \nu_t. \quad (6)$$

3 The case of the United States

In this section, we review the evidence for the United States.⁷ The Glass-Steagall Act, passed in 1933 in the aftermath of the Great Depression, included a chapter called “Regulation Q” that, among other things, imposed very tight upper limits on the interest rates that banks could pay for demand deposits. For all practical purposes, we will assume that banks did not pay interest on deposits. Thus, it seems natural to identify the monetary aggregate in equation (5) with M1, which includes currency and demand deposits. This was indeed the choice made by MELTZER (1963) and later pursued by LUCAS (1988).

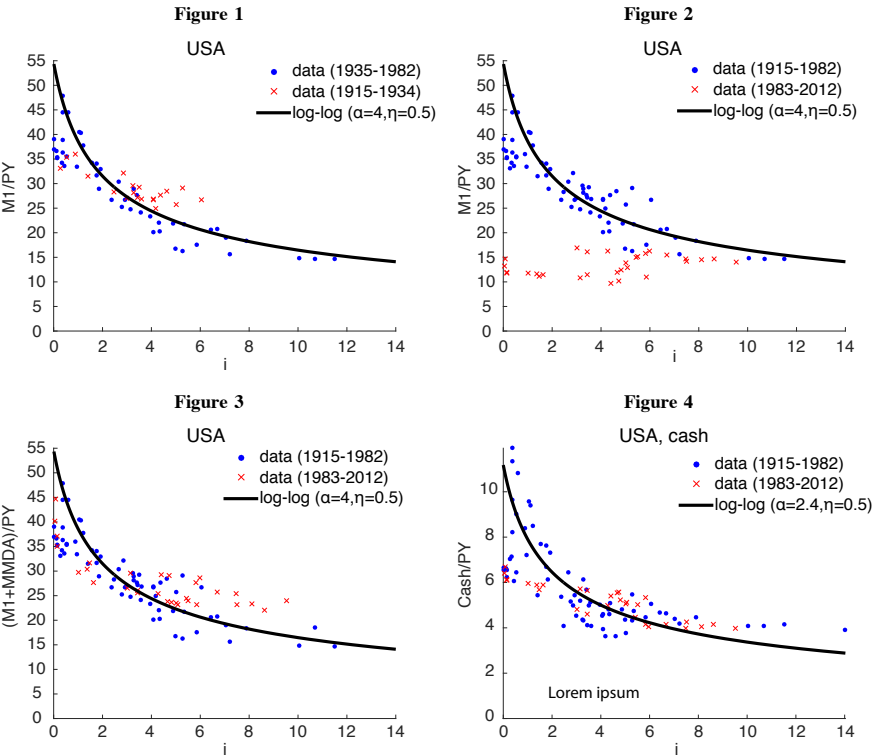
In Figure 1, we plot a curve corresponding to equation (6), choosing the value of the level parameter, κ , so that the curve takes the value 0.25 when the short-term interest rate is 6% for the Baumol-Tobin case of an elasticity equal to 1/2. In the same figure, we plot the ratio of M1 to nominal GDP against the short-term nominal interest rate, for the period 1935 to 1982 (blue dots), together with the data for the period 1915 to 1934 (red crosses).

As can be seen, the simple theory captures the behavior of the data remarkably well. The figure also plots the curves for the cases of $\sigma = 1/2$ and $\sigma = 2$, which correspond to elasticities of 2/3 and 1/3, respectively. There seems to be no noticeable difference between the two sub-periods in spite of the different prevailing regulations. The most likely reason is that from 1915 to 1934, short-term interest rates were relatively low, so if deposits did pay interest, the rates were very close to zero in any case. For this same reason, it is also likely that

⁷ For details, see LUCAS and NICOLINI (2015).

Regulation Q was not binding from 1937 to the late 1960s, since the short-term interest rate was below 5% during that entire period.

The increasing inflation and interest rates experienced during the 1970s, however, changed the circumstances that ultimately led to the regulatory changes. By 1980, banks were allowed to issue negotiable orders of withdrawal (NOW) accounts, and in 1982 they were allowed to issue money market deposit accounts (MMDA), both of which are essentially checking accounts that could pay interest.⁸ The NOW accounts were included in the M1 aggregate, but the MMDA were not.⁹



8 There are some differences between the newly created accounts and the existing demand deposits that still could not pay interest, but we will ignore those differences for the purposes of this discussion; see LUCAS and NICOLINI (2015) for details.

