

MEASURING THE QUALITY OF MONEY

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JEL CLASSIFICATION: E41, E52, E58, E51, E44

ABSTRACT: This article explains the theoretical importance of the quality of money as a factor of the demand for money and develops the composite indicator that measures the quality of money for the eurozone. The demand for money, i.e., the amount of money people keep in their balances, besides other well-known factors (e.g., interest rate, price level, and income) depends on how people subjectively perceive a particular money's ability to serve its main functions: a medium of exchange, a store of value, and the unit of account. These properties depend not only on the instruments of monetary policy and the extent to which they are used, but also on the institutional framework of the monetary system. The article suggests that the quality of money is influenced by the institutional framework and monetary policy and that thus the quality of money is a separate channel for the transmission of money policy that works not through the usual mechanism of changing the supply of money, but through central banks affecting the demand for money. An important contribution of this article is that it develops an empirical composite indicator, which measures the quality of money in the eurozone in 1999–2019 and shows the gradual decline in the quality of euro.

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INTRODUCTION

Monetary policy has an immense impact on the development of economies, and thus on the economic well-being of people. There are numerous studies investigating the channels through which central banks influence economies. How effectively certain goals may be achieved via monetary policy depends on how well we understand these channels and their relative importance. However, the recent emergence of unconventional monetary policy and vast expansion of financial markets calls for the revision of the standard view of monetary policy transmission channels.

The relationship between the demand for money balances and its determinants is a critical component in the formulation and transmission of monetary policy (Goldfeld 1994), especially because economic depressions and inflationary booms can be interpreted as caused by the disequilibrium between the supply¹ of and demand for money (Yeager [1956] 1997).²

Various factors have been proposed as the determinants of the demand for money. Yeager ([1956] 1997, 5–6) claims that the demand for money essentially depends on the volume of transactions and on the price level, with interest rates, expectations, and business conditions also playing a role:

Households and businesses demand cash balances for what are usually classified as transactions, precautionary, speculative, and investment motives. Consideration of these motives shows that the total of cash balances demanded tends to be positively associated with the physical volume of transactions paid for in money (which depends in turn on

¹ Throughout this text the “supply” of money will mean the available total stock of money. In cases where the argument is about the effects of the production of new money this will be indicated (e.g., “increase” or “change” in the supply of money).

² Yeager ([1956] 1997) views the equality between the demand for money and supply of money as the equilibrium condition and identifies the disequilibrium in the money market as the primary cause of depressions and inflationary booms. Depressions occur when there is an excess demand for money, in the sense that people want to hold more money than exists. Inflationary booms occur when there is an excess supply of money, in the sense that more money exists than people want to hold.

payment practices and other institutional conditions, on the human and business population, and on the level of production or real income) and with the level of prices and wages. Interest rates and expectations of future price levels and business conditions also presumably have some effect on the demand for money.

Yeager ([1956] 1997, 7) compares money to any other commodity by saying that the number of money units that people demand varies inversely with the purchasing power as the value of the unit: we want to hold more units of any good if its value is higher. And as with other goods, there is some value or purchasing power of money unit that equilibrates the amounts demanded and supplied.

According to Laidler (1971), a stable demand function is a characteristic monetarist belief and is also supported by the empirical evidence. By “stable” Laidler means that money holdings “can be explained ... by functional relationships which include a relatively small number of arguments” (Laidler 1982, 39).

In practice a “small” number of arguments has meant three or four—typically including a scale variable such as income, permanent income or wealth, an opportunity cost variable such as nominal interest rate or some measure of the expected inflation rate, and, if nominal balances have been the dependent variable, the general price level. (Laidler 1982, 39–40)

The liquidity preference framework emphasized the opportunity cost as the factor of the money demand. The demand for money depends on the tradeoff between the liquidity of holding money and the opportunity cost of holding it, which is the interest rate earned on holding less liquid but interest-earning alternatives.³ To this day authors name different factors in the demand for money balances, but the most prominent variables include the interest rate, level of income, price level, number of transactions, transaction costs, and the preferences of money holders.⁴

In the traditional framework, monetary policy works through changes in the supply of money. One of the defining features of

³ See, e.g., Modigliani (1944); Tobin (1958).

⁴ See, e.g., Goldfeld (1994); Serletis (2007).

monetarism is a “quantity theory” approach to macroeconomics, which is “a view that fluctuations in the quantity of money are the dominant cause of fluctuations in money income” (Laidler 1982, 3). Since the demand curve for money is downward sloping,⁵ an increase in the supply of money equilibrates the money market at the lower interest rate and higher quantity of money demanded.⁶ Shifts in the supply of money, interest rate, and the amount of financial assets held by market participants in turn affect the economy (and ultimately the aggregate demand) through different transmission channels.⁷

It is important that according to the traditional view the supply of money is essentially the key element through which central banks conduct the monetary policy. Monetary policy-induced changes in the supply of money are part of the transmission mechanism of monetary policy—the shifts in the demand for money are not.

This view is challenged by economists who suggest that central banks influence the demand for money through the quality of money. Hendershott (1969) claimed that the emphasis on the quantity of money and the Fisherian equation in judging the impact of monetary policy on the economy is misplaced, while its popularity stems from two factors: (1) the attractive simplicity of the naïve quantity theory and (2) historical correlations between money supply and output. Bagus (2009) argues that changes in the *quality* not only quantity of money are important for the demand and purchasing power of money. Quality of money is defined as the capacity of money, as perceived by economic actors, to fulfil its main functions, namely to serve as a medium of exchange, as a store of wealth, and as an accounting unit. According to Bagus and Howden (2016, 111), “As the purchasing power of money may change due

⁵ A lower interest rate means a lower opportunity cost for holding money, which increases the quantity of money demanded.

⁶ Modern monetary economics often uses the quantity theory of exchange in determining the purchasing power of money. The quantity theory of money is usually expressed with Fisher’s famous equation of exchange, $MV = PY$, where M is the quantity of money, V is its velocity (i.e., rate of circulation), Y is real output, and P is the price index of this output.

⁷ See Mishkin (1995); Taylor (1995); and Bernanke and Gertler (1995) on the channels of conventional instruments and Gagnon et al. (2011); Campbell et al. (2012); Bauer and Rudebusch (2013); and Kuttner (2018, 126) on the unconventional instruments.

only to a shift in the demand for money, the subjective valuation of money can change even with the expectation of a constant money supply.” Central banks influence characteristics of money (e.g., redemption of money and quality of the central bank’s balance sheet, conditions and stability of the banking system, organization and constitution of monetary authority), which determine actors’ preferences toward money. The quantity theory of money obscures the real problem at hand regarding the value of and demand for the monetary unit (Bagus and Howden 2016, 110).

