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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 fourteenth and fifteenth 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. Unlike fiat money, 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 an anticipated stabilization reduces demand for commodity money, which is opposite to the effect of anticipated standard stabilization on demand for fiat money.

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Keywords: Inflation, commodity money, debasements, seignorage, stabilization.

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1. Introduction

This paper describes and analyzes inflation in an economy with commodity money. The results are derived from a simple model of commodity money and are supported by historical data on money and prices in Medieval France, in the years 1350-1436. We show that there is much similarity between inflation of commodity money and that of fiat money. First, commodity money can be inflated by debasing the currency and inflation can be quite high. Second, the demand for commodity money falls as inflation rises. We also find two dissimilarities between the two types of money. The first is that due to the intrinsic value of commodity money, the demand for it becomes insensitive to inflation when the rate of inflation is high. The second dissimilarity is that under commodity money the demand for money falls with anticipation for stabilization, while it increases under fiat money.[1]

The paper first shows how repeated debasements lead to inflation, which can be rather high. In each new debasement the ruler issues a new coin with a lower content of the precious commodity, which is silver in our historical example. When the new coin enters into circulation, the quantity of money increases and prices rise. The ruler gains from such debasement since he collects seignorage from coins minted and reminted. The main intuition behind this result is basically Gresham's Law. The new coin, which has

[1] Some fiat money inflations and stabilizations were accompanied by issuance of new fiat notes, thus resembling more our commodity money model, but these cases were rare.

less silver content, drives out some of the older coins, which contain much more silver. Agents gain from reminting the old coins despite the loss of seignorage. An implicit assumption here is that coins circulated by tale rather than by weight. This assumption was recently questioned in Rolnick, Velde and Weber (1996), but we find that it is strongly supported by our empirical results.

The paper then analyzes demand for commodity money. Inflation erodes the value of money and operates as a tax on money holdings. Hence, if the public expects higher inflation the demand for money is reduced. But losses to holders of commodity money are a bounded function of the inflation rate, due to the alternative use of commodity money, which can be used to create new coins by reminting. Furthermore, when inflation is sufficiently high, so that all coins are reminted, the demand for commodity money becomes insensitive to the rate of inflation. The first main result of the paper is therefore that demand for money is negatively related to inflation, but at high rates of inflation it becomes insensitive to it.

Next the paper discusses the effect of anticipated stabilization. Note that under fiat money anticipation of stabilization reduces future expected costs of holding money and therefore increases the demand for money. 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 many inflationary episodes ended during the historical period we examine. Hence, in stabilization old coins become either completely useless or go through silver extraction, which is quite costly. Hence, stabilization is costly for money holders, and anticipation of such stabilization reduces the demand for money rather than increases it. This is the second main result of the paper.

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 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, that anticipation of stabilization reduces the demand for money. We estimate the probability of stabilization under rational learning and show that this probability has a negative effect on the demand for money. It is important to note that this finding also supplies 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 mainstream literature on money and inflation. Recent important contributions to the theory of commodity money are Li (1995), Sargent and Smith (1997), and Velde, Weber and Wright (1997). 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 a situation of repeated debasements, namely of 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, namely an empirical analysis of minting during inflation, which supports the main results of our model.[2] On

[2] Extending the analysis to issues of inflation comes at the cost of simplification. Instead of using search or cash-in-advance models as the above papers, we use a simpler model with money in the utility function.

the historical side our paper is related to various historical accounts of debasements. It is most closely related to Sussman (1993), which describes the same historical episode, but also to other studies of debasement, mostly 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 presents inflation dynamics, 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 thirteenth 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 thirteenth century these mints were gradually replacing private mints.

The royal mint system expanded throughout the fourteenth century and by 1415 there were 24 mints operating 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 in Paris of random samples of coins sent from mints. As a further reflection of the influence

[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

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 local dialects. This relatively 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 twelve deniers equaled one sou, and twenty 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 fifteen, ten (the most popular), five and three deniers, 3) petty coins, containing less silver, of two, one and half denier.

The objectives of medieval monetary authorities were similar to those of their modern successors. In ordinary times the monetary authority was concerned with responding to fluctuations in market prices of precious metals and with problems arising from wear and tear of coins in circulation. It also addressed other concerns such as monitoring mints, combating counterfeit and maintaining the quality of royal coins through legislative and enforcement measures.

