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Commodity money inflation: theory and evidence from France in 1350–1436 ☆

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Abstract

This paper presents a theory of inflation in commodity money and supports it by evidence from inflationary episodes in France during the 14th and 15th centuries. The paper shows that commodity money can be inflated similarly to fiat money through repeated debasements, which act like devaluations. Furthermore, as with fiat money, demand for commodity money falls with inflation. However, at high rates of inflation demand for commodity money becomes insensitive to inflation, since commodity money has intrinsic value in addition to its transactions value. Finally, we show that anticipated stabilization reduces demand for commodity money.

JEL classification: E31; N13

Keywords: Inflation; Commodity money; Debasement; Seignorage; Stabilization

1. Introduction

France experienced many inflationary episodes during the "hundred years' war" in 1350–1436. We use data on minting and prices from this period to test some of the

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basic predictions of monetary theory with respect to the demand for money during inflation. In order to run these tests we first apply the theory of money and inflation to commodity money. Our theory predicts that the demand for commodity money falls with inflation, similar to the demand for fiat money, as long as inflation is relatively low. When inflation becomes high the demand for commodity money becomes insensitive to the rate of inflation. Our theory also predicts that demand for commodity money declines when stabilization is anticipated. This effect is similar to stabilization of a fiat money inflation that replaces the old notes with new ones. Our data strongly support these two results.

The paper first describes how commodity money was inflated by repeated debasements. In each new debasement the crown issued a new coin with a lower content of the precious commodity, which was silver in our historical example. When the new coin entered circulation, the quantity of money increased and prices rose. The crown gained from such debasements since it collected seignorage from coins minted and reminted. The main intuition behind this result is Gresham's Law. The new coin, which had less silver content, drove out some of the older coins, which contained more silver. Agents gained from reminting old coins despite the loss of seignorage. This could be possible only if agents could not differentiate between coins, namely if coins circulated by tale rather than by weight. This assumption was recently questioned in Rolnick et al. (1996), but we find that it is strongly supported by our empirical results.

The theoretical part of the paper uses a Sidrauski-type model of demand for liquidity and applies it to commodity money under repeated debasements. It shows how debasements and inflation cause losses to coin holders by eroding the value of coins. Hence, expectations for higher inflation reduce the demand for money. But losses to holders of commodity money are bounded, due to the alternative use of coins by reminting them into new coins. Furthermore, when inflation is sufficiently high, so that all coins are reminted in every debasement, the demand for commodity money becomes insensitive to the rate of inflation and depends only on the rate of seignorage. This is the first main result of the paper.

Next the paper analyzes the effect of anticipated stabilization. Under commodity money, stabilization requires issuing new coins with higher content of silver, since the process of inflation has previously reduced the silver content of coins to very low levels. This is indeed how all the inflationary episodes we study ended. Hence, in stabilization old coins become either completely useless or go through silver extraction, which is quite costly. This makes stabilization costly for money holders, and anticipating it reduces the demand for money. This is the second main result of the paper.[1]

The empirical part of the paper examines these two predictions of the model. Although we do not have direct observations on the demand for money in medieval

[1] The effect of stabilization in fiat money depends on what the government intends to do with the old paper money. If it remains in use such anticipations increase the demand for money. If it is replaced or taxed, such anticipations reduce money holdings, just as in our historical case. For an example see Paal (2000) on the second Hungarian hyperinflation.

France, we do have data on minting volumes by the royal mints and our model enables us to relate the two variables. Our empirical analysis indeed shows that the negative effect of the rate of inflation on the demand for money is strong at low rates of inflation and disappears at high rates of inflation. We also find support to the other result of the paper. We estimate the probability of stabilization under rational learning and show that this probability has a negative effect on the demand for money. This finding can also be viewed as some evidence for rational Bayesian learning, which is interesting as well.

This paper, therefore, extends the existing literature on commodity money and connects it to the literature on money and inflation. Recent important contributions to the theory of commodity money are Li (1995), Sargent and Smith (1997), and Velde et al. (1999). While these papers develop the basic theory of commodity money and of a one-time debasement, our paper offers three important additions to this literature. First, it extends the analysis to repeated debasements, namely to inflation, which to our best knowledge has never been done before. Second, it derives testable quantitative predictions on the demand for money during inflation. That leads to our third contribution to the literature: an empirical analysis of minting during inflation, which supports the main results of our model.[2] On the historical side our paper is related to various historical studies of debasements, especially to Sussman (1993) that describes the same historical episode, but also to other studies on debasements in early periods of modern Europe.[3]

The paper is organized as follows. It begins with historical background in Section 2. Sections 3–6 provide the theory of commodity money inflation, where Section 3 outlines the model, Section 4 analyses minting and prices, Section 5 studies the demand for money and inflation, and Section 6 studies the effect of expected stabilization. Section 7 describes the data and Section 8 presents the empirical analysis. Section 9 concludes.

2. Historical background

During the French economic and commercial expansion of the 13th century, there was a growing demand for a common medium of exchange to facilitate commercial transactions. That development coincided with rulers' efforts to reaffirm their sovereignty by controlling the currency and raising seignorage revenues. They achieved these objectives by establishing a system of mints, which charged seignorage for coining private bullion into royal coins. By the end of the 13th century these mints were gradually replacing private mints.

[2] Extending the analysis from a one-time debasement to inflation comes at the cost of simplification. We use the simpler Sidrauski model instead of search or cash-in-advance models as the above papers do.

[3] See Bordo (1986) for a survey, Gould (1970) for the Tudor debasement, Kindleberger (1991) for debasements during the 30 years war; Miskimin (1984) for France; Motomura (1994) for Spain and Pamuk (1997) for the Ottoman Empire.

The royal mint system kept expanding throughout the 14th century and by 1415 it had 24 mints in France, requiring a relatively sophisticated mechanism of monitoring mint masters. It involved incentives, like paying mint masters some percentage of the coins struck, direct supervision by royal officials, and also inspection of random samples of coins sent from mints to Paris. As a further reflection of the influence and control of the central Parisian administration, the regional mint accounts were written in the French of the court, whereas all other local fiscal accounts were written in Latin or in local dialects. This well-organized and well-monitored mint system gave the crown an instrument capable of effectively carrying out its monetary policy.

Mints combined pure silver with base alloys to produce an alloy of a given fineness (percentage of silver) and then cut it into coins. The coins' face value was not stamped on them but rather assigned by the crown. The prevailing accounting system in France was the *tournois* system, based on the *denier tournois*, the penny of Tours. In this system, 12 deniers equaled one *sou*, and 20 sous made up one *livre*. The livre tournois was used as a numeraire by which all commodities, silver and gold included, were valued. Royal mints produced three types of coins: (1) full bodied gold coins of denominations greater than one livre, (2) silver coins of 15, 10 (the most popular), 5 and 3 deniers, (3) petty coins, containing less silver, of two, one and half denier.