More recently, Žukauskas and Hülsmann (2019) showed how monetary policy–induced the changes in the quality of money and shifts in the demand for money can explain the movements in the prices of financial assets. The reasoning is that the decline in the quality of money shifts the demand away from money to other assets (e.g., financial assets). They suggest a *total-demand* approach, which emphasizes the importance of quality of money for the *reservation* demand for money (demand by the holders of money). The notion of quality of money may shift the understanding of how central banks influence the economy. If it is correct, then theorists will need to accept that monetary policy works not only through the supply but also through the demand side of money.

There has been some discussion of the dimensions of monetary policy which may impact the quality of money and thus the demand for money.⁸ However, there have not been any attempts to measure this impact. The notion of the quality of money stems from the subjective value theory, in which the qualities that determine the value of objects are subjective and are hard to quantify. The absence of measurement makes it difficult to judge the importance of quality of money as a demand-side channel of monetary policy. This paper attempts to fill this gap. It will discuss the dimensions of monetary policy that are relevant for the notion of the quality of money, and it will quantify them by compiling a composite indicator of the quality of money.

The first part of the article will discuss the theory behind the subjective nature of the value and demand for money. The second part will focus on the quality of money. The third part will cover the

⁸ E.g., Bagus (2009); Bagus and Howden (2016).

methodological issues in compiling the composite indicator. The fourth part will present the results of the index. The fifth part will discuss the limitations and the importance of the quality of money and its measurement in the context of monetary policy.

1. THE SUBJECTIVE NATURE OF THE DEMAND FOR MONEY

The theory behind monetarism and the stable money demand function tends to overlook the subjective nature of the demand for money. The quantity theory of money as formulated by Fisher (1911) and restated by Friedman (1956) still dominates the way economists look at the purchasing power of money. This theory focuses on the supply of money, and it does not explicitly suggest a role for the subjective factors which determine the demand for money. “While such an analysis is not obviously incorrect, the attention the equation affords to past quantities, both of money and nominal transactions, obscures the real problem at hand regarding the value of and demand for the monetary unit.” (Bagus and Howden 2016, 110).

The qualitative (or demand-side) approach is older than the modern focus on the quantitative (supply-side) factors in the analysis of the value of money:

A long history of qualitative and demand-side analysis predates the modern attention to supply-side factors determining money’s value. Early authors such as Mariana ([1609] 1994) and Petty (1662) illustrate this long tradition of the quality theory of money. Smith ([1776] 1863) explains the origin of money by pointing to the importance of certain qualities such as a commodity’s divisibility and durability. Similar discussions of the qualities of a “good” medium of exchange are found in the classic works of Say ([1803] 1843), Mill ([1848] 1909), and Senior ([1850] 1854). Menger ([1871] 2007) explained the origin of money as a market process whereby commodities with certain marketable qualities prevail at becoming generally accepted exchange media. By the time Jevons ([1875] 1876) wrote his treatise *Money and the Mechanism of Exchange*, the characteristics or qualities of “good” money were generally known (and are still today summarily detailed in most introductory monetary economics texts). (Bagus and Howden 2016, 111–12)

Some economists, predominantly those in the Austrian school of economic thought, clearly recognize that the demand and value of money are subjective and that they stem from money's ability to fulfil its functions in the market (medium of exchange, store of value, unit of account). To be properly used as money, a good must have certain characteristics. Classically, these are divisibility, fungibility (or universal want), durability, and stability of value.

Mises in the *Theory of Money and Credit* and *Human Action* explained how prices and the value of money can be explained using the same principles used to explain the prices and value of other goods in the economy. The price of money is its purchasing power, and it emerges in the market as a *result* of the demand for and the supply of money (the so-called money relation). It is clear that according to Mises the demand for money is subjective. Catallactics can tell us about the advantages of holding money and about the factors which may influence the demand for money, but the demand for money can never be reduced to a specific function.

But all of these objective factors always affect the matter only as motivations of the individual. They are never capable of a direct influence upon the actual amount of his demand for money. Here, as in all departments of economic life, it is the subjective valuations of the separate economic agents that alone are decisive. The store of purchasing power held by two such agents whose objective economic circumstances were identical might be quite different if the advantages and disadvantages of such a store were estimated differently by the different agents. (Mises [1934] 2012, 154)

Also,

The various actors make up their minds about what they believe the adequate height of their cash holding should be. They carry out their resolution by renouncing the purchase of commodities, securities, and interest-bearing claims, and by selling such assets or conversely by increasing their purchases. With money, things are not different from what they are with regard to all other goods and services. The demand for money is determined by the conduct of people intent upon acquiring it for their cash holding. (Mises [1949] 1998, 401)

The subjective demand for money is closely linked to the recognition that money is a good. Like any other good, money is demanded by the market participants for its valuable services. Hutt (1956) explains that money should not be considered unproductive or barren, as was claimed by many influential authors (e.g., Aristotle, Locke), who influenced modern thinkers. Keynes claimed that by choosing to hold money for convenience and security market participants are foregoing the interest that could be earned by holding other assets which bring nothing “in the shape of output” (Keynes 1936, 226). However, according to Hutt, money is productive in exactly the same sense as other goods in the economy. Money assets held provide valuable services, and they derive their value from their power to render these services. The amount of money that market participants decide to hold is determined by the marginal utility of its services. In fact, this means that money has a “prospective yield (of ‘utilities’), which invites the holding of money, as the normal return to investment” (Hutt 1956, 198). The demand for money is effectively the demand to hold. It stems from the value of being in a position to acquire other things at “the most profitable time, or at the most convenient time” (Hutt 1956, 206). Thus, holding money is not forgoing the yield which could be earned by holding other interest-bearing assets. By holding money, one earns a nonpecuniary yield in the form of money services.⁹

The services that the owner receives from holding money are related to the uncertainty in the market economy. Rothbard ([1962, 1970] 2009, 767) recognizes that the demand for money emerges from the uncertainty that economic agents face: money’s “uses are based precisely on the fact that the individual is not certain on what he will spend his money or of the precise time that he will spend it in the future.” Although these uses are objective in the sense that every economic agent faces uncertainty, the demand for money is still subjective:

⁹ Also Hutt (1956, 207):

The fact that we hold money assets for any period at all indicates that, although we do not want to use these assets *in any other way*, their services *do* occupy a place on our scale of preferences, just like the services of all the other capital resources which we refrain from exchanging.

Economists have attempted mechanically to reduce the demand for money to various sources. There is no such mechanical determination, however. Each individual decides for himself by his own standards his whole demand for cash balances, and we can only trace various influences which different catallactic events may have had on demand. (Rothbard [1962, 1970] 2009, 768)

An important contribution of Rothbard is his application of total demand and stock analysis to the analysis of money and the purchasing power of money. Money is unique in the sense that people simultaneously have a reservation and exchange demand for money. As Rothbard ([1962, 1970] 2009, 757) noted, “In contrast to other commodities, everyone on the market has both an exchange demand and a reservation demand for money.” The total demand for money on the market consists of two parts: the exchange demand for money (by sellers of all other goods who wish to purchase money) and the reservation demand for money (the demand for money to hold by those who already hold it) (Rothbard, [1962, 1970] 2009, 756). Exchange demand for money is the pre-income demand, and reservation demand for money is the post-income demand. Individuals demand money that they do not yet own by offering their goods or services in return for money—this is the exchange demand for money. Individuals also demand money that they own by choosing to not spend it and keep it in their cash balances—this is the reservation demand for money.

