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The Puzzle with Increasing Money Demand – Evidence from a Cross-Section of Countries

Johann Graf Lambsdorff[1], January 2004

Abstract

The ratio of money demand to GDP may increase with portfolio demand, *monetization,* and a deeper division of labor. Using a cross-section approach to money demand for 126 countries this study shows that the share of agriculture, life expectancy at birth, openness, and trust in the banking system capture a good deal of these influences. Once these variables are included, GNP per head negatively impacts on the ratio of money demand to GDP, which is in line with the standard result by Tobin and Baumol.

JEL: E41, C21

1. Introduction

The positive impact of income on the ratio of money demand to GDP is standard to empirical investigations – and so is its contradiction with theory. Since Baumol, Tobin and Allais one expects the ratio of money demand to GDP to decrease with income, [Baumol and Tobin 1989]. The higher the transaction volume (proxied by income) the more one will endeavor to economize on monetary holdings. That this relationship is not given empirical recognition is precarious. This inconsistency has been commonly related to structural shifts arising in the long run. Our theoretical predictions would be valid only for short-term cyclical fluctuations. Friedman [1959] pioneered the assumption of a long-term upward trend of money demand (that is, a downward secular trend of income velocity). If this assumption holds, one should be able to identify the causes of structural changes and attempt to provide quantitative estimates. This study shows reproduces the standard empirical finding of a positive association between income and the ratio of money demand to GDP. But it shows that this association can be traced to the correlation of income with other variables: The share of agriculture, life expectancy at birth, openness, and trust in the banking system. Including these variables reconciles theory with evidence: A negative impact of income on money demand (relative to GDP) is obtained.

The study is organized as follows. Section 2 provides theoretical arguments for a long-term trend to increasing money demand (relative to GDP). Some basic regressions are carried out in Annex 2. These are intended to determine the appropriate functional form of GNP per head and the interest rate. These regressions are carried out for a cross section of 126 countries and bring about the standard results of a negative impact of the interest rate (or a positive impact of the reciprocal term) and a positive impact of income on the ratio of money demand

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to GDP. These results are not crucial to this study and are rendered to the appendix accordingly. Section 3 introduces some of the crucial variables mentioned. These are added to the regressions and explanations are provided how they contribute to explaining money demand. Section 4 extends the investigation by assessing also portfolio demand for money and including inequality in the analysis. Section 5 concludes. Annex 1 explains how the data was retrieved and compiled. Annex 3 reports the list of countries contributing to the regressions and annex 4 reports the crucial correlations.

2. Long-Term Determinants of Money Demand

One reason for a secular upward trend of money demand may relate to **monetization**. Monetization is defined as the fraction of total income received in the form of money, [Melitz and Correa 1970: 13; Jones 1976; Niehans 1971]. If, on the other hand, barter trade characterizes societies, exchange can be carried out without making use of money. The higher is the share of transactions based on money, the higher will be the ratio of money demand to the total transaction volume. As societies become richer, there is likely to be a tendency to depart from barter. This could explain a secular trend where growing economies experience an increasing money demand. Another impact on monetization may result if societies are characterized by a widespread use of reciprocal exchange. Economic actors then start to accumulate rights for reciprocal favors instead of piling up financial assets.[2] Reciprocity thus becomes an alternative medium of exchange, lowering the necessity to hold money. A variety of variables can be tested that are likely to relate to monetization. Driscoll and Lahiri [1973] and [Melitz and Correa 1970: 15], for example, suggest the share of the agricultural sector in national income. In a subsistence economy production and consumption go hand in hand. The basic exchange that takes place might be more of a barter type. The agricultural sector is therefore likely to go along with little monetization and a low money demand.[3]

Another reason for the secular upward trend emerges when incomes – even those received in the form of money – do not perfectly correlate with the transaction volume. An **increasing division of labor** characterizes modern societies. This characteristic of technological progress has been dealt with more explicitly in recent models of economic growth. These

[2] Kranton [1996] shows how the importance of reciprocity can become self-perpetuating when goods are only available to members of a network.

[3] Melitz and Correa [1970: 15] also test the urbanization ratio as a proxy for monetization. In accordance with their results I did not find a significant impact of this variable and refrain from reporting the details. The level of corruption in a country may also serve as a good proxy for reciprocity. Reciprocity can induce bureaucrats to serve their kin or members of a network instead of being devoted to the public. This can be the source of corruption. Likewise, for corruption to flourish trusted relationships must be established, which keep partners in the corrupt relationship from acting opportunistically. Countries with an established reciprocal exchange therefore provide ground for corruption, whereas a high level of monetization makes it difficult to strike a corrupt deal, [Lambsdorff 2002]. Yet, corruption did not exert a significant influence on money demand.