In ordinary times the monetary authorities were concerned mostly with responding to fluctuations in market prices of precious metals and with maintaining the quality of royal coins. That included monitoring mints, combating counterfeiting and responding to wear and tear of coins in circulation. But in periods of fiscal crisis the crown had an additional objective, namely to raise inflation tax. This was achieved by debasing the currency. A debasement was an act of lowering the silver content of the livre tournois, usually by issuing a new coin with the same face value, but with smaller content of silver. Debasements raised prices by raising the nominal value of bullion, in a similar way to modern exchange rate devaluations. The debasements increased the demand for nominal money, which was met by increased minting of new silver bullion and increased reminting of older coins. This minting activity increased the crown's seignorage revenues. When debasements were repeated they created inflation.

The period of the Hundred Years War experienced many episodes of repeated debasements. This war between England and France, which began in the 1330s and lasted with intervals until 1452, placed a heavy burden on government finance. The fiscal resources of the French monarchy were designed to cover its regular operation, while financing a war required additional resources on a grand scale. The French crown resorted to seignorage revenues by debasing the royal coins primarily because seignorage was part of the traditional feudal rights of the king. As such, the crown did not require the consent of the representative assemblies for levying this tax, while other taxes were always contested, hard to obtain and required extensive and lengthy bargaining to secure. Moreover, the collection costs involving seignorage revenues were small and the flow of funds to the treasury timely.

The extent of debasement depended on the (mis)fortunes of war and on the political bargaining power of the king. There were two main periods of extensive debasements: 1337–1360 and 1418–1436. The first was associated with the outbreak of the war, the major French defeats at Crecy and Poitiers (when King Jean II was captured by the English and held for ransom) and the onset of the Black Death. The second period followed the defeat at Agincourt and the civil war between the Armagnac and Burgundian factions. The episodes of inflation by repeated debasements always ended in "stabilizations". When fineness reached very low levels the crown stopped the process and issued new coins of high fineness. Soon enough, as the war went on, debasements would start all over again. These dynamics are reflected in the following four figures.

The first debasement period from 1337 to 1354 witnessed 34 mild debasement cycles with relatively long periods of stable money (see Fig. 1). The period from 1354 to 1360 saw 51 rapid debasement cycles that reached hyperinflationary magnitudes in 1360 (see Fig. 2). The average rise in the price of silver during debasement cycles in 1354–1360 was 200% and the average duration of such cycles was 400 days. The

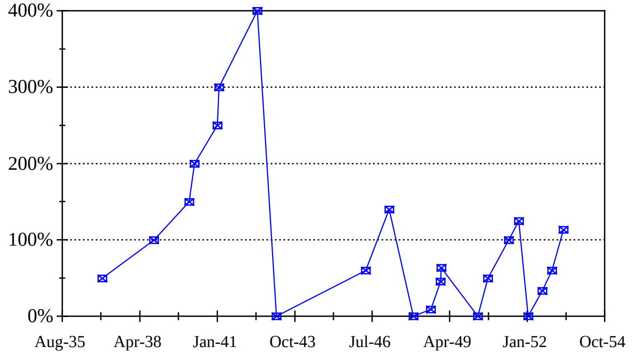

Fig. 1. Cumulative debasement rate, France: 1337–1354.

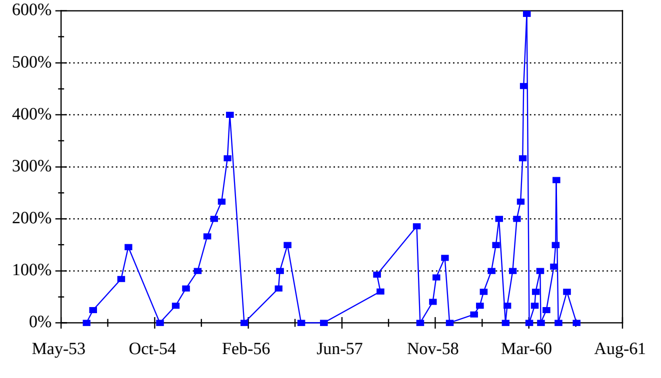

Fig. 2. Cumulative debasement rate, France: 1353–1360.

largest debasement cycle increased the price of silver by 600% and lasted only 116 days. The smallest cycle increased price by 66%. The shortest debasement cycle was 33 days during which the nominal value of silver increased by 100%.

The second debasement period from 1417 to 1422 was characterized by a prolonged process of debasement during which the nominal value of silver was increased by 3500% without any attempt to stabilize the currency (see Fig. 3). Milder debasements, with an average of 80% per cycle, followed until 1436 (see Fig. 4).

The periods of debasements raised not only the price of silver, which is shown above, but prices of gold and other commodities as well. These were inflationary episodes very similar to what we know from modern history. While high-quality price data for France are lacking, nevertheless, Table 1 reproduces data from Sussman (1993) for the Dauphiné, which shows that grain prices followed the course of mint prices whereas the price of gold followed the price of silver.

We next describe the mechanics of money creation, which enabled these inflationary episodes. The monetary authority offered to exchange, at the ‘‘mint price’’, any amount of bullion in return for royal coins. The mint price was the

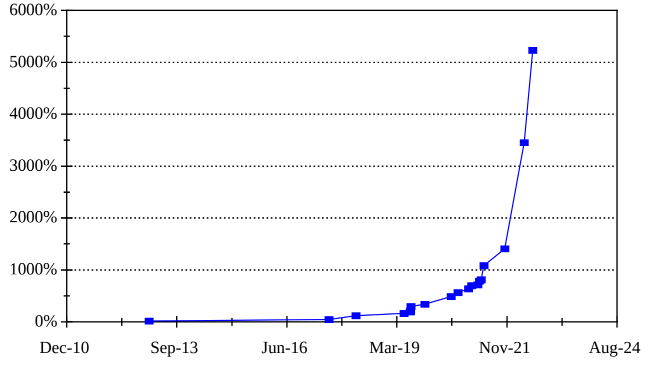

Fig. 3. Cumulative debasement rate, France: 1412–1422.

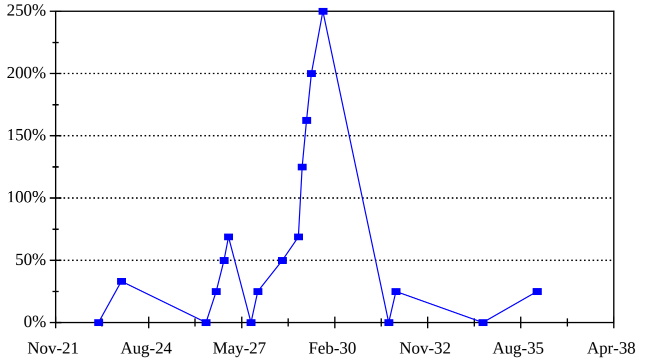

Fig. 4. Cumulative debasement rate, France: 1423–1436.

Table 1
Annual price changes in the Dauphiné, 1418–1422

	Silver		Gold	Grain
Year	Mint par (%)	Mint price (%)	Gold price (%)	Wheat price (%)
1418	50	13	22	50
1419	33	56	45	40
1420	50	43	88	−40
1421	167	75	100	100
1422	200	100	233	200
Cumulative	2300	775	2122	656

Source: Sussman (1993).