9 They were classified as savings accounts.

In Figure 2, we plot the same curve corresponding to equation (6) as in Figure 1, but including the data from 1983 onward. The data from 1915 to 1982 are indicated with blue dots, while the data from 1983 onward are indicated with red crosses. Figure 2 is what economists have in mind when they argue that money demand is no longer a stable relationship.

The purpose of LUCAS and NICOLINI (2015) is to argue that, for all practical purposes, MMDAs are very close substitutes for NOW accounts, and they develop a theory that implies that the real measure of money should include those newly created deposits. In Figure 3, we show the effect of adopting that view.¹⁰ Figure 3 is what we have in mind when we say that money demand is “as stable as ever”.

Thus, in a nutshell, we argue that the regulatory changes in the early 1980s changed the instruments with which agents made transactions and that, once those changes are taken into account, the money demand relationship is alive and well.

A second implication of the theory in LUCAS and NICOLINI (2015) is that the newly created deposits were very good substitutes for the standard demand deposits, but not good substitutes for cash.¹¹ Figure 4 shows the ratio of cash to output from 1915 to 2015, with the data between 1915 and 1982 in blue dots and the data since 1983 in red crosses. The figure shows no instability in the demand for cash. As implied by the theory, the regulatory changes in the early eighties did not affect the demand for cash.

4 A few other successful cases with moderate inflation rates

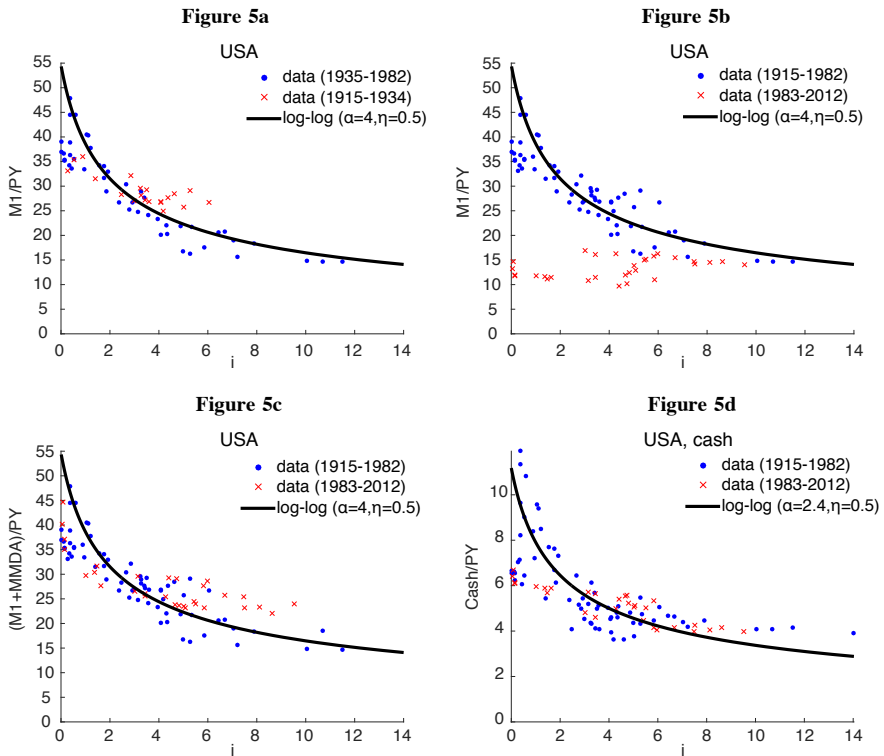
In this section, we review the evidence for four other developed economies: Australia, Canada, the United Kingdom and New Zealand. This is not a randomly selected sample. In BENATI, LUCAS, NICOLINI and WEBER (2017), we review the evidence on long-run money demand, using cointegration analysis, for a set of over 30 countries covering sample periods that span from a century to several decades. In that paper, we show that there is strong evidence for a money demand relationship for many countries, but not for all. The four economies selected here belong to the group for which the relationship can clearly be established with formal cointegration tests. Thus, this sample is by no means to be taken as a representative one. The objective of this paper is to argue that the notion that money demand became unstable is certainly not a generally established fact. We believe that this particular sample makes a compelling case. The question of

¹⁰ As in Figures 1 and 2, the data for the sub-periods before and after 1982 are depicted with blue dots and red crosses.