Exchanging goods with the help of money may require mathematical skills, suggesting that monetization increases with literacy. However, also this variable was insignificant.

Modern capitalism has been traced to Protestant ethics. One may assume that optimizing money demand is particularly an issue in countries with a large share of Protestants. Again, the share of Protestants was tested and found to be insignificant.

models emphasize the role of R&D in creating process innovation, allowing a deeper and thus more productive division of labor. I follow Grossman and Helpman [1991, ch. 3] and assume a constant returns to scale CES production function where A intermediate products $x(j)$ are combined to produce the output c:

$$c = \left[\int_0^A x(j)^{\alpha} dj \right]^{1/\alpha}, \quad \alpha \in (0,1).$$

The share L_X of the total labor force L is used for production. The rest is employed for R&D. The intermediate products are produced only with labor input. Assuming input for intermediate products to be equal to output ($x(j)$) and the labor force to be divided equally for the production of the A intermediate goods, we obtain: $x(j)=L_X/A$. Inserting this brings about output, c, in relation to the amount of intermediate products that are employed in the production and the productive labor force:

$$c = A^{(1-\alpha)/\alpha} L_X .$$

Thus, production increases with the labor force and the amount of intermediate products A. This latter term depicts the positive (but less than proportional) impact of the division of labor on production. Endogenous growth can now result when the rest of the labor force, $L_A=A-L_X$, is employed in R&D, and when there are positive spillover-effects such that knowledge increases proportional to A. This suggests that A increases constantly over time. Employing this model for our purposes, it is straightforward to observe that the transaction volume in the factor market is depicted by AL_X. As a result, increases in A proportionately increase the transaction volume but bring about a less than proportional increase of output. Technological progress, as depicted by this model, will therefore increase the ratio of money demand to GDP, forcing the aforementioned secular trend.[4]

The extent of technical know-how with regard to process innovation is difficult to quantify, particularly for a cross-section of countries. I suggest that life expectancy at birth captures a good deal of this variable.[5] The best form of storing knowledge might be human brain. In the case of learning-by-doing one cannot store knowledge elsewhere. Societies with a higher life expectancy would then provide a more economic usage (that is, a lower depreciation rate) of this knowledge. I will therefore include life expectancy at birth as an explanatory variable. Specialized knowledge that is necessary for process innovation may also be vulnerable to a holdup – an argument that is standard to the New Institutional Economics. Long and repeated exchange between firms and the producers of intermediate inputs can help to establish reputation effects or contain opportunism with the help of repetition. Higher life expectancy allows the exchange to become more durable, letting repetition become more likely and investments into specialized knowledge less likely to be exploited by opportunism.[6]

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[4] In line with this argument, for the last decades world trade grew substantially, indicating a worldwide trend to an increasing division of labor. At the same time world GDP grew too, yet at a slower pace. Thus, the ratio of (cross-border) exchange to output increased.

[5] That the aging process can have an impact on money demand has been recently given recognition, [Remsperger 2001].

[6] Other indicators of human capital instead of life expectancy at birth at may be considered for inclusion, for example school enrollment rates. These depict investments into human capital, but they refer less to a type of knowledge that is obtained by learning-by-doing. To the extent that process innova-

Countries that are well integrated into the world economy are also likely to be characterized by a deeper division of labor. If countries are strong in exchanging intermediary goods with other countries, they are embedded in a global division of labor. Such countries will have a high degree of openness (the ratio of export plus import to GDP), a variable that will be included in the regressions.[7]

Portfolio demand for money, finally, may overshadow transaction demand. Möller and Jarchow [1996] argue that the existence of portfolio demand is the reason for a decreasing secular trend and that its incorporation reconciles theory with evidence. They argue for the case of Germany that transaction demand for money increases at a lower pace than GDP, in line with theory. Money is also held for portfolio considerations and the increasing wealth accounts for an additional increase in money demand. It is this effect that they hold responsible for the secular trend. In regressions that do not control for wealth, the impact of income (which correlates with wealth) will therefore be biased, misrepresenting our theory. Whether the coefficient is biased upward or downward, however, depends on whether the ratio of wealth to GDP increases or decreases over time. A neoclassical growth model commonly suggests that the ratio of capital to GDP remains constant because in a steady-state both variables equally grow with population and with technological progress.

Yet, one reason for wealth increasing relative to GDP arises with the aging of society. Following a life-cycle hypothesis of consumption, the savings needed after retirement increase with life expectancy. This changes the ratio between wealth and income and increases money demand relative to GDP due to increased portfolio demand.

Holding money may also be preferred to other forms of financial capital. A crucial impact can result from an efficient and trusted banking system. Demand, time, and savings deposits, for example, are likely to increase with the development of honest banks and will remain poor if no trusted banking system is in place. Once these deposits are secure, money becomes attractive relative to holding other assets.