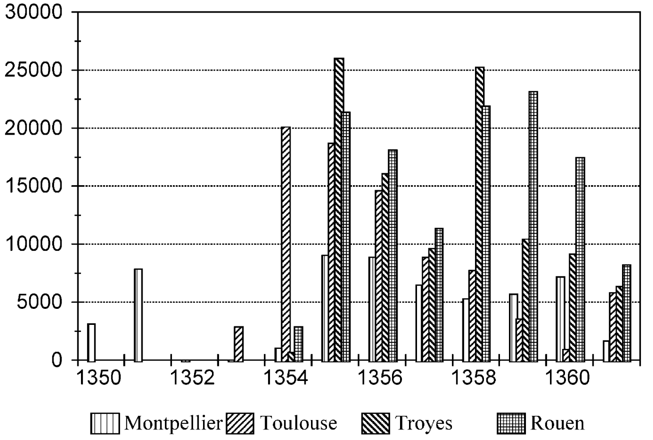

Fig. 5. Minting volumes: France 1350–1361 (in marcs of pure silver).

amount of coins minted from one unit of bullion net of seignorage and of mint's profits. Besides minting fresh bullion, the mint would also ''remint'' older coins into new ones. In ordinary times people preferred not to remint old coins to avoid seignorage losses, unless the old coins were damaged. But after a debasement people could remint old coins of high fineness into new coins of low fineness, of the same face value. That would increase the number of coins even after deduction of seignorage. Of course, that was possible only if the different coins with the same face value were indistinguishable in ordinary daily life. This is the main assumption we make in this paper.

There are a number of facts that support this assumption. First, our data show that debasements indeed triggered much minting and reminting. Fig. 5 presents the amounts of minting in the first debasement period at the four major mints: Montpelier, Toulouse, Troyes, and Rouen and shows how large minting was during these debasements. In 1355 alone total mint output for these four mints was about 75,000 marcs of pure silver (20 tons), while the annual average of total minting in France in non-debasement years was only 5,000 marcs.[4] Seignorage revenues also increased significantly during debasements. According to Maurice Rey, seignorage revenues in 1419 amounted to six times the ordinary royal revenues.

We also have ample direct historical evidence that information on the silver content of coins was costly. In order to find fineness one needed to assay the coins, which was an expert's job and was performed in Medieval Europe by money-changers. They were usually expert goldsmiths, either government agents or private entrepreneurs. "Changers manuals" were professional books, which described in detail the procedures for assaying and evaluating coins. Surviving archival documents, like changers account books, inform us about their operations and show that they were fully aware of the debasement process, since they catalogued, in detail, the coins from the various issues and determined their exchange rates. It is therefore plausible that these changers acted as middlemen between the public and the mints.

Costly information can explain both how different coins could circulate together indistinguishably, and how people could know which coins to remint after each debasement. If information is costly it is purchased only when the benefit is sufficiently high. Thus, people did not go to an expert before each transaction at the marketplace, but they did go to an expert after a debasement to check which coins to remint.[5] Indeed our historical data show that the bulk of reminting usually took place during the first days after each debasement.[6]

Replacing old coins with new coins also happened in stabilizations. This time coins were exchanged for fewer coins with higher fineness, which is called in the historical literature "recoinage". A different term is used since it usually involved a different technology. While reminting only required adding cheap metal to coins, recoinage required extraction of silver from old coins to increase fineness and should have been more costly.[7] This is a second assumption that we make in the paper, that recoinage was costlier than reminting. We have found some historical evidence that these recoinage costs were significant. For example, after the debasement cycles of 1353–1354 and 1360 debased coins were purchased by mints at much lower prices than bullion of the same amount of silver. The difference in price was 10–15%.[8]

[4] Note that minting levels in Montpelier and Toulouse decline after 1356. This is due to the stabilization of the currency in the South of France in return for taxes voted by the nobility of that region.

[5] Actually the mint itself could also supply this service to money holders.

[6] For more on asymmetric information and commodity money see Gandal and Sussman (1997).

[7] Recoinage could also be achieved by adding silver to the old coins, but that was not very likely in the historical period we discuss. Before discovery of silver in America, the amounts of silver in Europe were small and mostly in the form of coins.

[8] See De Saulcy (1879, pp. 352, 462).

3. The model

Consider a small open economy in a discrete time framework. There is an aggregate consumption good in the economy. Each individual produces 1 unit of the consumption good during each period of time. We further assume that the individual cannot consume his own product but only production of others. Hence, each individual has to trade in order to consume. We further assume that trading takes place in small quantities and thus each individual trades many times during a single period of time. We assume that there are two assets in the economy, silver (in the form of bullion) and money (coins). Both silver and the consumption good are assumed to be internationally tradable, and thus have a fixed relative price, which is assumed to be 1. Silver can be traded over time as well. Lending and borrowing of silver is done in the world's capital market at a world interest rate, which is assumed to be fixed and equal to r. The second asset is money, which comes in the form of coins that contain silver. Money is non-traded internationally, but is the only legal tender within the economy. The price of silver and of the physical good in terms of money is P_t.

There is a continuum of size one of consumers with infinite life horizons. They derive utility from consumption and from money holdings, since they need this money to carry out their many transactions during the period. This model therefore follows the tradition of money in the utility function, which began with Sidrauski (1967), and has been recently adapted to an open economy in Obstfeld and Rogoff (1996, Chapter 8). For the sake of simplicity consumers are assumed to be risk neutral. Their utility in time 0 is

$$U = \sum_{t=0}^{\infty} (1+\rho)^{-t} \left[c_t + v\left(\frac{m_t}{P_t}\right)\right], \tag{1}$$

where c_t is consumption in period t, m_t is the amount of money (coins) held by the individual at the beginning of period t and v is a standard concave utility function. For the sake of simplicity we assume that the subjective discount rate is equal to the world interest rate, i.e. $\rho = r$. Note, that due to the unit size of the population, m is also equal to the aggregate demand for money.

Money is issued by mints, which offer Q_t coins for 1 unit of silver in period t. We call Q_t the "mint price". The fineness, namely the proportion of silver in coins issued in period t is f_t. We assume that all coins have the same weight, and normalize it to be 1, the same weight as one unit of silver.[9] The overall amount of coins that can be made of one unit of silver is $1/f_t$, but consumers who bring silver for minting get fewer coins, since the mint extracts seignorage at a rate s_t, $s_t \geqslant 0$. Hence

$$Q_t = \frac{1-s_t}{f_t}. \tag{2}$$

[9] Historically, not all coins had the same weight. This is of course only a simplifying assumption.

In this paper we consider debasements, namely increases of Q_t by government, through reduction of fineness. More precisely, we consider episodes of repeated debasements over a long period of time, during which the mint price rises continuously.

Mints issue new coins in exchange of bullion, and also in exchange for old coins, by reminting during debasements, or by recoinage during stabilizations. As discussed in Section 2, recoinage is more costly. We therefore assume that reminting is costless (except for seignorage), while recoinage costs x per one unit of extracted silver.