The price level is determined by the intersection of the total demand and the total stock of money. The total-demand and stock analysis utilized by Rothbard is an elegant analytical tool which clearly shows the errors inherent in the quantity theory of money, which assumes a mechanistic relationship between the supply of money and prices. Both the exchange and reservation demand for money are subjective, thus an increase in the supply of money can produce different effects on prices depending on how people react to this change, by deciding to hold a higher or lower share of additional money in their money balances.

An important question is which one—exchange or reservation demand—is more important for the determination of prices and the purchasing power of money. According to Rothbard ([1962, 1970] 2009, 759), the reservation demand for money is more important because it is “more volatile.” The volatility of the reservation demand

comes from the fact that holders of money may, for some reason (e.g., they think that the purchasing power of money will go down), want to drastically reduce their holdings of money by spending them. They cannot reduce their exchange demand for money so easily, because it is a lot easier to spend their cash balances than to turn to exchanging their goods and services for nonmonetary goods (barter) or other competing money in the market. Thus, the importance of the reservation demand for money comes from the fact that it is more volatile and thus more important in the *changes* in prices and the purchasing power of money. However, precisely because it is more stable, an argument can be made that exchange demand for money, i.e., the supply of goods and services, has an important influence on the purchasing prices and power of money, at least in the short run. Even if the reservation demand for money decreases significantly, the exchange demand for money can stay relatively stable and keep the prices and purchasing power of money from dropping rapidly.

Horwitz (1990) applies subjectivist principles to the demand for money as well and criticizes as oversimplified “neoclassical and Keynesian models that portray the only opportunity cost of money held as interest-bearing securities”. His approach claims that the choice to hold money depends on the utility of the most valuable alternative forgone:

When an actor is facing a decision to hold wealth in the form of money, she is deciding between a number of prospective utility streams. We can broadly categorize those streams as the utility from non-financial assets and the utility from both the availability and interest returns from non-money financial assets. (Horwitz 1990, 465)

Most importantly, the demand for money is subjective, since only the chooser can determine the utility that their choice provides. Moreover, the cost of holding money is subjective, because it is never objectively realized.

What is given up in a choice is by definition what was not chosen, so the “measure” of that cost must necessarily be the expected utility of the sacrificed alternative. Such expectations can be definitively described only by the chooser. (Horwitz 1990, 465)

The subjectivity of the demand for money brings us back to the monetary policy. If the demand for money balances has an important subjective element to it, the demand for money can be influenced, but it is not mechanically determined by such factors as income, price level, or interest rate. If this is the case, then central banks and monetary policy may not just influence the amount of money that people are willing to hold through the manipulation of the money supply and the interest rate. The subjectivist approach to the demand for money allows for the recognition that the impact of central banks on money (and prices) may be much broader. And this is exactly the claim of the recent literature on the quality of money.

2. QUALITY OF MONEY AND ITS DIMENSIONS

The theory of the quality of money maintains that the demand for money depends on the quality of money. Money's quality can be defined as "the capacity of money, as perceived by actors, to fulfil all its main functions, namely to serve as a medium of exchange, as a store of wealth, and as an accounting unit" (Bagus 2009, 22–23). The quality of money is one of the important factors, along with uncertainty, financial innovations (credit cards, ATMs, money market mutual funds), frequency of payment, etc. that affect the reservation or cash balance demand for money (Žukauskas and Hülsmann 2019).

Money supply, according to this view, is just one of the factors affecting the quality of money. Existing total supply of money at any time does not matter in the sense that money can be used as a universal medium of exchange despite the amount of monetary units available (a lower amount just means a lower price level). Money supply matters for the quality of money if we add the dimensions of time and changes in the supply of money. Changes in the supply of money influence the extent of the stability of the purchasing power of money. However, there are a lot more factors or dimensions influencing the quality of money: "As the purchasing power of money may change due only to a shift in the demand for money, the subjective valuation of money can change even with the expectation of a constant money supply." (Bagus and Howden 2016, 111)

The idea behind the quality of money is that central banks, through monetary policy, influence other characteristics of money (besides money supply) that are relevant for money users. A shift in these characteristics impacts the quality and subjective value of money, and “[c]hanges in money’s quality affect the demand for money and, consequently, its purchasing power” Bagus (2015, 19).

According to Bagus, “good” monetary systems have objective qualities. The quality of a money is closely linked to the quality of the monetary regime, which can be defined as “the capacity of a monetary system to provide an institutional framework for a good medium of exchange, store of wealth, and accounting unit” (Bagus 2015, 19–20).

According to Bagus (2015), the unit of account function is fulfilled by nearly all monetary systems equally well, and it is impaired only in extreme situations. Thus it is meaningful to concentrate on the characteristics of a good medium of exchange and store of value.¹⁰ The main requirements for money as a medium of exchange are low storage and transportation costs, easy handling, durability, divisibility, resistance to tarnish, homogeneity, and ease of recognition. However, “These properties hardly change today as paper-based fiat standards have eased the physical usability of the monetary unit, as well as the costs to provide it” (Bagus 2015, 23). Another relevant property of a medium of exchange is the number of users, because more users imply more demand for the medium of exchange. “As more people accept it in trade, the medium of exchange is more useful” (Bagus 2015, 23). Existence of ample nonmonetary demand for the money as either a consumer good or a factor of production is yet another important characteristic for a medium of exchange. However, in fiat money systems, where money is not redeemable, it does not have this property altogether.

One of the most important variables in money’s function as a store of value is the possibility of increases in its quantity.

¹⁰ According to Röpke (1954), money’s functions often disappear in a certain order. First, money ceases to be a storage of wealth. Then, money loses its function as a unit of account. The last function that is lost in a hyperinflation is the function of medium of exchange.

“Different monetary regimes allow for different mechanisms to increase the quantity of money, thereby influencing money’s quality. Thus, monetary systems may set strict or less strict limits for increases in the money supply” (Bagus 2015, 24). The stability of the financial system is also an important property of money and a factor in its store-of-value function.

There are monetary regimes that are more prone to generate business cycles, over-indebtedness and illiquidity than other regimes. Business cycles, over-indebtedness and illiquidity may provoke interventions and bailouts on the part of the government or monetary authorities. In the wake of the bailouts the quantity of money is often increased, or even the quality of the monetary system is diluted. (24)

The monetary regime’s independence from the government and the restrictions that it sets to eliminate or limit the government’s manipulation of money are also important to money as a store of value. “Interventions by the government often decrease the quality of money in its own favor by increases in money’s quantity or through a deterioration in the reserves backing it” (25).