Yet, there is hardly convincing and sufficient data on trust in banks available for a cross-section of countries. What might serve as a proxy for our purpose is the ratio of currency to the total money demand, [Hanson and Vogel 1973: 366]. An underdeveloped banking system suggests that money must be held in the form of currency. To the contrary, less currency is needed if money can be held in banking accounts. To the extent that people trust banks they will substitute currency for deposits, [Claque et al. 1999: 188]. At the same time they are more likely to hold deposits instead of other non-monetary financial assets. For example, savings deposits become the more attractive as compared to stocks the more people

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tion is acquired on the job, they do not well depict this type of knowledge. Assessments of “years in school” were insignificant in the regressions.

[7] This measure of openness is somewhat distorted by a country's population, with larger countries being characterized by a lower openness. The larger a country, the more of its trade is domestic and not with foreign countries. For example, the total EU's openness may not surpass that of the USA, but the values for each of its member countries surely do. This means that trade within the EU is included in the statistics while trade between Texas and California is not. This distortion can be corrected by including also population into the regression. Population may also impact on currency substitution. The more likely it is that a randomly selected trading partner uses the same currency, the less interest people have in holding foreign currencies. Incorporating population into the regressions brought about insignificant results and did not contribute to our analysis.

trust the banking system. This suggests that a low ratio of currency to money is likely to go along with an overall higher money demand.[8] The ratio of currency to money will also have an impact on money supply. Private banks can increase lending and deposits when little currency is demanded from their clients. Increased money supply lowers interest rates and thus also increases money demand. However, this argument alongside with the recognition that money supply might be positively affected by the interest rate, suggests than the interest rate might be endogenous to the model – requiring adequate subsequent statistical treatment of this variable.

3. Empirical Evidence

Time series analysis is the standard approach to investigating money demand. There exists only scattered evidence on money demand in a cross-section analysis. Noteworthy but dated exceptions are Doblin [1951], Ezekiel and Adekunle [1969], Melitz and Correa [1970] with a reply by Wallich [1971] and Lothian [1976]. A more recent one, which, unfortunately, disregards important explanatory variables, is provided by Sell [1997]. In a related investigation, Lucas [1996: 665] correlates inflation and monetary growth for a cross-section of countries.[9]

A cross-section approach can enrich our understanding of the explanatory variables because it allows for the inclusion of variables that show little variation over time or that are even unavailable as time series. It therefore makes sense to validate results from time series analysis with those from cross-sections, particularly with regard to the long run forces governing the demand for money, [Wallich 1971, Lucas 1996: 665].

Regressing the ratio of money demand to GDP on GNP per head and the interest rate brings about the standard results, as shown in table 1, regression 1. This regression repeats the results from regression 5, table A2, annex 2. While GNP per head increases money demand relative to GDP (in contrast to the standard model by Baumol and Tobin), the interest rate lowers it. Instead of the simple (logarithm) of the interest rate, its reciprocal term has been used which subsequently exhibits a positive impact. Details on the choice of the functional form are provided in annex 2. Introducing the four aforementioned variables brings about significant results. For all four variables I obtain the expected impact at a high significance level. An increase in agriculture from 10 to 20 percent reduces money demand by 18 percent. An increase of life expectancy by one year increases money demand by 1.9 percent. A doubling of the ratio of currency to money reduces money demand by 26 percent. Increasing openness by 10 percentage points increases money demand by 2 percent. Once including the share of agriculture or life expectancy the impact of GNP per head falls to insignificance. The share of agriculture and life expectancy thus outperform income as a cause of the secular trend. If all variables are included simultaneously, as in regression 6, table 3, GNP per head enters even with a significant negative coefficient.

The results are checked in regression 6 by including regional dummies. This is to make sure that the results are of global validity and not driven by regional peculiarities. Yet,

[8] Melitz and Correa [1970: 13-4] also include the ratio of currency to money as an explanatory variable. They provide an additional argument for its likely impact. Because currency holdings entail substantially higher risks than demand deposits people will more strenuously try to economize on money.

[9] Panel-data, certainly, combine time-series and cross-section data to a richer investigation of money demand. This approach is provided in Herwartz and Reimers [2001].

these variables are largely insignificant. The various regressions have also been tested for linearity. Running a White-heteroskedasticity test provides no evidence for rejecting the simple linear form employed. As shown in regression 7, including a squared term for GNP per head did not affect the significance of the four variables. The impact of the four variables is therefore not related to the idea that an inappropriate functional form of GNP per head was employed. Altogether, the share of agriculture, life expectancy, the ratio of currency to money, and openness are important variables, which deserve recognition for the explanation of money demand.