We next lay out the informational and timing assumptions of the model. Each period opens with an announcement of a debasement (or a stabilization). Mints operate at the beginning of the period, while trade in goods, which requires money, takes place only later. We assume that all coins look alike for ordinary people and cannot be distinguished without help of experts. Such help is costly. To simplify things we assume the following cost structure: in each period an individual can obtain one evaluation of his coins for free, but additional evaluations are infinitely costly. As a result, an individual evaluates coins only at the beginning of the period before going to the mint (or at the mint). Then they decide how much silver to mint, which coins to remint, which coins to turn into silver and which coins to keep in circulation. Later on in the period, when goods are continuously traded, the set of coins changes and the initial information is lost, since all coins look alike. Hence, due to the law of large numbers, by the end of each period the composition of coins held by each individual is the same as the economy-wide composition.[10]

The government imposes no taxes and finances its activity by seignorage only. In each period it sets both fineness f_t and the seignorage rate s_t and uses the seignorage revenues to finance its expenditures. We assume that the government spends these revenues on imports rather than domestically. This assumption is made for tractability only, and assuming alternatively that seignorage revenues are used domestically, does not affect the main results of the model.[11] Finally, if the government decides to stabilize the currency, it issues new coins with higher fineness. In other words, it reduces the mint price Q and fixes it at the new lower level thereafter.

We further assume that all markets are perfectly competitive and that expectations are rational. We first analyze debasements and inflation that continue forever, without any stabilization. In the next stage we add stabilizations to the analysis. The public anticipates stabilization at the end of the debasements process, but does not know its exact timing.

[10] Actually we could assume that most consumers did not know even in the beginning of the period the composition of coins they were left with, since most of them used the mint as the expert. The mint probably told them: "We give you more coins for these, and you can keep the other coins."

[11] Historically, the crown used seignorage income for both domestic purchases and imports. Interestingly, it listed its seignorage revenues in its accounts by its silver value.

4. Minting decisions and the supply of money

We begin the analysis of equilibrium dynamics by looking at the decisions made in the beginning of the period, after the consumer learns of the composition of his coins from the expert or the mint. First, the consumer remints all coins from which he gets more coins back. Formally, the consumer remints all coins with fineness f such that

$$fQ_t = \frac{f}{f_t}(1 - s_t) \geqslant 1. \tag{3}$$

Since fineness is non-increasing over time, only the older coins with higher fineness are reminted. Hence, for every t there is a former period $\tau(t) < t$, such that coins older than it are reminted and $f_{\tau(t)}$ is the highest fineness held. This threshold period is defined by the two following conditions: $f_{\tau(t)} < 1/Q_t$ and $f_{\tau(t)-1} \geqslant 1/Q_t$. Note that the decision on reminting does not depend on the price of silver P_t.

Next the consumer decides on exchanging silver for coins or coins for silver. He mints silver into coins as long as the price of silver P_t is less than or equal to the mint price Q_t. Finally, the consumer can also go to the goldsmith and turn coins into silver, if the value of extracted silver exceeds the number of coins used. Hence, silver is extracted from coins of fineness f if

$$P_t \geqslant \frac{1}{f}\frac{1}{1 - x}. \tag{4}$$

The supply of money can therefore be described by a step function, as in Fig. 6, which has the price on the vertical axis and the quantity of money M_t or m_t on the horizontal axis. The amount $M_{t,r}$ is the historically given amount of coins from the last period after reminting, but before bullion minting or silver extraction. This

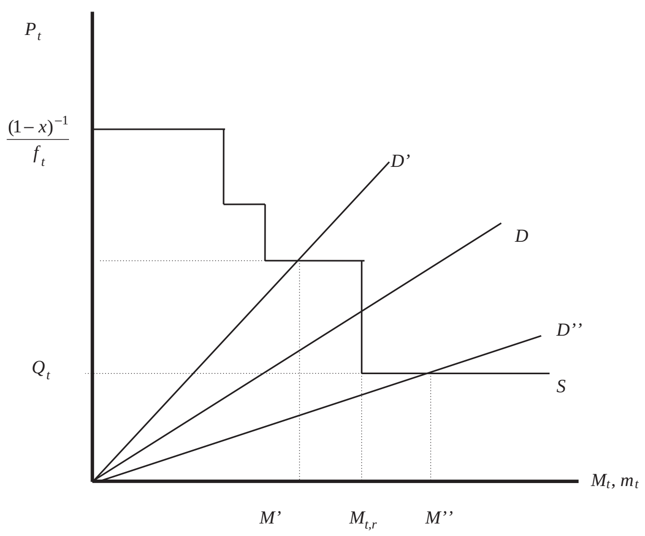

Fig. 6. The demand and supply for money.

amount does not depend on the price P_t, as explained above. At Q_t the supply becomes infinitely elastic as silver is minted into coins at the mint price. The steps to the left of $M_{t,r}$ reflect the possibility of extracting silver from coins, as shown in (4), first the coins with highest fineness, then with less fineness, until the lowest fineness f_t.

Money is demanded by consumers only, as the government only imports goods and does not use coins. The demand is proportional to the price level P_t and is presented in Fig. 6 by rays from the origin. The equilibrium, which determines both the equilibrium price level and the equilibrium quantity of money, is given by the intersection of the supply step function and the demand for money. The equilibrium price must, therefore, be within the following range:

$$\frac{1}{f_t}\frac{1}{1-x} \geqslant P_t \geqslant Q_t = \frac{1}{f_t}(1-s_t).$$

Fig. 6 presents three possible equilibria. If the demand for money is small, as in D', silver is extracted from coins. If the demand for money is D, there is neither silver extraction nor silver minting and $M_t = M_{t,r}$. In both cases the price of silver exceeds the mint price Q_t. If the demand for money is larger, as in D'', bullions are minted into coins and the price equals the mint price.

Consider next the effect of debasement on equilibrium. A debasement introduces a new coin with lower fineness. Hence it raises Q_t and shifts some of the supply curve upward. If the new fineness is low enough, so that f_t falls below $f_{\tau(t-1)}(1-s_t)$, there is reminting, which shifts the supply curve to the right as well, as it makes the upper step in the supply curve wider. Hence, a debasement tends to raise the price. Clearly, there can be a debasement, which leaves the price unchanged, if there is no reminting and if the previous price exceeds the new mint price. But if debasements are repeated, they finally raise prices. Thus, repeated debasements cause inflation.

When the authorities declare stabilization, all coins must be reminted and hence the supply of money becomes infinitely elastic at the new mint price Q_t. As a result, the equilibrium price, in the case of stabilization, is equal to the mint price.