To sum up, the quality of money as a store of value and a medium of exchange can essentially change in five ways (Bagus and Howden 2016, 113):

1. Money supply—the supply of money in existence today and in the future
2. Redemption ratio (in the case of commodity money systems)—the amount and value of assets or other goods that back the currency (that money can be redeemed for)
3. Conditions and stability of the banking system—a financially troubled, illiquid banking system increases risk of bailouts, which may lead to higher quantity of money (if financed through debt monetization)
4. Institutional framework of the monetary authority, which can mean:
 - a. The independence of the central bank (if the central bank follows directives from the government, this increases the risk of debt monetization to finance spending)

- b. Accountability and transparency—the quality of money will improve if central bankers are accountable and responsible for their policies and if there is transparency
 - c. The central bank's constitution, that is, its philosophy or objectives (e.g., price stability versus ancillary aims of full employment, increasing asset prices, and maintenance of a currency), its price inflation target, whether it has a rule-based monetary policy or simply targets asset prices
 - d. Staff and decision-makers at the central bank, who influence monetary policy primarily through building consensus
5. Quality of the central bank's balance sheet—the quality of the reserves and assets backing the money determines the central bank's ability to maintain and defend the currency's value in the future

Therefore, by incorporating the quality of money, it is possible to understand how the purchasing power of money can vary with a constant money stock, namely when the perceived quality of money changes. The quality of money affects the purchasing power of money by first altering the demand for money, which reflects the changed valuation of a fixed quantity of money on each person's value scale. When the quality of money improves, the demand for money, and, consequently, money's purchasing power, will be higher. If subjective valuation of money falls, people will reduce their cash balances and prices will increase. The subjectivity of valuation and demand for money also means that changes in the perceived quality of money can be very abrupt (which would lead to a strong and quick change in the purchasing power of money), whereas changes in the quantity of money are usually gradual.

3. METHODOLOGY OF THE COMPOSITE INDICATOR

Based on the framework discussed above, this section will develop an empirical composite indicator for the quality of money and apply it to the euro area. "Composite," also known as "synthetic," indicators are "formed when individual indicators are compiled into a single index, on the basis of an underlying model

of the multi-dimensional concept that is being measured” (Nardo et al. 2005, 8). Essentially, a composite indicator consists of numerous “components” that reflect a “complex system,” making it easier to understand in full rather than by reducing it to its “spare parts” (Greco et al. 2019). The literature on composite indicators suggests a particular procedure to compile a composite indicator. We will analyze the quality of money using these steps.

THEORETICAL FRAMEWORK

The first step in the creation of a composite indicator is the theoretical framework, which establishes what is being measured, its measurable dimensions, and eventually the indicators that constitute the composite indicator. The strength of the theoretical framework determines how meaningful the composite is. The quality of money and its measurable dimensions have already been discussed above. Here we will focus on the indicators.

The selected indicators must carry relevant information about the core components of the phenomenon being measured. Practitioners use proxy variables when direct indicators or data are not available (OECD and JRC 2008). Although the selection of indicators is vested in the theoretical framework, practitioners admit that it is a process which depends on the judgments of the researcher.¹¹

The selection of the indicators for the quality of money index and the dimensions of it was heavily influenced by the existing scholarship on the quality of money, which has been discussed above. As shown in table 1, the index consists of five dimensions and eighteen indicators. The indicators in the central bank balance sheet dimension follow the suggestions of Bagus (2015) and Bagus and Howden (2016). The rest of the indicators were selected to reflect the other significant aspects of the quality of money. The choice of dimensions and indicators will be discussed below.

¹¹ According to the Competence Centre on Composite Indicators and Scoreboards (2020), “Because there is no single definitive set of indicators for any given purpose, the selection of data to incorporate in a composite can be quite subjective. Different indicators of varying quality could be chosen to monitor progress in the same performance or policy area.”

The Central Bank Balance Sheet

The quality of money can be measured indirectly by the assets that back the monetary base. Central bank assets serve as collateral that “backs” the currency and represents the central bank’s capability to defend the value of the currency domestically and internationally. The balance sheet will be assessed by three liquidity ratios, two international strength ratios, and one equity ratio (see table 1). The idea behind the liquidity ratios is that the higher the share of liquid and high-quality assets in the central bank’s reserves, the higher the quality of money will be. During a crisis, liquid assets can be used to support a faltering currency. International strength ratios indicate a central bank’s potential to defend the external value (i.e., the foreign exchange rate) of a currency. International strength ratios show the percentage of monetary liabilities that are backed with foreign reserves, which can be used to support the currency’s value on the foreign exchange market. The equity ratio indicates the central bank’s leverage. A higher ratio implies a more conservative situation (i.e., less leverage) and an increased quality of money.

Money Supply

Changes in the money supply is one of the factors influencing the quality of money. Existing total stock of money at any time does not matter in the sense that money can be used as a medium of exchange despite the number of monetary units available. However, changes in the money supply influence the long-term stability of the purchasing power of money. The index contains four indicators that represent different definitions of the money supply: monetary base, central bank balance sheet, and monetary aggregates M1 and M3.

Interest Rates

There is a link between money supply and interest rates. The European Central Bank (ECB) communicates its monetary policy stance by setting an interest rate target. This target is achieved primarily through open market operations—by purchasing

or selling financial assets in the market and thus increasing or decreasing the monetary base. Thus, changes in the interest rates set by the central bank show how inflationary its monetary policy is. A decrease in the interest rates is achieved through an increase in the money supply, which in the long term means a lower purchasing power of money. The quality of money index contains four indicators measuring interest rates. Three of them represent three key interest rates set by the ECB: the rates on the deposit facility, the main refinancing operations (MRO), and the marginal lending facility. The fourth indicator is based on spread between the main refinancing operations rate and Taylor's rule interest rate.

Taylor's rule is a guideline for how central banks should change interest rates in response to changes in economic conditions. It was established to adjust and set prudent rates for the short-term stabilization of the economy while still maintaining long-term growth (Taylor 1993). Machaj (2016) admits that Taylor convincingly demonstrates that low interest rates contributed to the housing bubble and mortgage market expansion. However, Machaj (2016, 12) criticizes the Taylor rule from an Austrian perspective by saying that "any rule recommended for interest rates higher than the actual ones would have been better than that actually followed (even a rule based on astrology). Apart from that, there may be nothing specific about the Taylor rule that makes it a panacea for macroeconomic problems." The technical problem with the Taylor rule is that it has many variants and that it cannot be applied precisely (e.g., it is difficult to measure the potential output). The fundamental problem is that following this rule does not ensure economic stability: "[T]argeting ... macroeconomic variables is not a recipe for intertemporal coordination understood in the Hayekian sense: as coordination between successive stages of production" (Machaj 2014). Nevertheless, in this indicator we will use the Taylor rule as a rough guide and the basis for the evaluation of the interest rate set by the monetary authority. Following the Taylor rule does not ensure macroeconomic balance, but it is quite clear that strong deviations from it are related to macroeconomic imbalances.