Table 1: OLS
Dependent variable: (Logarithm of) the Ratio of M2 (Money + Quasi Money) to GDP

Independent variables	1	2	3	4	5	6	7	8
Constant	1.33	2.77	0.99	2.61	1.35	2.95	3.43	3.20
	(6.3) *)	(7.7)	(4.1)	(4.8)	(6.5)	(5.9)	(6.8)	(1.9)
GNP per head (log.)	0.194	0.032	0.057	0.110	0.189	-0.102	-0.122	-0.167
	(7.3)	(0.7)	(1.6)	(2.7)	(7.2)	(-2.3)	(-2.6)	(-0.4)
GNP per head (log.), squared								0.004
								(0.2)
1/log(Lending Rate), extended	2.34	2.51	2.65	2.56	2.04	2.66	2.55	2.62
	(4.8)	(5.3)	(5.7)	(5.2)	(3.9)	(6.0)	(5.2)	(5.1)
Share of Agriculture		-1.80				-0.92	-0.99	-0.96
		(-4.1)				(-1.9)	(-2.0)	(-1.7)
Life Expectancy			0.019			0.018	0.015	0.018
			(4.4)			(4.9)	(3.4)	(5.1)
Ratio of Currency to Money (log.)				-0.26		-0.24	-0.24	-0.24
				(-2.5)		(-2.5)	(-2.4)	(-2.5)
Openness					0.20	0.13	0.13	0.13
					(2.4)	(1.8)	(1.7)	(1.8)
Middle East, Dummy							0.18	
							(1.3)	
Africa, Dummy							-0.19	
							(-1.7)	
Latin America and Caribbean, Dummy							-0.12	
							(-1.3)	
Obs.	126	126	126	125	126	125	125	125
Adj. R^2	0.47	0.53	0.54	0.50	0.50	0.62	0.64	0.62
JB+)	2.5	5.9	7.7	7.2	1.2	5.5	2.9	5.7

*) All t-statistics (given in parenthesis) are White-corrected to adjust for heteroskedasticity.
+) The Jarque-Bera measures whether a series is normally distributed by considering its skewness and kurtosis. The assumption of a normal distribution can be clearly rejected for levels above 6.

The interest rate and money demand interact in a more complex way when considering also money supply effects. The interest rate may not be exogenous to money demand but balance

money demand and supply, where banks increase their lending and the money supply multiplier in response to higher interest rates. Testing the relevance of this effect for our regressions requires an instrument that well correlates with the interest rate but not with the error term of the model. The (logarithm of the) inflation rate well serves this purpose. It affects money demand largely via its impact on (and strong correlation with) the nominal interest rate. But increased inflation does not raise the money supply, because banks will only increase lending in response to a higher real interest rate. Using this instrument I conduct a Hausman two-step test of exogeneity [Hausman 1978; see also Pindyck and Rubinfeld, 1991: 303-5]. In the first stage, the interest rate is regressed on all independent variables of the model and the instrument, but not the dependent variable of the model, the ratio of money to GDP. In a second stage, the estimated residuals from the first stage are included as an explanatory variable in the model. If the residual variable is statistically significant in the second stage, even when controlling for the interest rate (the presumed exogenous variable), then the interest rate is in fact endogenous. Results from the second stage revealed that the residual variable failed in achieving significance. I conclude that the interest rate is exogenous to the model. Our concern with money supply and the endogeneity of the interest rate seem to be immaterial for data that relate to a cross-section of countries.

A more fine-tuned approach incorporates also interaction terms, in particular those between GNP per head and the four newly introduced variables. This would signal a more complex interaction of these variables with GNP per head and money demand. Only one interaction term, life expectancy times GNP per head, showed a significant positive impact once omitting life expectancy itself from the regression. If a low GDP goes along with high life expectancy this might by indicative for an aging generation that lives at the expense of future generations. In this case, low savings rates are likely to go along with lower wealth and little money demand. Since this regression did not increase the R^2 it is not reported and I will continue with the simple explanatory variables in subsequent regressions.

3. Portfolio Demand and Inequality

As suggested in section 2, wealth as determined by the stock of savings should significantly impact on money demand. Some countries may have large money demand because wealth is large in proportion to GDP. A crucial variable could therefore be the stock of savings relative to GNP, as determined in Annex 1. Regression results are shown in table 2.