¹¹ For details on the theoretical model, see LUCAS and NICOLINI (2015).

what explains the behavior of money demand in other countries is left for future research.

Figures 5a to 5e show the equivalent to Figure 1 for the United States, as well as for four new countries considered, for the periods for which we have data.¹² Given the change in regulation in the 1980s that we just mentioned, we use just cash for the United States, which was barely affected by those changes in regulation. For the other four countries, we use M1, which adds demand deposits to cash. In all cases, we chose the parameter α^j so the curve goes through the average of the data; but in all cases, we used the Baumol-Tobin case and set the elasticity equal to 1/2.



12 A detailed description can be found in Appendix 1 in BENATI, LUCAS, NICOLINI and WEBER (2017).

We find the evidence presented in Figure 5 remarkable. We only had one degree of freedom for each country, similar to a fixed country effect, that was chosen to match averages – the five values for κ^j . The slope, in all cases, is the one implied by the theory, under the assumption that the cost of making transactions is a linear function of the number of transactions. It is hard to find an alternative theory in economics that can deliver this close of the match to the data for periods that range between an entire and half of a century, and for so many countries. The period includes, for some countries, a Great Depression and a World War. And we only used a fixed country effect.

In Figures 6a to 6e, we present the same evidence but show the time series for the interest rate and the ratio of money balances to output. In each case, the time period corresponds to the available data. In each chart we added the theoretical counterpart of the money-to-output ratio, using equation (6). In this case, however, we allowed for two degrees of freedom per country. In particular, we allowed for country-specific values for the elasticity, σ^j . To calibrate the values of κ^j , σ^j , we used ordinary least squares for data after 1960. The reason we ignored data before 1960 in the calibration is apparent in Figures 6, and it is why we are showing these time series. To be specific, consider the case of the United States (Figure 6a). The dashed red line is the theoretical curve, and the solid blue line is the data. The two periods where the discrepancies become large are, precisely, the Great Depression and World War I. There are obvious reasons for these departures, which are beyond the economic relationships studied in the theoretical model. The effect of the war is also seen clearly from the rest of the figures. Recall that in Figure 5 we included the data corresponding to the Depression and the war years, which makes Figure 5 even more remarkable.

4.1 The stability of money demand from the 1960s

The previous discussion suggests that an analysis of the post-1960s data may be of additional interest, since there are no major events that can affect the ratio of money to output for reasons other than those considered in the theory.

This does not mean that other changes – either regulatory (as was the case in the United States) or technological (transactions today barely resemble those of a few decades ago) – did not take place. Rather, the question is whether these changes are important enough to blur the effect considered in the theory. A glimpse at Figure 6 suggests that the theory performs well. Addressing this question in more detail is the purpose of this section.

Figure 6a
USA

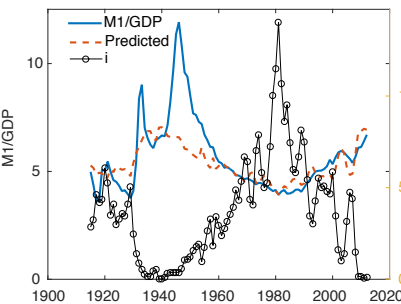
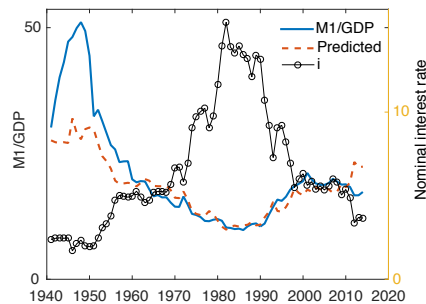