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 by the monetary authority 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. Thus,

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(1997) for the Ottoman Empire.

debasements generated inflation by increasing 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 money supply through minting of new silver bullion and of older coins and thus increased the crown's seignorage revenues. Such periods of repeated debasements were very common during the hundred years war. During such episodes fineness fell to very low levels and many episodes ended in 'stabilizations,' when the crown stopped the process and issued new coins of high fineness, which became the only legal tender. These episodes of debasements and stabilizations are the topic of this paper.

We next describe money creation. In ordinary times money supply was generated primarily through minting of private bullion. The monetary authority offered to exchange, at the 'mint price', any amount of bullion in return for royal coins. The mint price was the amount of coins minted from one unit of bullion net of seignorage and 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 there were two situations in which such exchange took place. The first one was following a debasement. Then, by reminting coins of high fineness into coins of lower fineness, but of the same face value, people could increase their money holdings, even after deduction of seignorage. Thus, debasements triggered much reminting. The second situation was stabilization, where people were forced to remint their old coins, as only the new coins were legal. To describe such an exchange, to coins with higher fineness, we use a different term, 'recoinage,' since it involved a different technology. While regular 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. Indeed we find historical evidence to such costs. For example, after the debasement cycles of 1353-4 and of 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%.[4]

Our description above of reminting during debasements implies that coins of various levels of fineness circulated together at the same face value. Reminting reduced the scope of this phenomenon, but as long as people did not remint all their old coins, there were still some types of coins in circulation. Could people distinguish between these different coins? The answer is no, since this information was costly. In order to find fineness one needed to assay the coins, which was an expert's job. There is ample historical evidence on moneychangers in Medieval Europe, who specialized in coin evaluation and exchange. They were usually expert goldsmiths, either government agents or private entrepreneurs. "Changers manuals" were professional books, which described in detail the procedures for essaying and evaluating coins. Surviving archival documents, like changers account books, inform us about their operations. These accounts show that changers 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 changers were amongst the first to observe debasements of coinage and that they acted as middlemen between the public and the mint.

Costly information can explain both how different coins could circulate together on the one hand and how people could know which coins to remint on the other hand. If information is costly it is purchased only when the benefit is sufficiently high. Thus

[4] See De Saulcy (1879), p. 352, 462.

individuals did not go to an expert before each transaction at the marketplace and hence coins circulated by tale in the goods markets. But people did go to an expert after a debasement to check which coins to remint. Indeed our historical data shows that the bulk of reminting usually took place during the first days after each debasement.

The main period of debasement explored in this paper is during the Hundred Years War. 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 expenses. Financing a war required additional resources on a grand scale. The French crown resorted to seignorage revenues by debasing the royal coinage 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. The Hundred Years War witnessed two 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.

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, which 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, Ch. 8). For the sake of simplicity consumers are assumed to be risk neutral. Utility of individuals in time 0 is:

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

where 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. $\rho = r$.

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, namely the same weight as one unit of silver.[5] 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 government extracts seignorage at a rate s_t. Hence:

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

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 in exchange of 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). Then 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 folks and cannot be distinguished without help of experts, who are called 'money changers.' 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 once each period. As assumed above, many transactions take place during a single period and coins circulate many times, so that individuals cannot keep track of the coin composition of their money. Hence, the optimal strategy is to check their coins at the beginning of the period, to decide which coins to remint, which coins to turn into silver and which coins to keep in circulation. During 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.

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 from minting new coins 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 the alternative assumption, that seignorage revenues are used domestically, would not change the main results of the model.[6] 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

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

anticipates stabilization at the end of the debasements process, but does not know its exact timing.