Regression 1 repeats the approach of regression 6, table 1. But the observations are restricted to countries where data on the ratio of savings to GNP was available so as to allow a comparison to the subsequent regressions. The share of agriculture and openness become insignificant. This may result from the smaller coverage; particularly some countries with a large share of agriculture are now missing. As shown in regression 2, the ratio of savings to GNP enters significantly with an expected positive coefficient. This result was also obtained when introducing regional dummies, as in regression 3, table 2.[10] The Jarque-Bera is now on an acceptable level.[11]

[10] In contrast to table 3, these are now significant. This results from two countries. Oman has a very low money demand, but it is omitted in the smaller sample now relevant. Once omitted, other Middle Eastern countries exhibit money demand above average. Suriname, likewise, has a surprisingly high money demand. Once excluded in the smaller sample, Latin America's money demand is significantly

The impact of life expectancy hardly changes when controlling for the ratio of savings to GNP. Hence, increased savings going along with higher portfolio demand are not the only channel by which life expectancy impacts on money demand.

One further explanatory variable is equality. Money demand is likely to increase with equality because, in line with the standard model by Baumol and Tobin, the rich economize more on their monetary holdings. I test this by including the Gini-coefficient for income inequality. Indeed, as revealed in regression 4, it enters significantly with a negative sign.

Table 2: OLS
Dependent variable: (Logarithm of) the Ratio of M2 (Money + Quasi Money) to GDP

Independent variables	1	2	3	4	5
Constant	2.85	2.58	3.39	4.07	3.75
	(5.4)	(5.0)	(7.1)	(5.7)	(5.2)
GNP per head (log.)	-0.067	-0.069	-0.112	-0.087	-0.090
	(-1.5)	(-1.6)	(-2.4)	(-1.7)	(-1.9)
1/log(Lending Rate),	2.83	2.72	2.36	1.89	1.72
extended	(6.7)	(6.3)	(4.9)	(3.9)	(3.3)
Share of Agriculture	-0.64	-0.35	-0.71	-0.47	-0.88
	(-1.1)	(-0.6)	(-1.3)	(-0.8)	(-1.5)
Life Expectancy	0.015	0.015	0.012	0.010	0.011
	(3.7)	(3.9)	(2.6)	(2.5)	(2.2)
Ratio of Currency to	-0.25	-0.22	-0.23	-0.31	-0.23
Money (log.)	(-2.1)	(-2.0)	(-2.0)	(-2.9)	(-2.4)
Openness	0.13	0.11	0.11	0.09	0.07
	(1.8)	(1.7)	(1.6)	(1.9)	(1.5)
Ratio of Savings to		0.27	0.22	0.26	0.19
GNP (log.)		(2.6)	(2.2)	(2.3)	(1.6)
Gini-Inequality				-0.012	-0.004
				(-2.5)	(-0.8)
Middle East, Dummy			0.26		0.40
			(2.0)		(3.1)
Africa, Dummy			-0.21		-0.10
			(-2.0)		(-1.1)
Latin America and			-0.20		-0.23
Caribbean, Dummy			(-2.2)		(-2.1)
Obs.	94	94	94	80	80
Adj. R^2	0.62	0.64	0.69	0.71	0.76
JB	14.3	7.5	4.8	1.2	2.4

This impact, however, is difficult to separate from the regional dummies. Once these are introduced, as in regression 5, the Gini-coefficient falls to insignificance. This raises the question whether this coefficient contributes to explaining money demand or whether it correlates with regional peculiarities, causing a spurious correlation with money demand. It is beyond the scope of this paper to answer this question, because the Gini-coefficient was merely

below average. It is beyond the purpose of this study to provide more detailed regional analyses. It suffices for our purpose that the various regional dummies did not considerably change the coefficients obtained so far.

[11] Malta is one country with an exceptionally high money demand. Excluding Malta considerably lowers the Jarque-Bera (its value in regression 3 would drop to 1.6) without further affecting the regression results. This provides some confidence that the results are robust, even when a normal distribution is not perfectly obtained.

introduced as a control variable, making sure that no potential explanatory variable has been missed.

In sum, life expectancy and the ratio of currency to money remain significant and survive controlling for wealth and inequality. Openness and particularly the share of agriculture turned out to be less significant. This lower significance, however, seems to relate more to a sample selection issue because many countries with high shares of agriculture are now omitted in the smaller sample. Although the results are not throughout significant in table 2, the more representative sample of countries used in table 1 provides an argument in favor of their explanatory power.

4. Conclusion

Using a cross-section approach to money demand for 126 countries corroborates some standard findings from time series analysis. In standard regressions that disregard a broader set of explanatory variables income exerts a positive impact on the ratio of money to GDP, that is, a negative impact on income velocity. High interest rates decrease money demand. But this study argues that it is not income per se that causes the secular trend but rather closely correlating variables. The share of agriculture, life expectancy at birth, openness, and trust in banks outperform income as a cause of the secular trend. Once included, income negatively impacts on money demand relative to GDP, which is in line with theoretical considerations.