5. Debasements and inflation

In this section we consider the case of repeated debasements at a fixed rate π. Assume that the monetary policy the government pursues is the following: the rate of seigniorage is fixed over time, namely $s_t = s$, and the government debases the currency every period at a fixed rate π.[12] Formally:

$$\frac{Q_t}{Q_{t-1}} = \frac{f_{t-1}}{f_t} = 1+\pi. \tag{5}$$

If the rate of debasement is fixed, the number of types of coins in circulation is fixed as well, and we denote it by T. Every period a new coin is introduced and the oldest coin is reminted, namely $\tau(t) = t - T + 1$ for every t. T is the unique integer which

[12] Historically, during debasement episodes seignorage rates often increased. In our analysis we treat inflation and seignorage rates as independent. We return to this issue later in the paper.

satisfies the following inequalities, which are derived from (3):

$$\frac{1}{1+\pi} \leqslant (1+\pi)^{T-1}(1-s) < 1. \tag{6}$$

We next show that after a few debasements the price P_t becomes equal to the mint price Q_t. To see this note that the dynamics of the supply of money are

$$M_t = M_{t-1} + R_t[(1+\pi)^T(1-s) - 1] + Q_t E_t,$$

where R_t is the amount of coins reminted in time t and E_t is the amount of bullion minted into coins in t. Hence, if there is no minting of new bullion $M_t \leqslant M_{t-1}[(1+\pi)^T(1-s)]$ and the term in brackets is smaller than $1+\pi$ according to (6). Hence, if there is no minting of new silver, the quantity of money grows at a rate lower than $1+\pi$. This cannot last long and after a few debasements there must be minting of new silver. Note that silver is minted only if the equilibrium price equals the mint price, and the equilibrium is at the horizontal part at the right side of the supply curve in Fig. 6, so that

$$P_t = Q_t. \tag{7}$$

It can be shown that once this equality is reached, it holds from then on. Hence, during inflation the price of silver equals the mint price. The intuition behind this result is simple. Since the government uses the silver it gets as seignorage outside the economy, it reduces the silver contents of all circulating coins continuously. Hence, consumers need to mint new bullion continuously, which they would not have done had the price of silver exceeded the mint price.[13]

In the rest of the section we focus on the steady-state equilibrium. As shown above, the rate of inflation at the steady state is π and the price equals the mint price. We distinguish between two main cases. In the first there is more than one type of coins in circulation, i.e. $T > 1$. We call this case "partial reminting". In the second case the rate of inflation is so high that there is only one coin in circulation, i.e. $T = 1$. We call this case "full reminting".

5.1. Debasements with partial reminting

We next describe the steady-state distribution of coins when T is greater than 1. The quantity of coins of fineness f_{t-u}, from u periods ago, $0 \leqslant u \leqslant T-1$, is the quantity of coins minted in $t-u$, N_{t-u}, and it is equal to

$$N_{t-u} = M_t \frac{\pi}{1+\pi-(1+\pi)^{1-T}}(1+\pi)^{-u}. \tag{8}$$

Note that this economy-wide distribution of coins is also the distribution for any individual by the end of the trading period, due to high circulation of coins.

The individual maximizes utility (1) with respect to the budget constraints. Let us denote the optimal value of utility by V_t. Due to stationarity, the optimal value

[13] Note that if the government uses its seignorage revenues domestically the equilibrium price might not always equal the mint price, but the main results of the model remain intact.

depends only on the amounts of assets inherited from the past. Since the coin composition by the end of each period is the same for all individuals, due to the law of large numbers, only the overall amount of money and the quantity of silver bullion b matter. Hence

$$V_t = V\left(b_{t-1}, \frac{m_{t-1}}{P_{t-1}}\right). \tag{9}$$

The Bellman equation can therefore be written as

$$V\left(b_{-1}, \frac{m_{-1}}{P_{-1}}\right) = \max\left\{c_0 + v\left(\frac{m_0}{P_0}\right) + \frac{1}{1+r} V\left(b_0, \frac{m_0}{P_0}\right)\right\}. \tag{10}$$

The budget constraints are as follows. The amount of silver changes according to

$$b_0 = b_{-1}(1+r) - e_0, \tag{11}$$

where e_0 is the amount of bullion minted. The consumer's quantity of money changes through minting, reminting, and through trade. Hence

$$m_0 = (1-w)m_{-1} + wm_{-1}(1+\pi)^T(1-s) + P_0(1-c_0) + P_0 e_0, \tag{12}$$

where w denotes the share of coins of highest fineness, which are being reminted, and is equal, according to (8), to

$$w = \frac{\pi}{(1+\pi)^T - 1}. \tag{13}$$

Substituting (11) and (12) into the Bellman equation (10) we get

$$V\left(b_{-1}, \frac{m_{-1}}{P_{-1}}\right) = \max\left\{\begin{array}{l} b_{-1}(1+r) - b_0 + 1 - \dfrac{m_0}{P_0} \\ \quad + \dfrac{m_{-1}}{P_0}[1 - w + w(1+\pi)^T(1-s)] \\ \quad + v\left(\dfrac{m_0}{P_0}\right) + \dfrac{1}{1+r} V\left(b_0, \dfrac{m_0}{P_0}\right) \end{array}\right\}. \tag{14}$$

Hence, the first-order condition with respect to silver bullion is

$$1 = \frac{1}{1+r} V_b\left(b_0, \frac{m_0}{P_0}\right). \tag{15}$$

The first-order condition with respect to real balances is

$$1 = v'\left(\frac{m_0}{P_0}\right) + \frac{1}{1+r} V_m\left(b_0, \frac{m_0}{P_0}\right). \tag{16}$$

Shifting (14) one period ahead we can calculate the marginal optimal value with respect to silver:

$$V_b = 1 + r. \tag{17}$$

The marginal optimal value with respect to real balances is

$$V_m = \frac{P_0}{P_1}[1 - w + w(1+\pi)^T(1-s)] = \frac{1 - w + w(1+\pi)^T(1-s)}{1+\pi}. \tag{18}$$

Substituting (18) in the first-order condition (16) and using (13) yields

$$v'\left(\frac{m_t}{P_t}\right) = 1 - \frac{1}{1+r}\frac{(1+\pi)^{T-1}(1+\pi-\pi s)-1}{(1+\pi)^T-1}. \tag{19}$$

Eq. (19) describes the demand for money in any period t. The left-hand side is the marginal utility from holding money, while the right-hand side is the marginal cost of holding money. It is a weighted average of the loss due to inflation, to coins not reminted, and a smaller loss to coins that are to be reminted in the next period. Since the supply of money is endogenous in this economy, Eq. (19) determines the steady-state amount of real balances: $M_t = m_t$.

The equilibrium real balances therefore depend both on the rate of inflation and on the rate of seignorage. Furthermore, the number of coin types in circulation T is endogenous as well and depends on these two variables. In order to find how real balances depend on π and s in the reduced form, consider the rate of debasement, at which the number of coins switches from $T+1$ to T. This rate is determined by $(1+\pi)^T(1-s)=1$. At this rate the marginal costs of both types of coins are equal and the real balances are determined by

$$v'\left(\frac{M_t}{P_t}\right) = 1 - \frac{1}{(1+r)(1+\pi)}. \tag{20}$$

We therefore conclude that real balances depend negatively on the rate of inflation as long as more than one type of coin circulates. Interestingly, demand for money does not depend on seignorage.