Figure 6b
Australia



Canada

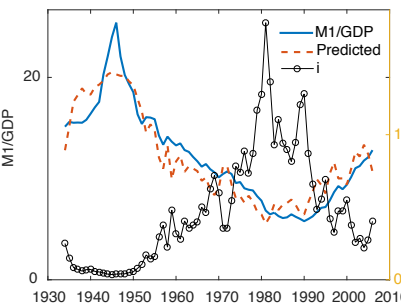


Figure 6c

Great Britain

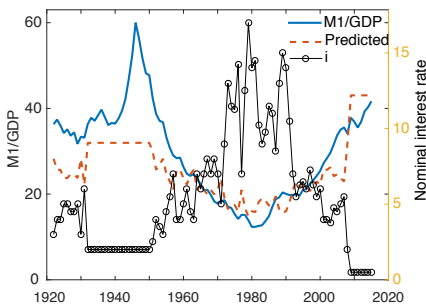


Figure 6d

New Zealand

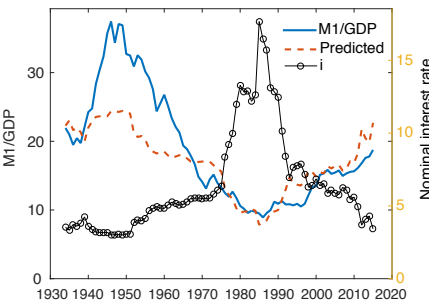


Figure 6e

Figure 7a

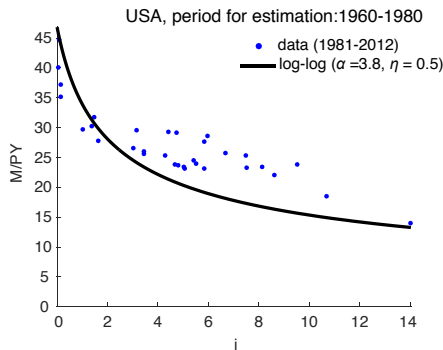


Figure 7b

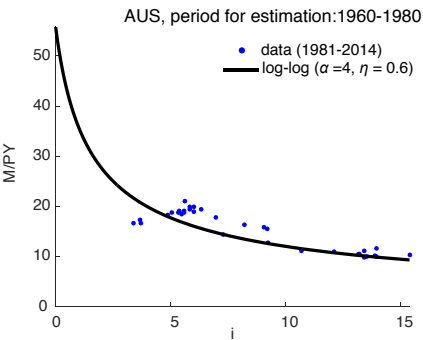


Figure 7c

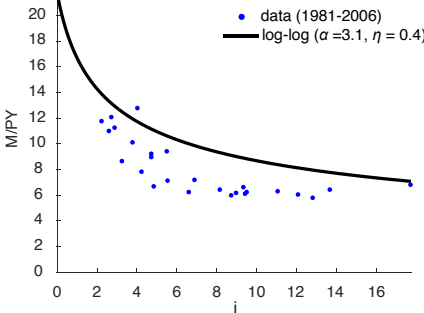


Figure 7d

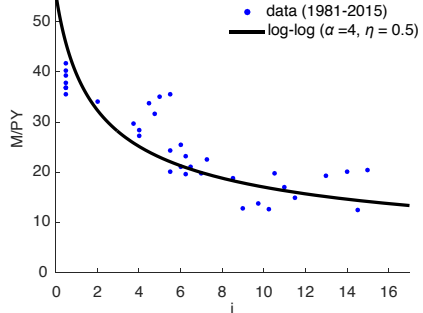
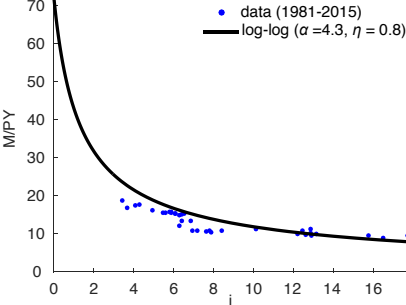


Figure 7e



Note that focusing on the period that starts in 1960 has the advantage of isolating the discussion from major events, but it also offers enough variation on nominal interest rates so as to see the forces of the theory operating. As can be seen in Figure 6, in all five countries (and in many other countries as well) the interest rates were low at the beginning, went up considerably until the 1980s, and then went down again to reach values as low as, or even lower than, those experienced in the 1960s.