Life expectancy is likely to impact on money demand via its correlation with accumulated savings and with inequality. However, life expectancy remains significant even when controlling for these variables. This suggests the existence of furthers links between life expectancy and money demand. A plausible conjecture relates to the division of labor. In case of an increasing division of labor, the transaction volume increases more than GDP, requiring more liquidity in relation to GDP. A higher life expectancy may facilitate hierarchical relationships within firms and organizations, because these can be based on the authority of elders. The best form of storing organizational knowledge might be human brain. Societies with a higher life expectancy would then provide a more economic usage (that is, a lower depreciation rate) of this knowledge, which, in turn, allows a deeper division of labor. In contrast, where organizational knowledge is scarce or expensive, societies cannot develop a complex division of labor.

The results provide direction to monetary policy. Central banks should depart from assuming a simple secular trend of an ever-increasing money demand, respectively, a decreasing income velocity. Instead, they should address in how far the variables identified here could be held responsible for changes in income velocity.

Annex 1: Description of Data

The data used are largely from the IMF's International Financial Statistics, December 2000. The data obtained were Money (Series Code 34...ZF; for some European Countries I aggregated 34A.NZF and 34B.NZF), Quasi Money (35…ZF), Currency Outside Banks (14A..ZF), Deposit Rate (60L..ZF), Lending Rate (60P..ZF), nominal GDP (99B..ZF or 99A.*ZF), real GDP (99BVPZF), and Consumer Prices (64…ZF). The data range from 1974 to 2000. Because the Bretton Woods system ended in 1973, this is a common period for investigations of monetary issues. Not for all countries there have been continuous data for the aforementioned

period. I required 10 annual observations to be available at least for a country to be included. From these data I determined the rate of inflation (based on consumer prices), growth of GDP (based on the level of real GDP), the ratio of a broad monetary aggregates (money plus quasi money) to GDP, and the ratio of currency to money (the ratio of currency outside banks to money plus quasi money).

Determining the average interest rates and inflation rates across years by a simple arithmetic mean would be inappropriate because years with hyperinflation would enter excessively. The geometric mean is superior because it reflects the average devaluation of money due to inflation, and the average yield with regard to interest bearing investments. In the case of Argentina, for example, a simple arithmetic mean would yield large values because the years of hyperinflation, 1989 and 1990, excessively dominate the calculation. For all other variables a simple arithmetic average appeared appropriate, because the data is rather evenly distributed with no outliers as in the case of inflation and interest rates.

Data on openness are from the World Penn Tables and reflect average values between 1974 and 1992. Data on the share of Protestants and GNP per head are from LaPorta et al. [1999]. The share of agriculture as percent of GDP, the share of literates, and life expectancy at birth are taken from the CIA Factbook 2000. The share of urban population in 2000 is determined by the United Nation's Statistics Division. The 2001 Corruption Perceptions Index is from Transparency International. Inequality in income is measured by the Gini-coefficient. The data are from the World Development Indicators 2002 and were compiled largely between 1991 and 1998. Some missing countries have been substituted by assessments from Deininger and Squire (1996).[12]

A country's savings stock was determined first by using gross national savings data from the World Savings Data Base, a project by the World Bank.[13] I determine the average over the years 1974-1995. More recent data was not available. From this I determine the ratio of the savings stock to GNP by a perpetual inventory method, assuming an annual depreciation rate of 7 percent.[14] This is done here by computing a truncated savings stock (S'_{1995}), resulting from the gross savings between 1974 and 1995. To this truncated stock I add the savings stock from 1973: $S_{1995}=S'_{1995} + (1{,}07)^{-22} S_{1973}$. This old stock ($S_{1973}$) is determined by introducing the assumption that the ratio of accumulated savings to GDP remains constant over time.[15] The old savings stock is then given by $S_{1973}= GNP_{1973}\cdot S_{1995}/GNP_{1995}$. Inserting this and solving for S_{1995} produces:

$$S_{1995} = \frac{S'_{1995}}{1-(1.07)^{-22} GNP_{1973}/GNP_{1995}}$$

[12] The authors provide updated data at the following address:
http://www.worldbank.org/research/growth/dddeisqu.htm

[13] The data can be retrieved from http://www.worldbank.org/research/projects/savings/data.htm

[14] The value of 7 percent is considered to be a realistic approximation of the real world depreciation rate, see for example Benhabib and Spiegel [1994].

[15] This assumption is in line with the steady-state in neoclassical growth models but in contrast to ideas that wealth might increase more than GDP. But even if it does, this impact is likely to be small. Using the procedure presented here, the ratio of GDP to capital has also been determined for 1990. It was observed that the value on average for all countries hardly differed from the one for 1995.