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. First, the consumer mints silver into coins as long as the price of silver P_t is less than or equal to the mint price Q_t. Second, the consumer remints all coins with sufficiently high fineness, such that reminting can increase the number of coins. Formally, the consumer remints all coins with fineness f such that

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

Since fineness is non-increasing over time, namely $f_u \leq f_{u-1}$ for every time u, only the older coins with higher fineness are reminted. Hence, for every t there is a former period $\tau(t) \leq t$, such that coins older than it are reminted and $f_{\tau(t)}$ is the highest fineness held. This threshold period is defined by: $f_{\tau(t)} < 1/Q_t$ and $f_{\tau(t)-1} \geq 1/Q_t$. Finally, consumers can also 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_u if

(4) $$P_t \geq \frac{1}{f_u}\frac{1}{1-x} .$$

The supply of money can therefore be described by a step function, as in Figure 1, which has the price on the vertical axis and the quantity of money M_t on the horizontal

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

axis. The amount of money $M_{t,r}$ is the historically given amount of coins from last period after reminting, but before bullion minting or silver extraction. This amount does not depend on the price P_t, since reminting does not depend on price, as shown by equation (3). The demand for money is the demand of consumers only, as the government imports only. The demand for money is proportional to the price level P_t and is presented in Figure 1 by a ray 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:

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

Figure 1 presents three possible equilibria. If the demand for money is small, as in *D*', coins are transformed to silver by extraction. If the demand for money is as in *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 large, as in *D*'', bullions are minted into coins and the price is equal to 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 $f_{\tau(t-1)}(1\text{-}s_t)$, there is reminting, which shifts the whole 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.[7] Formally:

$$\text{(6)} \qquad \frac{Q_t}{Q_{t-1}} = \frac{f_{t-1}}{f_t} = 1 + \pi \ .$$

If the rate of debasement is fixed, the number of coins in circulation is fixed 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 satisfies the following inequalities, which are derived from (3):

$$\text{(7)} \qquad \frac{1}{1+\pi} \leq (1+\pi)^{T-1}(1-s) < 1 \ .$$

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 monetary dynamics are:

$$\text{(8)} \qquad M_t = M_{t-1} + \widetilde{N}_t[(1+\pi)^T(1-s) - 1] + Q_t e_t ,$$

where $\widetilde{N}_t$ 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 $M_t \leq M_{t-1}[(1+\pi)^T(1-s)]$

and the term in brackets is smaller than $1+\pi$ according to (7). 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, as shown in Figure 1, and hence:

(9) $$P_t = Q_t,$$

and this equality holds from then on. 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 coins continuously. Hence, consumers need to mint new bullion, which they would not have done had the price of silver exceeded the mint price.[8]

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. There are two main cases. In the first there is more than one type of coins in circulation, i.e. $T>1$. In this case reminting is partial. In the second case the rate of inflation is so high that there is only one coin in circulation, i.e. $T=1$. In this case all former coins are reminted.

5.1. Debasements with Partial Reminting

We next describe the steady state distribution of coins when T is greater than 1.[9] The quantity of coins of fineness f_{t-u} for all $0 \leq u \leq T-1$ is the quantity of coins minted in period $t-u$, and is equal to

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[7] Historically, the debasement episodes consisted not only of reduction in fineness, but often of increased seignorage rates as well. In the theoretical part of the paper we treat inflation and seignorage rates as independent. We return to this issue in the empirical part of the paper in Section 8.

[8] We should stress here that if the government uses its seignorage revenues domestically the equilibrium price might not always equal to the mint price, but the main results of the model remain intact.

[9] It can be shown that the distribution of coins converges to this steady state distribution.

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

Note that this distribution of coins is economy-wide, but also holds for any individual by end of 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 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 matters. Hence:

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

Hence, the Bellman equation is

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

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

(13) $$b_0 = b_{-1}(1+r) - e_0,$$

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

(14) $$m_0 = (1-w)m_{-1} + wm_{-1}(1+\pi)^T(1-s) + P_0(1-c_0) + P_0e_0,$$

where w is the share of coins of highest fineness, which are being reminted, and is equal according to (10) to

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

Substituting (13) and (14) into the Bellman equation (12) we get:

(16) $$V\left(b_{-1},\frac{m_{-1}}{P_{-1}}\right)=\max\left\{\begin{array}{c}b_{-1}(1+r)-b_0+1-\frac{m_0}{P_0}+\frac{m_{-1}}{P_0}\left(1-w+w(1+\pi)^T(1-s)\right)+\\ +v\left(\frac{m_0}{P_0}\right)+\frac{1}{1+r}V\left(b_0,\frac{m_0}{P_0}\right)\end{array}\right\}.$$