To illustrate in more detail the stability of the theoretical relationship derived in (6), we proceed as follows. First, we calibrate the parameters κ^j , σ^j by minimizing the sum of squared errors, using ordinary least squares with data from 1960 to 1980 for each country. Then we plot the so calibrated curve with the data from 1981 onwards. Figures 7a to 7e depict the results, which are quite remarkable (recall that the curves were not calibrated to the data plotted, but rather to data from the previous two decades).

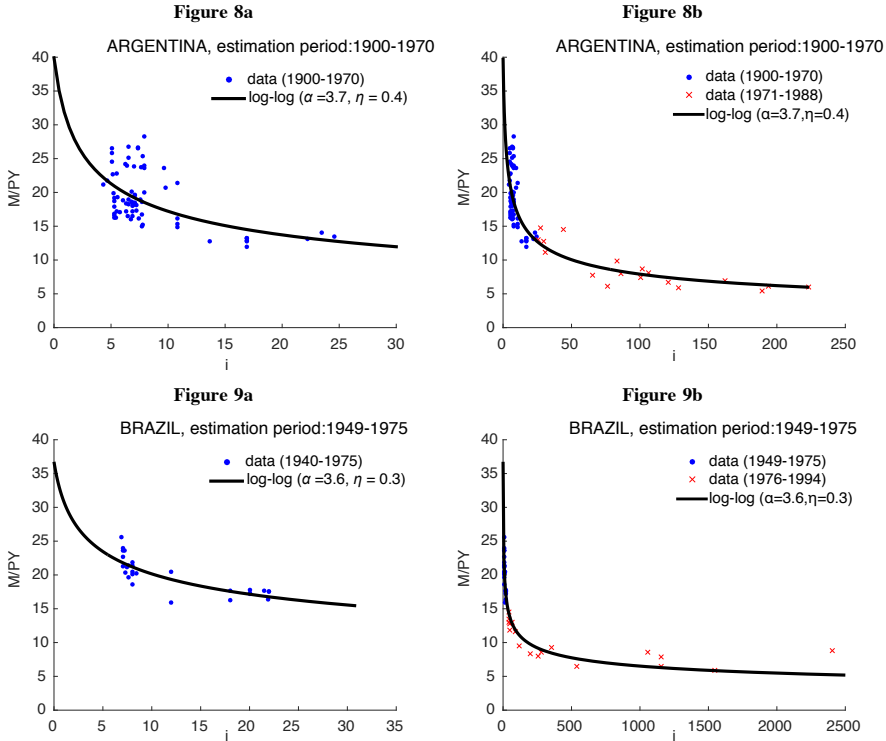
5 Two cases of hyperinflation

The cases studied above are all examples of countries that went through moderate inflationary periods in the 1970s and 1980s. But there are many countries that went through extreme hyperinflation, and some of these were covered in the analysis in Benati et. al. (2016). Here, we review two cases – Argentina and Brazil – using the same logic of that in the previous case. In both cases we use M1 as a measure of money.¹³ The data are also from BENATI, LUCAS, NICOLINI and WEBER (2017).

For Argentina, we calibrated the parameters κ^j , σ^j in the same way as before, using data from 1900 to 1970. The interest rate range was from below 5% to almost 30% during this period. In Figure 8a we plot the calibrated curve and the data. Then, in Figure 8b, we plot the same calibrated curve but extended to cover a range for the interest rate up to 250% (the maximum during the hyperinflation period). The blue dots represent the data from 1900 to 1970, the same data from Figure 8a. The red crosses represent the data from 1971 to 1988, a period of very high and increasing interest rates. It is important to emphasize that the theoretical curve in Figure 8b is the same as that plotted in Figure 8a – no information after 1970 has been used to calibrate it. For Brazil, we calibrated the parameters using data from 1949 to 1975. The interest rate went from 5% to around 25% during this period. In Figure 9a we plot the calibrated curve and the data. As before, in Figure 9b we extend the period to 1994, in order to include the hyperinflation

¹³ This decision is not necessarily the most reasonable since, during some periods, the banking sector (at least in Argentina) created money-like deposits that were included in M1 by the central bank and which paid interest.

period and blue dots represent the data from 1949 to 1975 and the red crosses represent the data from 1976 to 1994.