Financial System Stability

The conditions and stability of the financial system matter for the quality of money, because a financially troubled, illiquid banking system increases risk of bailouts, which may lead to a higher quantity of money (if financed through debt monetization). The stability of the financial system is measured by three indicators: the Composite Indicator of Systemic Stress (CISS), the euro interbank offered rate–overnight index swap rate (Euribor–OIS) spread, and the liquidity ratio of the eurozone banking sector (for a more detailed explanation of each indicator, see table 2).

Forward Guidance

Forward guidance is central bank communication—announcements, speeches, press conferences—which aims to provide information about the likely path of future policy and interest rates (Kuttner 2018, 126). Forward guidance is an unconventional instrument of monetary policy that the ECB uses to guide the expectations of market participants about the future stance of monetary policy. Forward guidance is connected to the quality of money: expectations for prolonged periods of inflationary monetary policy mean that market participants expect the interest rates to stay low and the money supply to increase faster than otherwise. The index contains one indicator (the spread between current rate of main refinancing operations and the OIS rate) which captures the extent to which market participants expect monetary policy to remain or become inflationary (see more in table 1).

Table 1. Indicators of the quality of money index

Dimension: Central bank balance sheet		
Indicator	Reasoning and explanation	Source
Liquidity I ratio	RATIO OF GOLD RESERVES TO MONETARY BASE. Gold has traditionally held a coveted position as a highly liquid asset. Gold can be sold in high quantities without bid-ask spread crises. In contrast to other nonmoney financial assets, gold has no credit risk, as it does not represent a debt (Bagus and Howden 2016, 119).	ECB
Liquidity II ratio	RATIO OF RESERVE ASSETS (GOLD AND FOREIGN RESERVES) TO MONETARY BASE. Foreign exchange reserves ¹² are normally very liquid, as they are traded daily in large volumes. Their value is less assured than gold's, since credit risk implies that their value could theoretically be reduced to zero in extreme cases (Bagus and Howden 2016, 119).	ECB
Liquidity III ratio	RATIO OF RESERVE ASSETS AND GOVERNMENT DEBT TO MONETARY BASE. The share of government bonds on the balance sheet is important when assets are viewed in terms of credit risk. High-quality government bonds (i.e., US Treasury bills) enjoy a very large and liquid market, enabling them to be sold en masse without losses through increased bid-ask spreads. Credit risk is also low. The value of such bonds is backed by the government's taxing power and ultimately by the productivity of the economy (Bagus and Howden 2016, 119–20).	ECB
Defense potential ratio	RATIO OF FOREIGN RESERVES TO MONETARY BASE. Selling foreign reserves on the open market and purchasing domestic currency can support the value of the currency in times of crisis or speculative attacks (Bagus and Howden 2016, 117).	ECB
External strength ratio	RATIO OF FOREIGN RESERVES TO TOTAL WORLD FOREIGN RESERVES. The higher a central bank's share of total world foreign exchange reserves a central bank is, the greater its potential to defend the currency internationally will be. This ratio may also indicate a currency area's previous capacity to generate exports, which benefits the quality of money through increased trade-based demand and by showing the currency area's competitiveness (Bagus and Howden 2016, 118).	ECB, IMF
Equity ratio	RATIO OF CAPITAL TO TOTAL ASSETS. Available equity can cushion potential losses on the asset side of the balance sheet and can thus prevent a government-initiated recapitalization, which could potentially increase the quantity of money, lowering the quality of money (Bagus and Howden 2016, 120).	ECB

¹² Foreign reserve assets are assets denominated in foreign currency and include reserve position in the International Monetary Fund (IMF), special drawing rights (an international reserve asset) created by the IMF, financial derivatives, loans to nonresident nonbanks, long-term loans to an IMF Trust account, and other assets that meet the reserve assets definition.

Dimension: Money supply		
Indicator	Reasoning and explanation	Source
Monetary base growth	Monetary base (currency in circulation and credit institutions' deposits held with the Eurosystem) is a measure of money supply. The growth is calculated as an annual rate.	ECB
Balance sheet growth	The size of the balance sheet (total assets) of the central bank is an important measure of money supply in circumstances of quantitative easing. Quantitative easing expands the balance sheet of the central bank beyond the level required to hold the interest rate at the target (Bernanke and Reinhart 2004). Balance sheet growth is calculated as an annual rate.	ECB
M1 growth	Monetary aggregate M1 is the sum of currency in circulation and overnight deposits. M1 growth is calculated as an annual rate.	ECB
M3 growth	Monetary aggregate M3 is the broad monetary aggregate: the sum of M1, deposits with an agreed maturity of up to two years, deposits redeemable at notice of up to three months, repurchase agreements, money market fund shares/units, and debt securities with a maturity of up to two years. M3 growth is calculated as an annual rate.	ECB

Dimension: Interest rate		
Indicator	Reasoning and explanation	Source
ECB deposit facility rate	The rate on the deposit facility, which banks may use to make overnight deposits with the Eurosystem.	ECB
ECB MRO rate	The interest rate on the main refinancing operations, which provide the bulk of liquidity to the banking system.	ECB
ECB marginal lending facility rate	The rate on the marginal lending facility, whereby the Eurosystem offers overnight credit to banks.	ECB
MRO and Taylor's rule rate spread	The spread between the target rate of the ECB's MRO and the Taylor rule's suggested rate indicates the stance of monetary policy interest rate-wise.	ECB, Bloomberg

Dimension: Financial system stability		
Indicator	Reasoning and explanation	Source
CISS	Composite Indicator of Systemic Stress (Hollo, Kremer, and Lo Duca [2012] is an indicator of contemporaneous stress in the financial system. Its specific statistical design is shaped according to standard definitions of systemic risk. The index incorporates five market-specific subindices created from a total of fifteen individual financial stress measures. The main goal of using stress indices such as the CISS is to measure the current state of instability, i.e., the financial system's current level of friction, stress, and strains (or their absence) and to condense that state of financial instability into a single statistic. The CISS's specific aim to emphasize the systemic nature of existing stresses in the financial system (systemic stress is interpreted as an ex post measure of systemic risk, i.e., risk which has materialized already).	ECB
Euribor-OIS rate spread	Euribor ¹³ reflects bank credit risk, and OIS ¹⁴ is considered risk-free; thus, the Euribor–OIS spread is widely seen as a gauge of the creditworthiness of the banking system. In times of stress, the Euribor, referencing a cash instrument, reflects both credit and liquidity risk, but the OIS has little exposure to default risk because these contracts do not involve any initial cash flows. The OIS rate is therefore an accurate measure of investor expectations of the effective rate set by the central bank over the term of the swap, whereas Euribor reflects credit risk and the expectation on future overnight rates. (Sengupta and Tam 2008)	ECB, Bloomberg
Banking system liquidity ratio	The liquidity of the commercial banking system is measured as the ratio of short-term assets (loans [up to one year], cash, and reserves at the ECB) divided by short-term liabilities (deposits redeemable at notice) and deposits of up to one year. This ratio shows the extent to which the banking system could fulfil its short-term obligations in case of financial troubles and bank runs.	ECB

¹³ The Euribor rates are based on the average interest rates at which a large panel of European banks borrow funds from one another.