This procedure was particularly helpful in adequately dealing with countries whose savings data was incomplete. For example, if savings data prior to 1985 was not available, I would add $(1.07)^{-11}S_{1984}$ to S'_{1995}. Since this term is larger than $(1.07)^{-22}$ S_{1973} lack of savings data does not result in a smaller assessment of the savings stock. From the resulting savings stock I determine a ratio of the savings stock to GDP (S_{1995}/GDP_{1995}).

Annex 2: Preparatory Regressions

There are 126 countries with data on inflation, GNP per head, and monetary aggregates. As a dependent variable I employ the ratio of a broad monetary aggregate (money + quasi money) to GDP, that is, the inverse of income velocity. Regression 1, table A1, reports the results. Inflation diminishes money demand while GNP per head exerts a positive impact on money demand. A doubling of income increases the ratio of money demand to GDP by more than 22 percent. This value seems to be largely in line with evidence from time series, [Fair 1987].

Table A1: OLS
Dependent variable: (Logarithm of) the Ratio of M2 (Money + Quasi Money) to GDP

Independent variables	1	2	3	4	5
Constant	2.30	3.03	4.09	3.89	3.99
	(9.3)[#]	(7.5)	(5.3)	(4.4)	(7.5)
GNP per head (log.)	0.222	0.241	0.212	0.228	0.210
	(8.3)	(9.1)	(7.1)	(7.9)	(8.2)
Inflation (log.)	-0.122			-0.000	
	(-3.2)			(-0.0)	
Deposit Rate (log.)		-0.173		0.123	
		(-4.0)		(0.9)	
Lending Rate (log.)			-0.272	-0.375	
			(-3.1)	(-2.0)	
Lending Rate, (log.) extended [*)]					-0.256
					(-4.3)
Obs.	119	115	104	96	126
Adj. R^2	0.46	0.47	0.47	0.51	0.45
JB [+)]	2.1	3.3	1.6	4.8	1.7

[#)] All t-statistics (given in parenthesis) are White-corrected to adjust for heteroskedasticity.
*) For missing values a forecast has been determined by the deposit rate and the inflation rate.
+) The Jarque-Bera measures whether a series is normally distributed by considering its skewness and kurtosis. The assumption of a normal distribution can be clearly rejected for levels above 6.

A standard impact on money demand can be expected from interest rates because these indicate the foregone profit from holding money vis-à-vis investing into other interest bearing assets. I therefore include the deposit rate and lending rate in regressions 2 and 3. As shown in regression 4, the lending rate exerts the strongest influence. It will be used henceforth.

In order to carry out subsequent regressions for as large a coverage as possible, I determine missing values of the lending rate by their forecasted value. I carry out this forecast by regressing the lending rate on the deposit rate (if not available on the inflation rate) and determine forecasted values from this regression. The correlation coefficient between inflation and the interest rates is above 0.8; that between the two interest rates is close to 0.9, suggesting that the forecast should be good. This extended index for the lending rate is used in

regression 5. It obtains a negative impact at a high significance level. The 126 countries included in regressions 5 are reported in Annex 1.

Table A2: OLS
Dependent variable: (Logarithm of) the Ratio of M2 (Money + Quasi Money) to GDP

Independent variables	1. Low Interest Countries	2. High Interest Countries	3. Low Interest Countries	4. High Interest Countries	5	6
Constant	7.66	3.44	1.12	0.784	1.33	-1.63
	(5.1)	(4.9)	(2.9)	(1.0)	(6.3)	(-1.2)
GNP per head (log.)	0.158	0.256	0.159	0.256	0.194	0.982
	(5.7)	(3.6)	(5.7)	(3.6)	(7.3)	(2.8)
GNP per head (log.), squared						-0.054
						(-2.3)
Lending Rate (log.), extended	-0.725	-0.224				
	(-3.6)	(-2.1)				
1/log(Lending Rate), extended			3.48	2.81	2.34	2.86
			(4.0)	(2.0)	(4.8)	(5.0)
Obs.	62	64	62	64	126	126
Adj. R^2	0.47	0.24	0.48	0.25	0.47	0.49
JB	2.3	0.3	2.4	0.2	2.5	3.0

Various tests have been carried out to find out whether the impact of the (logarithm of the) interest rate is linear, indicating a constant elasticity. A White heteroskedasticity test indicates problems with regard to linearity. In table A2, regressions 1 and 2, the sample of countries is divided into those with low and those with high interest rates. In line with the idea of a liquidity trap, the coefficient for the interest rate is much larger for countries with low interest rates.[16] This suggests that alternative functional forms should be used for regressions with the complete sample of countries. A variety of functional forms have been tested, the aim being that the assumption of linearity should subsequently hold. It turned out that the inverse of the (logarithm of the) interest rate well serves this purpose. As shown in table A2, its impact is largely equal for high interest and for low interest countries. This variable will be

[16] This result contradicts the idea that the interest rates impacts on money demand in the form of a semi-elasticity. Fair [1987: 473], for example, rejects the idea of a constant elasticity and argues that an increase of the interest rate from 5 to 6 percent should have a smaller impact (on money demand per head) than an increase from 50 to 60 percent. This leads him, as many others, to include the interest rate in a non-logarithmic form, where the coefficient depicts a semi-elasticity. But quite to the contrary, our results suggest that an increase of the interest rate from 5 to 6 percent has an even greater impact than one from 50 to 60 percent.