While our theory is on the stock of money, our data from Medieval France detail the flows of minting. Luckily, our model enables us to easily calculate the flow of minting, which depends on the amount of money and on the distribution of coins. The amount of real minting in period t is

$$\frac{N_t}{P_t} = \frac{\pi}{1+\pi-(1+\pi)^{1-T}}\frac{M_t}{P_t}. \tag{21}$$

From this equation we see that inflation affects minting in three channels. First, the overall demand for money M/P falls with inflation. Second, higher inflation reduces the value of old coins more rapidly and that increases minting as shown in the first term in the RHS of (21). This exerts a positive effect of inflation on minting. Third, higher inflation reduces the number of coin types in circulation T and that also affects minting positively. In order to consider the three effects together, consider again the rate of inflation at which the number of coins falls from $T+1$ to T. At this rate minting is

$$\frac{N_t}{P_t} = \frac{1}{s}\frac{\pi}{1+\pi}\frac{M_t}{P_t}. \tag{22}$$

Hence, inflation affects minting in two ways: positively by reducing the number of types of coins in circulation and negatively by reducing the demand for money. The overall effect depends on the elasticity of the demand for money with respect to π. In our empirical analysis we test for the effect of inflation on the amount of real minting. If the effect we find is negative, it clearly shows that real balances are negatively related to the rate of inflation.

5.2. Debasements with full reminting

We next turn to the case where inflation is so high, that all the old coins are reminted and there is only one coin in circulation, i.e. $T = 1$. This case holds when

$$(1+\pi)(1-s) > 1. \tag{23}$$

The solution to utility optimization in this case is similar to that in Section 5.1, though simpler, since all coins are reminted and $w = 1$. In this case the equilibrium amount of money is given by

$$v'\left(\frac{M_t}{P_t}\right) = \frac{r+s}{1+r}. \tag{24}$$

Hence, the demand for money at a high rate of debasement does not depend on the rate of inflation but on the rate of seignorage only.

This is a very surprising result, and it is unique for inflation in commodity money. More precisely, it is a result of the intrinsic value of coins, namely of their silver content, in addition to their transaction value. When inflation is high, holders of commodity money can avoid the inflation tax by reminting. In doing so they reduce their losses to seignorage only. Hence, their demand becomes insensitive to the inflation rate.

This is the main result of the paper. There exists a threshold rate of inflation π^*, which below it the demand for money is negatively related to the rate of inflation, but above it the demand for money becomes insensitive to the rate of inflation and depends on the rate of seignorage only. This threshold rate of inflation between partial and full reminting is derived from (23) and is equal to

$$\pi^* = \frac{s}{1-s}. \tag{25}$$

Note also that above the threshold rate of inflation π^* full reminting makes the real amount of minting equal to real balances, since all coins are new. Hence, at inflation above π^* the amount of minting also depends on seignorage only and not on the rate of inflation. This is important for our empirical tests.

6. Debasements and stabilization

In Section 5 we described a debasement process that goes on forever. While this is a helpful simplification, it is not realistic. Rulers could not debase their currency forever by bringing fineness as close as possible to zero, since at very low levels fineness becomes practically indistinguishable from zero and commodity money loses its value. Indeed, our historical records show that periods of repeated debasement ended in stabilizations. Since such stabilization was anticipated it affected the demand for money. This effect is the topic of this section. As in Section

5, we assume that there is a fixed rate of debasement π and a fixed rate of seignorage s. We further assume that the rate of debasement is high so that full reminting prevails. Let z_t denote the probability in period t that stabilization occurs next period. Later on, we make this probability endogenous as well.

Before solving the model we show that in this case the price is equal to the mint price as well, if the rate of seignorage is sufficiently high. Note that if there is no minting of new bullion, money supply grows by a rate $(1+\pi)(1-s)-1$, which is much lower than the rate of debasement π. Even if the demand for real balances falls, as stabilization anticipations rise, it cannot fall to zero. We therefore conclude that there is some minting of new bullion and the equilibrium price still equals the mint price.[14] Hence, the rate of inflation is equal to the rate of debasement π.

We solve the model recursively first by calculating optimal utility from stabilization, and then calculating optimal utility before stabilization. If stabilization occurs in period t, optimal utility V^S depends on the accumulated amounts of silver and real balances, and is equal to

$$V^S\left(b_{t-1},\frac{m_{t-1}}{P_{t-1}}\right)=\frac{1+r}{r}+b_{t-1}(1+r)+\frac{m_{t-1}}{P_{t-1}}(1-s)(1-x)-l^*+\frac{1+r}{r}v(l^*), \tag{26}$$

where l^* is the amount of real balances after stabilization, which is determined by

$$v'(l^*)=\frac{r}{1+r}.$$

Eq. (26) also shows the cost of recoinage during the stabilization.

Optimal utility prior to stabilization V satisfies the Bellman equation:

$$V\left(b_{t-1},\frac{m_{t-1}}{P_{t-1}}\right)=\max\left[c_t+v\left(\frac{m_t}{P_t}\right)+\frac{z_t}{1+r}V^S\left(b_t,\frac{m_t}{P_t}\right)+\frac{1-z_t}{1+r}V\left(b_t,\frac{m_t}{P_t}\right)\right] \tag{27}$$

under the constraint

$$c_t=1+\frac{m_{t-1}}{P_t}(1+\pi)(1-s)+b_{t-1}(1+r)-b_t-\frac{m_t}{P_t}. \tag{28}$$

Note that the partial derivatives of V are

$$V_b=1+r \quad \text{and} \quad V_m=\frac{P_{t-1}}{P_t}(1+\pi)(1-s)=1-s.$$

The first-order condition of the Bellman equation with respect to silver b is therefore redundant. The first-order condition with respect to real balances is

$$v'\left(\frac{m_t}{P_t}\right)=1-\frac{z_t}{1+r}(1-s)(1-x)-\frac{1-z_t}{1+r}(1-s)=\frac{r+s+(1-s)xz_t}{1+r} \tag{29}$$

[14] Even if price is higher than mint price, the qualitative results of the model remain intact. This is therefore only a simplifying assumption.

Hence, the demand for money depends both on the rate of seignorage and on the anticipation of stabilization. The probability z_t has a negative effect on the demand for money due to the positive cost of silver extraction x. Intuitively, agents try to minimize the cost of recoinage, by holding fewer coins.

We next describe how the probability of stabilization evolves over time, using Bayesian learning under very simple assumptions. Assume the public only knows that the process of debasement cannot go on forever, as there is a minimum level of fineness f^*. Stabilization might occur at any time before the economy reaches f^*. Hence, if this fineness is expected to be reached in T^*, the probability of stabilization at time $t+1$ is

$$z_t = \frac{1}{T^* - t}. \tag{30}$$

Since fineness falls at a rate π, T^* can be deduced from

$$f^* = f_{T^*} = f_t(1+\pi)^{-(T^*-t)}.$$

Hence the probability of stabilization is

$$z_t = \frac{1}{T^* - t} = \frac{\log(1+\pi)}{\log f_t - \log f^*}. \tag{31}$$

The probability of stabilization, therefore, depends negatively on fineness. The lower fineness is, the higher the probability that the process of debasements ends soon. This probability also depends positively on the rate of debasement.