The exercises performed in Figures 8 and 9 are reminiscent of the work of CAGAN (1956), applied to the hyperinflations of the interwar period. We believe, however, that these data present even stronger evidence of stability in real money demand, since the data during the periods of very high inflation conform very well with a curve that was calibrated using a previous period of much more moderate inflation rates.

A caveat is in order. The data after the successful stabilizations – in 1991 in Argentina and in 1995 in Brazil – do not conform to the curve. While nominal interest rates went down dramatically within a year in both countries, real money balances took almost a decade to return to the theoretical curve in Argentina, and they have yet to do so in Brazil. We are currently exploring modifications to the theory above to try to account for that behavior.

As we mentioned above, the countries we analyzed here are not a randomly selected sample. Rather, they are part of the set for which we do find strong evidence of a stable long-run money demand. In Figures 10a to 10d, we present the cross plot between the interest rate and the ratio of M 1 to output for four countries, together with a theoretical curve like the one in (6), where we set $\sigma^j = 1$ and choose \mathcal{H}^j to have the curve cross the point consisting on the averages for the two variables. The four countries are Germany, Denmark, South Africa, and Norway. As can be seen, there is no relationship between the data and the theory.

Figure 10a

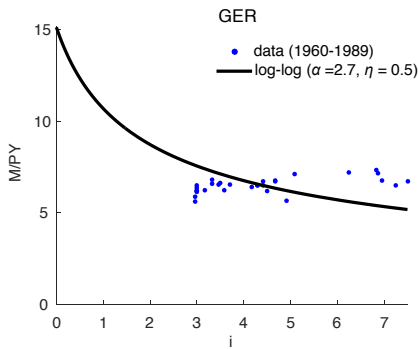


Figure 10b

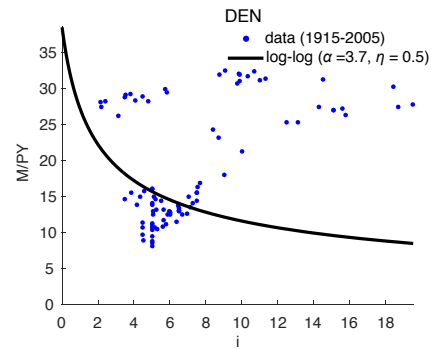


Figure 10c

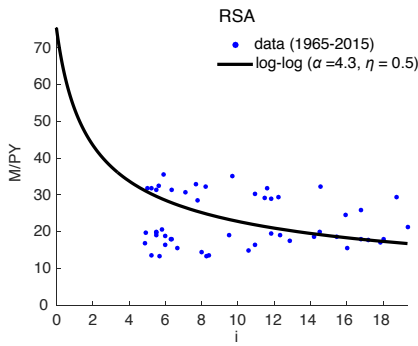
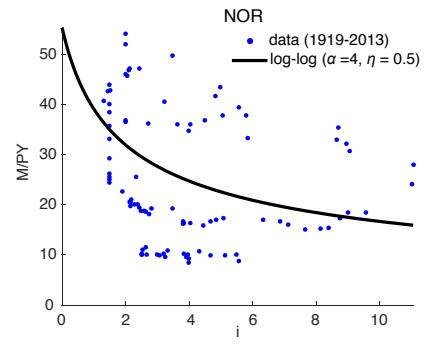


Figure 10d



6 Conclusions

In this paper, we reviewed evidence that very strongly confirms a stable relationship between the ratio of money to output and a short-term interest rate for several countries and many different periods, but not for all periods in those countries (the exceptions are the post stabilization years in Argentina and Brazil) and not for all countries (our examples are Germany, Denmark, South Africa, and Norway).

At the same time, we also argued that in countries in which the relationship appears to break down (as in the United States), changes in regulation can explain those apparent failures.