¹⁴ The OIS rate represents a given country's central bank rate over the course of a certain period.

Dimension: Forward guidance		
Indicator	Reasoning and explanation	Source
MRO rate minus 2-year OIS rate spread	The OIS rate reflects expectations of future short-term interest rates plus a term premium (Hubert and Labondance 2018), which also shows expectations about a given country's central bank rate over the course of a certain period. The spread between the current MRO and the OIS rate shows to what extent market participants expect the central bank's interest rate policy to continue into the future.	ECB, Bloomberg

The dimensions and indicators of the index are flexible in the sense that they are mostly not specific to a particular central bank and can be applied to any currency and central bank. In this article, we will focus on the euro area and European Central Bank. To ensure maximum flexibility in using the index, it will be calculated using monthly data.¹⁵ The period for the euro analysis is the end of 1999 until the end of 2019.

One aspect not captured by the index is the institutional framework of the central bank (its independence, accountability and transparency, constitution, and staff and decision-makers) due to the lack of publicly available and quantifiable indicators. Although there are quantitative indicators of central bank independence, they are only available on an annual basis.¹⁶ Quantitative indicators of other aspects of the institutional framework are not available, since they are heavily subjective and depend on value judgments.

Once the indicators have been established, further steps in compiling the composite indicator are normalization of the data, weighting of the indicators, and aggregating them into a composite indicator. We will go through these steps very briefly; more information on the methodology can be found in the appendix.

¹⁵ If the index data is monthly, it can be easily used to calculate quarterly or yearly changes.

¹⁶ E.g., Garriga (2016), Masciandaro and Romelli (2019). Moreover, since the evaluation of central banks' independence does not change much over the years, it is more useful as a tool for comparing different central banks' level of independence than for tracking the change in a particular bank's independence.

NORMALIZATION

Normalization converts the data of the indicators on a common scale. This is crucial for the comparability of different indicators and to combine them into a composite. The normalization method used for the quality of money index was the min-max transformation. The reasons why the min-max transformation was chosen over the other methods were primarily a) the data used in the index are time series of variables which do not have high variability or any extreme values (in the cases of extreme values, methods based on standard deviation or distance from the mean are preferred) and b) according to the theoretical framework, changes in the indicator's value are important in the same way, regardless of the level (if this were not the case, the transformation should be concaved (log, root, exponential, or power) instead. The min-max transformation brings all the values of all the indicators onto a scale of 0 to 100, where 0 represents the lowest value and 100 represents the highest value (the formula used in the normalization can be found in the appendix).

WEIGHTING

Composite indicator is composed of individual indicators, which may have specific weights. There are different weighting methods, but they all fall into two categories: expert/public opinion-based methods and statistical methods. The weighting procedure selected needs to reflect the object or phenomenon, and it needs to be simple in order to be able to communicate the final weighting scheme. Literature on composite indicators considers weighting based on statistical methods to be more "objective," as statistical methods are not based on a decision-maker's subjective valuation.¹⁷ Two statistical tools that are often used in weighting are correlation and multiple linear regression analysis.

The weighting of the composite indicator was decided separately at the level of the dimensions and indicators, following two steps. The first step applied regression analysis and determined the weights of the dimensions. The second step applied correlation analysis and established the weights of the individual indicators

¹⁷ See Booyesen (2002); Zhou, Ang, and Poh (2007); and Decancq and Lugo (2013).

in each dimension (a detailed explanation of the two steps can be found in the appendix).

Table 2 shows the results of the first step, which used the linear regression analysis for dimension weights. After the adjustment, the coefficients of determination are not equal, but they are more balanced than in the case of equal weighting.

Table 2. Weighting adjustments in the first step (dimensions)

Dimensions	R2 with Equal Weights	R2 After Adjustment	Weights
Central Bank Balance Sheet	14%	36%	35% (max)
Money Supply	38%	44%	15%
Interest Rate	0%	15%	35% (max)
Financial System Stability	56%	35%	5% (min)
Forward Guidance	65%	30%	10%

In the second step, the equal weighting of indicators in each dimension was adjusted to avoid double counting using the correlation analysis. As explained in the appendix on methodology, the weights were distributed equally among all indicators in each dimension unless there were high levels of correlation (higher than 0.6).

AGGREGATION

The aggregation process combines the values of a set of indicators into one composite indicator. An important distinction of aggregation methods in the literature is between “compensatory” and “noncompensatory” approaches.¹⁹ According to Bouyssou (1986, 151), aggregation is noncompensatory if no tradeoffs occur and is compensatory otherwise. The definition of compensation therefore presents a tradeoff. Compensatory aggregation assumes that poor

¹⁸ Foreign reserve assets are assets denominated in foreign currency and include reserve position in the International Monetary Fund (IMF), special drawing rights (an international reserve asset) created by the IMF, financial derivatives, loans to nonresident nonbanks, long-term loans to an IMF Trust account, and other assets that meet the reserve assets definition.

¹⁹ See Munda (2005); and Greco et al. (2019).

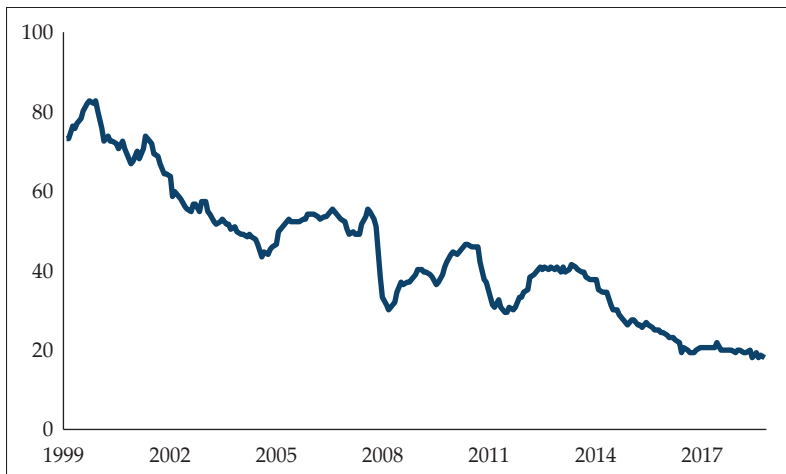
performance in some indicators can be compensated for by high performance in other indicators.