Finally note that since only one coin circulates, the amount of minting is equal to the amount of money: $N_t = M_t = m_t$. Hence, minting depends negatively on the rate of seignorage and negatively on the probability of stabilization. As debasement continues, anticipation of stabilization rises, and hence minting is reduced. This is also an explanation to the puzzle raised by Rolnick et al. (1996), who find the amount of minting to be too small given the rates of inflation in such situations.

7. The data

The data used in this paper are derived from original mint accounts found in the national French archives and in the regional archive of the Isere at Grenoble.[15] Periodical mint accounts were submitted to the central monetary administration in Paris. They contain information on the type and quantity of coins minted, on costs, seignorage revenues and net profits of mint. Due to losses, fires and the war the extent of coverage of these documents is incomplete, but we were able to assemble a data set that covers the main periods of debasements during the 1350s and in 1415–1422 from 12 mints of varying importance and location. The full list of mints and dates of accounts is in the appendix.

It is important to note that the data do not come in fixed periods of time but rather in periods with varying lengths, since the frequency of submitting mint accounts to

[15] For greater detail see Sussman (1993).

the auditors in Paris was not uniform. The length of accounts varied from 1 day to 15 months, the average length being 1 month. Account lengths varied both across mints and over time. Under normal circumstances accounts were submitted annually or semi-annually. However, during debasements, they were submitted more frequently. This is due to tighter control over mints in such periods, and also because mints had to submit accounts following changes in any of the characteristics of the coinage. A further complication arises from the fact that royal orders reached mints with varying delays, due to distances between mints and Paris, due to difficulty of travel in war zones and due to the necessity of sometimes passing through provincial administrative centers.

Although the data are in varying lengths of time, they cover continuous periods of time for the 12 mints and enable us to use pooled data on the main variables: mint prices, from which we derive rates of debasements or rates of inflation, seignorage rates, and amounts of minting. Data on amounts of minting are given in units of silver minted. This happens to be equal to what we define as real minting in the model, since

$$\frac{N_t}{P_t} = \frac{N_t}{Q_t} = \frac{N_t f_t}{1 - s}.$$

The right-hand side is the amount of silver minted (including seignorage), which is reported in the accounts. As for inflation rates, these are calculated for each account, namely for each data point, as the rate of change since the last debasement compounded to annual terms. In the regressions we also use a variable that stands for the aggregate inflation rate, which is the rate of debasement at representative mints: Rouen for the 1337–1361 period, and Romans for the 1400–1423 period.

8. Empirical analysis

Our model describes how the demand for commodity money is related to three main variables: the rate of inflation, the rate of seignorage and the anticipated probability of stabilization. For lack of data on quantity of money we use data on mint outputs instead. We test the two main conclusions of the model. The first is that the demand for money falls with inflation up to some level, while above it becomes insensitive to the rate of inflation but depends negatively on seignorage. The second is that anticipation of stabilization reduces the demand for money.

Before we describe the empirical analysis we address three important issues. The first is related to the correlation between the rate of seignorage and the rate of inflation. While the model treats the two variables as independent, historically they tended to rise together in times of tight fiscal conditions. But as our data show, the correlation between the rates of debasement and of seignorage is positive but not so high. Actually, the correlations for all mints are smaller than 0.5. Hence, we treat these variables, inflation and seignorage, as independent explanatory variables in our regression analysis.

The second empirical issue is that lengths of mint accounts varied significantly, as described above. The dependent variable we use is the overall amount of minting in the account period, instead of minting per unit of time, and we add the length of the account period to the explanatory variables. This procedure reflects what we learn from the records, namely that most minting activity was concentrated in the beginning of each period, following the debasement. In any case, we check and find that using quantities of minting per unit of time does not change the results by much.

The third and main issue is how to distinguish between the direct and the indirect effect of inflation on the demand for money, where the indirect effect is through the anticipated probability of stabilization, as shown in Eq. (31). We deal with this issue in two ways. The first is to estimate the effect of inflation on the demand for money during periods that are relatively far from stabilizations, so that the indirect effect through anticipation of stabilization is negligible. The second way is to estimate the probability of stabilization and then estimate both the direct effect of the rate of inflation and the effect of the probability of stabilization on minting.

We begin our empirical analysis with estimations of a basic equation, of mint output as a function of the rate of inflation, the rate of seignorage, and the length of account period, excluding for the meanwhile the probability of stabilization. These estimations are presented in Table 2. According to Regression I, the rate of seignorage has a negative effect on the amount of minting and the inflation rate also has a negative effect on minting. Remember that the model predicts that the effect of inflation on minting is unclear, as it reduces demand for money on the one hand, but on the other hand it reduces the number of coin types, so that a larger proportion of coins is reminted in every period. According to Regression I the overall effect in our historical episodes was negative, which clearly shows that the effect of inflation on

Table 2
Effects of inflation and seignorage on minting

Dependent variable	Log(mint output)					
Regression	I	II	III	IV	V	VI
Inflation			<50%	>50%	<50%	>50%
Days to stabilization					>120	>120
Method		Fixed effects	Fixed effects	Fixed effects	Fixed effects	Fixed effects
Constant	5.50					
	(22.68)					
Seignorage rate	−1.01	−0.77	−0.47	−1.40	−0.44	−2.31
	(−3.58)	(−2.53)	(−1.11)	(−2.55)	(−0.75)	(−2.88)
Inflation rate	−0.17	−0.28	−0.36	−0.22	−0.40	−0.08
	(−2.27)	(−3.70)	(−3.19)	(−2.13)	(−2.68)	(−0.49)
Log (length of	0.52	0.57	0.55	0.61	0.53	0.71
account period)	(13.76)	(15.66)	(9.77)	11.58	(7.15)	(9.17)
R^2	0.70	0.51	0.48	0.50	0.47	0.48
DW	1.38	1.62	2.08	1.29	2.17	1.29
No. of observations	539	539	248	278	159	150

Note: *t*-values in parenthesis; all regressions estimated using GLS procedure.

the demand for money was negative. Finally, the effect of the time length of account is very significantly positive, as expected, but the elasticity is smaller than 1, slightly above 0.5. We interpret it as a result of the concentration of minting at the beginning of the period. It cannot be a result of potential negative correlation between length of account period and inflation, since that should increase measured elasticity to above 1. Regression II in Table 2 is the same equation as Regression I, only with fixed effects for mints. The results are fairly similar to those of regression I.[16]

Regressions III–VI in Table 2 examine whether the effect of inflation differs under low and high inflation rates.[17] According to Eq. (25) the threshold rate of inflation between partial and full reminting is equal to $\pi^* = s/(1-s)$. The rate of seignorage was not fixed during the period and rose with inflation. Since on average it was around 1/3, the threshold rate of inflation should be about 50%.[18] Regressions III and IV in Table 2 show that the effect of inflation is much larger and more significant when inflation is below 50%. However, at high rates of inflation the probability of stabilization becomes higher, which might add an indirect effect to inflation on the demand for money. To reduce this indirect effect Regressions V and VI are limited to periods far from stabilization, namely at least 120 days before any stabilization. These regressions fully confirm our main hypothesis: the rate of inflation has a large negative effect on the demand for money in Regression V, where inflation is below 50%, while the effect of the rate of seignorage is insignificant. In Regression VI, when inflation is above 50% and reminting is full, the rate of inflation has no effect on the demand for money, but the rate of seignorage suddenly has a significant negative effect. Regressions V and VI therefore strongly support our model, but at the price of reducing the amount of data they use, due to the restriction of being far enough from stabilizations. In order to use all our data, we need to add stabilization anticipations to the empirical analysis. This is what we do next.