The reason is that the state of both regulation and technology in the financial sector affects the decisions of agents regarding which particular asset they use for a given transaction. For decades, a simple monetary aggregate, M1, exhibited remarkable stability in the United States (until 1980) and, quite remarkably, it still does so for Australia, Canada, New Zealand and the United Kingdom. Early monetarists used M1 based on casual observation on what were the most common payment instruments at the time, without using theory to guide the decision. In a sense, we find it remarkable that one can identify stable money demand relationships in so many (but not all) countries and for long periods of time, given that the object that we use to measure money has not ever been revised. Until very recently, no attempt has been to use theory to guide the choices in the data. An exception we celebrate is the model of FREEMAN and KYDLAND (2000), which is based on work by PRESCOTT (1987), and which was used by LUCAS and NICOLINI (2015) to precisely argue that theory can and should be used to understand how regulation (and potentially technological changes) can bring about changes in the supply of money. This research agenda is recent, and we have only begun to work with alternative models. But we believe that this is a promising avenue to understand several of the puzzling examples, some of which are mentioned in this paper.

Does money demand research have any implications for policy? One might be tempted to argue that the answer is no, since, at least until the outbreak of the international financial crisis of 2008, central banks in many countries had been extremely successful in controlling inflation without even paying attention to the evolution of monetary aggregates. We do agree that this evidence is conclusive: inflation-targeting regimes that are based on controlling short-term interest rates can manage to keep inflation low and not very volatile *once inflation is already low and under normal circumstances*. The Great Moderation is very strong evidence of that. But many developed economies in the last decade kept their policy rates

at the effective lower bound for several years. In some of these countries, fears of deflation have arisen and “helicopter drops” have been discussed. The evidence presented here is consistent with the notion that long-run inflation can ultimately be controlled by properly managing *the right* monetary aggregate. We are short of theory and still face several puzzles in the data. We may not yet be ready to take our findings to the policy debate. But we believe that what we have so far justifies further studies on the role of monetary aggregates on prices.

References

- BAUMOL, WILLIAM (1952), “The Transactions Demand for Cash: An Inventory Theoretic Approach”, *Quarterly Journal of Economics* 66, pp. 545-556.
- BENATI LUCA, ROBERT LUCAS, JUAN PABLO NICOLINI and WARREN WEBER (2017), “International Evidence on Long-Run Money Demand”, Working Paper No. 737, Federal Reserve Bank of Minneapolis.
- CAGAN, PHILLIP (1956), “The Monetary Dynamics of Hyperinflation”, in FRIEDMAN, MILTON (Editor), *Studies in the Quantity Theory of Money*, University of Chicago Press, Chicago, IL.
- FREEMAN, SCOTT and FINN KYDLAND (2000), “Monetary Aggregates and Output”, *American Economic Review* 90 (5), pp.1125-1135.
- FRIEDMAN, BENJAMIN and KENNETH KUTTNER (1992), “Money, Income, Prices, and Interest Rates”, *American Economic Review* 82 (3), pp. 472-492.
- IRELAND, PETER (2009), “On the Welfare Cost of Inflation and the Recent Behavior of Money Demand”, *American Economic Review* 99 (3), pp. 1040-1052.
- LUCAS, ROBERT E., JR. (1988), “Money Demand in the United States: A Quantitative Review”, *Carnegie-Rochester Conference Series in Public Policy* 29, pp. 137-167.
- LUCAS, ROBERT E., JR. and JUAN PABLO NICOLINI (2015), “On the Stability of Money Demand”, *Journal of Monetary Economics* 73, pp. 48-65.
- MELTZER, ALLAN (1963), “The Demand for Money: The Evidence from the Time Series”, *Journal of Political Economy* 71, pp. 219-246.
- PRESCOTT, EDWARD C. (1987), “A Multiple Means-of-Payment Model”, in BARNETT, WILLIAM A. and KENNETH J. SINGLETON (Editors), *New Approaches to Monetary Economics*, Cambridge University Press, pp. 42-45.
- TELES, PEDRO and RUILIN ZHOU (2005), “A Stable Money Demand: Looking for the Right Monetary Aggregate”, *Economic Perspectives* 29, pp. 50-63.
- TOBIN, JAMES (1956), “The Interest-Elasticity of Transactions Demand for Cash”, *Review of Economics and Statistics* 38 (3), pp. 241-247.