Linear compensatory aggregation was chosen as the most suitable method for aggregating the quality of money index. The value of the composite index was the arithmetic average of all the indicators weighted by their respective weights. The primary reason for this choice is that the theoretical framework, which is the source of the different dimensions of the index, implicitly assumes the possibility of compensation (bad performance in one of the dimensions of quality of money can be compensated with good performance in the others). Moreover, linear compensatory aggregation is the most common method used in the creation of composite indicators (Gan et al. 2017).

4. RESULTS

The results of the quality of money index are presented in figure 1 below. The quality of money index suggests that over the period of the euro's existence the quality of money overall has declined by 55 points (on a scale of 0 to 100), from 73 in December 1999 to 18 in August 2019. The rate of decline on average is 0.22 points per month, or 2.7 points per year.

Figure 1. Quality of money index



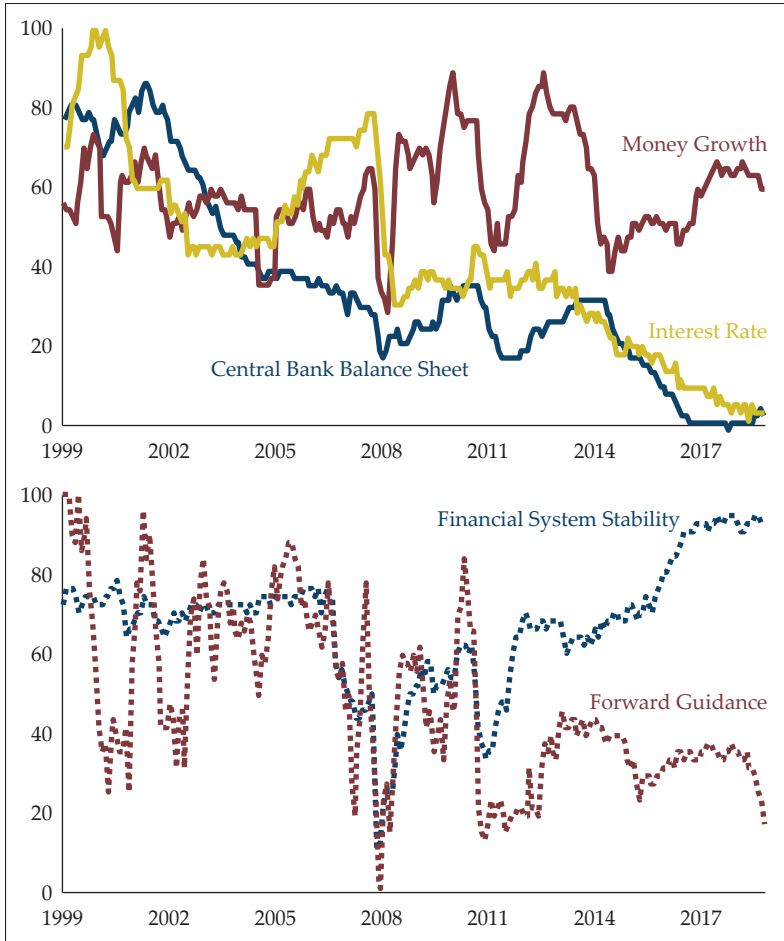
Scale: 0 to 100.

We can distinguish four periods for the euro in the quality of money index. The dynamics of the quality of money were different during each of these periods, and they represent distinctive economic conditions and ECB policy environments.

The first period, from 1999 to mid-2005, marks the initial decline in the quality of money in the eurozone. The two most important drivers of the decline were the ECB's balance sheet and interest rate policy (see Figure 2 below for the dynamics of each dimension). The quality of the balance sheet declined quite significantly during this period due to a decline in liquidity. The monetary base was growing faster than the value of gold or gold receivables, and the value of reserve assets in general was falling. Moreover, there was a drop in the value of foreign reserves and a decline in the central bank's equity ratio. In general, the ECB's balance sheet during this period became less liquid, and it had less foreign reserves and equity as a ratio to total assets. During the first period the ECB also significantly reduced the interest rate. The MRO rate was reduced from 4.75 in 2000 to 2 percent in 2003. The interest rate also fell below the one suggested by the Taylor rule after September 2001.

The second period lasted from about mid-2005 to mid-2008. The quality of money during this period stopped declining and stayed relatively stable. The quality of the balance sheet was still declining, but it was offset by the increased interest rates—the ECB had been transitioning out of the stimulating monetary policy and had gradually increased the MRO rate to 4.25 percent in 2008.

Figure 2. Dimension of the quality of money index



The third period, from mid-2008 to early 2013, was one of financial and economic turmoil. This period saw two very significant drops in the quality of money. The first one lasted from the second half of 2008 to the first half of 2009. There were many factors that contributed to this drop.

Firstly, the financial system's stability declined rapidly. Financial turmoil spread to the real economy, which halted economic growth

and induced the ECB to try to save the financial sector and prop up the economy by rapidly reducing the interest rates to a new record low of 1 percent. It quickly increased the growth of the money supply, and this increased expectations in the market that the central bank would continue with the inflationary monetary policy.

After the first half of 2009, the economic and financial situation in the eurozone somewhat stabilized, and the drop in the quality of money was partially offset by the increase in financial stability and reduced growth in the money supply. However, the situation worsened very quickly again in the second half of 2011, when financial markets started panicking again due to the sovereign debt crisis in some of the euro countries, primarily Greece. The stability of the financial system rapidly declined again, and the bond yields of weak euro member governments soared. This was the catalyst for ECB president Mario Draghi's famous speech in which he said that "[w]ithin our mandate, the ECB is ready to do whatever it takes to preserve the euro." The ECB again lowered the interest rate, increased the money supply, and started conducting quantitative easing and forward guidance. This caused the quality of the balance sheet to decline, since the new policies reduced the liquidity, reserves, and equity of the ECB. All this contributed to the significant drop in the quality of money during this period. After these measures, the stability of the financial system increased again and somewhat reversed the drop in the quality of money.

The last period started around 2013 and lasted at least until the end of 2019. During this period, the ECB continued conducting the policies of quantitative easing and forward guidance. The interest rates were reduced further until they reached 0 percent in 2016. The growth of money supply again increased and was especially high in 2013 and 2014. Quantitative easing led to the vast expansion of the central bank's balance sheet and of the excess reserves of the commercial banks at the ECB. The ECB's communications focused on forward guidance, assuring market participants of accommodative monetary policy in the future. All these measures convinced financial markets that the troubles are behind them, and different measures showed the gradual stabilization of the financial system. Throughout this period the quality of money declined, and financial system stability is the only dimension of the index that increased. This suggests that the policies enacted by the ECB were successful

in stabilizing the financial system, but these policies caused a significant decline in the quality of money in the eurozone.

Below the limitations of the quality of money index and the importance of the quality of money—as a theoretical notion and a measurement—will be discussed briefly.