We first estimate a measure of the expected probability of stabilization using the following method. In every period t we know the actual duration until stabilization, i.e. $\bar{t}-t$, where $\bar{t}$ is the actual date of stabilization. Expected duration until stabilization is equal to $(T^*-t)/2$ under the assumption of uniform distribution, but it is also equal to the expectation of $\bar{t}-t$. Hence, we can write:

$$\bar{t}-t = \frac{T^*-t}{2} + \varepsilon_{t,\bar{t}} = \frac{\log f_t - \log f^*}{2\log(1+\pi_t)} + \varepsilon_{t,\bar{t}}. \tag{32}$$

We therefore estimate a regression of the actual time to stabilization on two explanatory variables: the logarithms of fineness and of the rate of inflation. This regression is presented in Table 3 and it indeed shows that the expected time to stabilization decreases with inflation and increases with fineness. We now have a measure of the expected time to stabilization, which is the explained part of the

[16] Random effect versions to all regressions in Table 2 yield very similar results.

[17] For selecting sub-samples we use the inflation rate for each individual mint account. The inflation variable in the regression is the annual rate common to all mints. See Section 7 for precise definitions.

[18] When inflation was low the average seignorage rate was 27%, while at high rates of inflation the seignorage rate was 37% on average and even reached a maximum of 75%!

Table 3
The expected probability of stabilization

Dependent variable	Number of days to stabilization
Method	Fixed effects
Log(inflation rate)	−85.26
	(−3.78)
Log(fineness)	238.55
	(10.65)
R^2	0.47
DW	0.4553
No. of observations	506

Note: *t*-values in parenthesis; regression is estimated using GLS procedure with cross section weights.

Table 4
Effects of inflation and probability of stabilization: fixed effects regressions

Dependent variable	Log(mint output during period)		
Regression	I	II Inflation $<50\%$	III Inflation $>50\%$
Seignorage rate	−0.72	−0.43	−1.09
	(−2.11)	(−0.85)	(−1.95)
Inflation	−0.26	−0.44	−0.01
	(−3.13)	(−3.75)	(−0.05)
Log(probability of stabilization)	−0.18	−0.1	−0.37
	(−2.20)	(−0.59)	(−3.31)
Log(length of account period)	0.57	0.55	0.64
	(15.10)	(9.40)	(12.66)
R^2	0.67	0.49	0.49
DW	1.74	2.04	1.30
No. of observations	488	225	256

Note: *t*-values in parenthesis; all regressions estimated using GLS procedure with cross section weights.

regression in Table 3. The expected probability of stabilization is calculated as 1 over this expected time.

The next step is to add this calculated probability as a fourth explanatory variable in the minting equation. With this added variable we try to examine together our two hypotheses, namely that the demand for money reacts differently to high and low inflation and that it is negatively related to the probability of stabilization. Table 4 presents three regressions, with log of mint output as the dependent variable, and inflation, seigniorage, length of account and the probability of stabilization as the dependent variables. All regressions control for mints fixed effects. Regression I replicates the main results presented above: the seignorage rate and inflation have negative effects on minting, while the length of the period of account has a positive effect with elasticity less than 1. The new result is that the probability of stabilization has a significantly negative effect on minting, namely on the demand for money. The next two regressions in Table 4 deal separately with periods of inflation below and above 50%. While the effect of inflation is negative and significant at low rates of inflation, its effect at high rates of inflation is zero. While the effect of the rate of seignorage is insignificant at low rates of inflation it becomes negative and significant at high rates of inflation, just as the model predicts. The probability of stabilization has a strong negative effect on the demand for money at high rates of inflation. Interestingly, it is insignificant at low rates of inflation, probably because the anticipation of stabilization is low then.

The regressions in Table 4 give further support to the two main hypotheses of our model: at high rates of inflation the demand for money becomes insensitive to inflation but depends negatively on seignorage, and the probability of stabilization has a negative effect on the demand for money, beyond the effects of seignorage and inflation.

9. Summary and conclusions

In this paper we use data from many inflationary episodes in Medieval France in order to examine how the demand for money reacts to the anticipated inflation rate. We interpret our results as strongly supporting the predictions of Monetary theory, as applied to the specific historical period and its specific institutional framework.

Our analysis of commodity money predicts that the rate of inflation reduces the demand for money, due to inflationary losses to money holders, similar to fiat money. But our analysis also predicts that this effect prevails only at low rates of inflation, while at high rates of inflation full reminting prevails, so the demand for money becomes insensitive to inflation and is affected only by the rate of seignorage. These predictions are supported by the data. Our analysis also predicts that anticipation of stabilization reduces the demand for money, since stabilization imposes a cost on money holding. This prediction is supported by the data as well.

Our results can be applied to many other historical episodes of debasements in Europe in the early modern period, in the Low Countries, Spain, England, Italian city-states, Germany, and in the Ottoman Empire. Though French data are perhaps the most extensive and of the highest quality, we believe that our approach can be used to explain similar episodes in other countries and other times. But we believe that our results can be viewed even more broadly. We show that rational optimizing behavior, rational learning and rational expectations are good guides for understanding economic behavior even in Medieval Europe.

Our analysis also shows that the French have been loyal to their money throughout this long period of repeated debasement cycles, despite the large tax that inflation and seignorage imposed on money holding. This is quite puzzling. Why didn't the French people create alternative means of payment? Is it due to the public good aspect of royal money? Are there economies of scale in its use? Is it an example of a large coordination failure? These questions are not addressed here, but they are raised by our story and they are relevant for understanding the role of money not only in the past but in the present as well.

Appendix

This appendix lists the mints and the periods of time for each mint for which we have minting accounts:

1. Chaumont:	March 5, 1360–December 18, 1360.
2. Crémieu:	July 14, 1389–December 23, 1422.
3. La Rochelle:	January 18, 1360–May 28, 1361.
4. Mirabel:	April 5, 1405–September 19, 1422.
5. Montpelier:	June 27, 1351–August 26, 1351;
	July 8, 1354–December 16, 1384;
	February 10, 1404–June 24, 1417.
6. Poitiers:	March 13, 1354–March 3, 1361.
7. Romans:	February 1, 1402–October 7, 1422.
8. Rouen:	October 7, 1354–May 20, 1362.
9. St. Lô:	July 1, 1360–March 11, 1362;
	February 6, 1397–July 30, 1404.
10. St. Pourçain:	April 14, 1354–August 8, 1361.
11. Toulouse:	December 7, 1353–August 5, 1361;
	May 12, 1365–December 19, 1384;
	November 15, 1404–April 2, 1423.
12. Troyes:	December 7, 1354–April 22, 1405;
	February 3, 1412–April 28, 1419.

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