Hence, the first order conditions are:

(17) $$1=\frac{1}{1+r}V_b\left(b_0,\frac{m_0}{P_1}\right)$$

with respect to silver and:

(18) $$1=v'\left(\frac{m_0}{P_0}\right)+\frac{1}{1+r}V_m\left(b_0,\frac{m_0}{P_0}\right)$$

with respect to real balances. Shifting (16) one period ahead we can calculate the marginal optimal value with respect to silver and real balances:

$$V_b=1+r$$

and:

$$V_m=\frac{P_{-1}}{P_0}\left[1-w+w(1+\pi)^T(1-s)\right]=\frac{1-w+w(1+\pi)^T(1-s)}{1+\pi}.$$

Hence the demand for money is determined by the following condition, which holds for any period t:

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

Equation (19) describes the demand for money. 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 the coins, which are not reminted, and a smaller loss for the coins that are to be reminted next period. Since the demand for money is endogenous in this economy, equation (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 coins in circulation T is an endogenous variable, which depends on these two variables as well. In order to find how real balances depend on π and s in the reduced form, consider the rate of debasements, 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. At this rate of debasement equilibrium real balances are

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

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

While our theory predicts the equilibrium stock of money, our data from Medieval France consists of 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 N/P is:

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

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 old coins are reminted and there is only one coin in circulation, i.e. T=1. This case holds when

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

Solution of the optimal utility 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 debasements 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. As a result their demand becomes insensitive to the inflation rate.

The rate of inflation at which individuals begin to remint all their coins and at which the demand for money depends only on the rate of seignorage only is

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

When inflation exceeds π^* and full reminting prevails, the real amount of minting is equal to real balances, since all coins are new. Hence, at rates of inflation above π^* the amount of minting also depends on seignorage only and not on the rate of inflation.

6. Debasements and Stabilization

In section 5 we describe a debasement process that goes on forever. While this is a helpful simplification, it is not very 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, which reduced fineness to very low levels, 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 agents remint all coins every period. 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. Hence, even if the demand for real balances falls as stabilization becomes more anticipated, it cannot decline to zero. We therefore conclude that there is minting of new bullion and the equilibrium price equals the mint price.[10] Hence, the rate of inflation is equal to π.

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

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

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

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

Next denote by V the optimal value of utility prior to stabilization in period t. The Bellman equation is

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

under the constraint:

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

[10] Note that even if the price is higher than the mint price the qualitative results of the model remain intact.

Before we derive the first order conditions, note that due to the envelope theorem, 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 money is:

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

Hence, the demand for money depends both on the rate of seignorage and on the probability of stabilization. This probability has a negative effect on the demand for money. Note that this effect depends on x being positive, namely it depends on the cost of silver extraction being positive. Hence, the probability of stabilization has a negative effect on the demand for money since agents wish to minimize the cost of recoinage, of converting debased coins into good coins.

We next try to describe how the probability of stabilization evolves over time, using a Bayesian learning process under very simple assumptions. Assume that the public only knows that the process of debasement cannot go on to zero fineness, and there is a minimum level of fineness f^*. Hence, if the economy is expected to reach this fineness in period T^*, and there has been no stabilization until t, the probability of stabilization is uniform, and is equal to

(30) $$z_t = \frac{1}{T^* - t}\,.$$

Fineness falls at a rate π, and hence T^* can be deduced from

---

This is therefore only a simplifying assumption.

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

We therefore get that 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 is 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, Velde and Weber (1996), who find the amount of minting to be too small given the rates of inflation in such situations.

7. Data and Descriptive Statistics

The data used in this paper is derived from original mint accounts found in the national French archives and in the regional archive of the Isere at Grenoble.[11] 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 wars 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 does not come in fixed periods of time but rather in periods with varying lengths, since the frequency of submitting mint accounts to the auditors in Paris was not uniform. The accounts' lengths vary from one day to fifteen months, the average length being one month. Accounts' 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. During debasement these changes were more frequent. 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 necessity to sometimes pass 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 calculate the main variables and how they evolve over time. The data are pooled and allow us to test our two main hypotheses. The relevant variables are 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 in units of silver minted. It is equal to 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 the inflation variable, we have calculated two inflation rates. One is a rate of inflation for each account, namely the rate of change since last

[11] For greater detail see Sussman (1997).

debasement compounded to annual terms. In our regressions we use an annual rate of inflation calculated as the rate of change of the mint price in a year at a representative mint. These are Rouen for the 1337-1361 period, and Romans for the 1400-1423 period.