5. DISCUSSION AND LIMITATIONS

As mentioned previously, the framework of quality of money is based on the subjective value theory. Money as a good is valued to the extent that it fulfils the needs of market participants. In particular, money is valued when it has the properties of being a medium of exchange, a store of value, and a unit of account. However, these properties, which ones are most important, and how a particular money fulfils them are subjective value judgments. Therefore, attempts to chart the compositions of these properties cannot be thorough and objective by definition. They in themselves will be bound up in value judgments, which may be different from those of market participants. Moreover, the methodology (normalization, weighting, aggregation) of the creation of a composite index in itself requires the researcher to make subjective decisions.

Not all the dimensions that may be important to the quality of money can be easily quantified; e.g., the scholarship identifies the organization of monetary authority (the central bank's independence, its accountability and transparency, its constitution, and its decision-makers) as one of the dimensions that is important. However, there are no quantifiable indicators to measure it. These questions are especially laden with subjective judgments. This suggests that some of the identified dimensions of the quality of money are more quantifiable than others.

Nevertheless, the composite indicator of quality of money allowed the significant decrease in the quality of the euro since its introduction to be captured. Thus, changes in the quality of money may be an important factor in the changes in the demand for money. In theory, given all the other factors (interest rate, income, prices, etc.) in the demand for money, the preference of market participants to hold money balances may change due to fluctuating quality of money. Empirical measurement has shown that changes

in the quality of money over a year may be quite significant. Why is this important?

Quality of money is one more factor which needs to be incorporated into the analysis of the demand for money. This factor is quite different from the ones already accounted for in theories about the demand for money, particularly the quantity theory of money. A qualitative theory of the value of money allows the subjective judgments of market participants to be weighted. This means that the changes in the perception of value—and thus the demand for money—can be a lot more abrupt and extensive in comparison to the results of the quantitative theory of money, in which demand for money depends on more stable factors (quantity of money, level of output, etc.).

Moreover, the notions of quality of money and demand for money are intricately linked to prices. Price level is the result of the intersection of the demand for money balances and money supply. Shifts in the supply of money, as well as demand for money, result in changes in the price level. Thus, changes in the quality of money as one of the factors of money demand may cause changes in the price level. More particularly, if decreasing quality of money reduces the demand for money, the price level increases.

The application of the quality of money index to the eurozone, and the analysis of the index's dynamics alongside the policies of the ECB, showed that the economic and financial problems of the eurozone led the monetary authority to make decisions and enact policies which led to the deterioration of the euro's quality. Monetary policy became more inflationary. The quality of money was sacrificed in order to prop up the economy and save banks and other financial institutions.

The decreasing quality of the euro is in line with the theoretical reasoning suggested by Žukauskas and Hülsmann (2019). They claim that the quantity theory of money cannot explain why prices in the financial sector grow faster relative to prices in the nonfinancial sector and suggest a novel explanation of how monetary policy influences the prices of financial assets relative to nonfinancial assets that is based on the quality of money. A decline in the quality of money decreases the demand for money, with market participants shifting to financial assets as an alternative form of holding wealth, resulting in the increased price of financial assets.

Lastly, if quality of money, which depends on monetary policy and the overall functioning of the monetary system, is a factor in money demand, then quality of money is one of the transmission mechanisms for monetary policy. The actions of central banks influence the quality of money, which in turns affects the money demand. According to this framework, then, monetary policy not only influences the economy by changing the supply of money, but also by affecting the demand for money. Demand for money becomes (at least partly) an endogenous variable in the monetary policy.

CONCLUSIONS

This article suggests that the quality of money is a concept that offers new insights on how monetary policy may influence not only the supply of money, but also the demand for it. It offers an empirical measurement of the quality of money index here applied to the euro area. The index suggests that the quality of the euro has fallen significantly since its introduction in 1999. To the extent that the demand for money subjectively depends on the quality of money, this fall has been significant enough to influence the price level in general and prices in particular (e.g., financial asset prices).

It is important to incorporate the quality of money into the analysis of the demand for money. Moreover, since central banks influence the quality of money, it is vital to treat it as one of the channels for the transmission of monetary policy. Central banks, their institutional frameworks, and their policy decisions impact the quality of money, which in turns affects the demand for money, the price level, and other variables in the economy.

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APPENDIX

NORMALIZATION

In cases where an indicator's higher values represent higher values in the index,

$$I_a^t = \frac{x_a^t - \min(x_a)}{\max(x_a) - \min(x_a)} * 100$$

Also, in cases where an indicator's higher values represent higher values in the index,

$$I_a^t = \frac{\max(x_a) - x_a^t}{\max(x_a) - \min(x_a)} * 100, \text{ where:}$$

I_a^t is the transformed value of an indicator (a) at time t ,

x_a^t is the data point of an indicator (a) at time t ,

$\min(x_a)$ is the minimum of all data points of an indicator (a), and

$\max(x_a)$ is the maximum of all data points of an indicator.

WEIGHTING

Weighting of dimensions (subindices)

The composite index of quality of money contains five subindices, which each contain a varying number of indicators. The weight of each subindex is decided through the regression analysis of the particular subindex and the composite index. The deciding factor is the subindex's coefficients of determination (R^2) of single-variate regressions. The aim is for the coefficients of determination of each subindex to be as close as possible to each other, which means that the proportion of predictable variance in the dependent variable (composite index) due to each independent variable (subindex) should be more or less equal and not dominated by any one subindex. The procedure starts with equal weighting of all the subindices, and the weights of the subindices with the lowest coefficients of determination are increased (at the expense of subindices with high coefficients of determination) until the level of the highest possible equality is reached. There are several restrictions to this procedure. First, for reasons of simplicity and aesthetics, the increment of

adjustment (up and down) is 5 percentage points. Second, each subindex should have a weight of no less than 5 percent. This is for theoretical integrity, to maintain at least minimum representation of each factor (subindex) in the composite index. Thirdly, no subindex should have a weight of more than 35 percent (roughly one-third). This is to avoid the overrepresentation of a subindex.

Weighting of individual indicators

The weighting of indicators in the subindices corresponds to the weights of the subindices, which are decided in the first step. Therefore, the general rule is that the weights of the indicators in a dimension are equal to the weight of the subindex divided by the number of indicators in it. There are two rules according to which the weights of individual indicators can be adjusted to reflect the indicators more accurately.

- Some subindices have several groups of indicators, which refer to different topics or types of indicators/measurements. For example, the central bank balance sheet subindex contains for liquidity, international strength, and equity position subtopics. The first rule is that for a certain subtopic, all indicators in a subtopic are weighted equally despite the number of indicators (which means that different indicators may have different weights in the subindex depending on the number of them in the topic).
- The second rule for weighting the individual indicators in a subtopic is based on the correlation analysis. When indicators have a high and statistically significant correlation (judged by Pearson's coefficient of correlation, which is higher than 0.6), they are treated as one indicator (their weights are reduced to jointly equal the weight of other indicators).

Table 2 shows the results of the first step, which used the linear regression analysis to establish the weights of dimensions. After the adjustment, the coefficients of determination are not equal, but they are more balanced than in the case of equal weighting.