I also ran regressions with the non-logarithmic form, but the non-logarithmic interest rates show a highly uneven distribution with some countries being outliers. The assumption of linearity could be rejected for the regressions

used from now on. I also tested the impact of an interaction term: GNP per head times the interest rate. Irrespective of the functional form chosen for the interest rate this turned out insignificant; the results are not reported here.

An important question arising is whether also the relationship for income is linear. Based on data for five industrial countries for the last 100 years, Bordo and Jonung [1990] argue that initially income velocity drops with increasing income (the ratio of money to GDP increases), but that this impact is reversed as countries become richer and financial innovations provide sufficient substitutes to holding money. This results in a concave curve for the ratio of money demand to GDP, where money demand is negatively affected by increasing income beyond a certain threshold.

I run a rather simple test here by including also the quadratic term of GNP per head, thus testing whether a second order polynomial fits the data. As can be seen from regression 6, table A2, the quadratic term enters significantly into the regression. The coefficients imply that a changing income has no impact on income velocity if countries have a (logarithm of the) GNP per head of 9.1.[17] The results by Bordo and Jonung [1990] are thus supported here, although I am applying a totally different set of data. A country such as the United States with a (logarithm of the) GNP per head of 9.6 is located on the decreasing side of the curve. A further increase in GNP is likely to decrease money demand (relative to income) there. For the Euro area, whose member states (which entered separately into the regression) have an average (logarithm of the) GNP per head of 9.2, an increase in income should leave the income velocity largely unaffected. This suggests that the secular trend, at least as induced by a growing income, has come to an end in the Euro area. A regression in section 3 will test whether the quadratic term remains significant once introducing further explanatory variables.

Annex 3: List of Countries

The 126 countries included are: Antigua, Argentina, Australia, Austria, Bahamas, Bahrain, Barbados, Belgium, Belize, Benin, Bhutan, Bolivia, Botswana, Brazil, Burkina Faso, Burundi, Cameroon, Canada, Central African Rep., Chad, Chile, China, Colombia, Congo, Costa Rica, Cote d'Ivoire, Cyprus, Denmark, Dominica, Dominican Rep., Ecuador, Egypt, El Salvador, Equatorial Guinea, Ethiopia, Fiji, Finland, France, Gabon, Gambia, Germany, Ghana, Greece, Grenada, Guatemala, Guinea-Bissau, Guyana, Haiti, Honduras, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Kuwait, LAO People's Dem. Rep., Lesotho, Libya, Madagascar, Malawi, Malaysia, Mali, Malta, Mauritania, Mauritius, Mexico, Morocco, Mozambique, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Rwanda, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Singapore, South Africa, Spain, Sri Lanka, St. Kitts, St. Lucia, St. Vincent & Grenadines, Sudan, Suriname, Swaziland, Sweden, Switzerland, Syrian Arab Rep., Tanzania, Thailand, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkey, Uganda, United Kingdom, United States, Uruguay, Vanuatu, Venezuela, Zambia, Zimbabwe.

[17] This results from introducing the coefficients for GNP per head (Y) into the first derivative of the dependent variable (M/Y) and setting this equal to zero: $d(M/Y)/dY=0.982-2*0.054*Y=0 \Leftrightarrow Y \sim 9.1$.

Annex 4: Correlations

Correlation Matrix	M2 to GDP (log.)	GNP per head (log.)	Share of Agriculture	Life Ex-pectancy	Ratio of Currency to Money (Log.)	Openness (Imp.+Exp.)/GDP	Gini-Inequality
M2 to GDP (log.)	1.00	0.66	-0.71	0.65	-0.61	0.28	-0.51
GNP per head (log.)	0.66	1.00	-0.84	0.76	-0.76	0.16	-0.44
Share of Agricul-ture	-0.71	-0.84	1.00	-0.73	0.77	-0.29	0.34
Life Expectancy	0.65	0.76	-0.73	1.00	-0.51	0.08	-0.48
Ratio of Currency to Money (Log.)	-0.61	-0.76	0.77	-0.51	1.00	-0.17	0.21
Openness (Imp.+Exp)/GDP	0.28	0.16	-0.29	0.08	-0.17	1.00	0.04
Gini-Inequality	-0.51	-0.44	0.34	-0.48	0.21	0.04	1.00

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