We first present some description of French debasements in the years 1330-1436. The first debasement period was characterized by repeated cycles of debasement and stabilizations. The period from 1337 to 1354 witnessed 34 mild debasement cycles with relatively long periods of stable money (Figure 2). The period from 1354 to 1360 saw 51 rapid debasement cycles that reached hyperinflationary magnitudes in 1360 (figure 3). The average rise in the nominal value of silver during such a cycle was 200% and the average duration of a debasement cycle was 400 days. The largest debasement cycle increased silver price 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 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 (figure 4). Milder debasements (average of 80% per cycle) followed until 1436 (figure 5).

The debasements resulted in substantial minting and large government revenues. While complete data for all the mints operating in France is lacking, our data allows us to assess the quantitative aspects of these episodes. Figure 6 shows mint outputs of four major French mints. Total mint output for the four mints in 1355 was about 75,000 marcs of pure silver (20 tons) while the annual average of total minting in France in non-debasement years was 5,000 marcs. The revenues of government were also impressive: according to Maurice Rey, the 1419 seignorage revenues amounted to six times ordinary royal revenues. Figures 7, 8 and 9 show, respectively, minting levels and seignorage revenues at the mints of Rouen and Montpelier and the Dauphine mints (Cremieu, Mirabel and Romans). The figures illustrate the high share of seignorage revenues out of total minting. It is interesting to compare Rouen (Figure 7) and Montpelier (Figure 8). In 1356, following the capture of King Jean by the English at Poitiers, the Estates of Languedoc (southern France) voted to suspend debasement whereas the mints of the North continued to debase the currency. In response, mint outputs and seignorage revenues in Montpelier started to decline, while at Rouen they reached an all time high.

In the theoretical section of the paper we identify the price of silver with commodity price and thus the rate of inflation becomes equal to the rate of debasement. We next show some supportive evidence. While high quality price data for France are lacking, nevertheless, Table 1 reproduces data from Sussman (1993) for the Dauphine, which shows that grain prices followed the course of mint prices whereas the price of gold followed the price of silver.

[Insert Table 1 here]

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 to test the two main conclusions of the model. The first is that the demand for money falls with inflation up to some level and above it becomes insensitive to the rate of inflation. 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 seignorage rate 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 shows, the correlation between the rates of debasement and of seignorage is positive but not so high, and the correlations for all mints are less 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 equation (31). We deal with this issue in two ways. First, we estimate the effect of inflation on the demand for money during periods, which are relatively far from stabilizations, so that the indirect effect through anticipation of stabilization is negligible. Second, we 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 too has a negative effect on minting. Note, that our model predicts that inflation has a negative effect on the demand for money, but its effect on minting is unclear, as at a higher rate of inflation fewer coin types circulate and a larger proportion of coins is reminted. According to Regression I the overall effect in our historical episodes was negative. That clearly shows that the effect of inflation on the demand for money was negative, which is the first main result of our model. Finally, the effect of 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.[12]

[Insert Table 2 here]

Regressions III-VI in Table 2 examine whether the effect of inflation differs under low and high inflation rates.[13] According to equation (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 we describe, and rose with inflation. Since on average it was

[12] Random Effect versions to all regressions in Table 2 yield very similar results.

[13] 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.

around 1/3, the threshold rate of inflation should be about 50%.[14] 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 in Regression VI, when inflation is above 50% and reminting is full, it has no effect on the demand for money.

Next we estimate a measure of the expected probability of stabilization and add it as a fourth explanatory variable to the minting equation. This probability is estimated in 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:

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

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. The probability of stabilization is exactly equal

[14] 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%!

to 1 over the expected time to stabilization. Therefore, the probability of stabilization rises with inflation and is negatively related to fineness.

[Insert Table 3 here]

We next add the probability of stabilization as an explanatory variable in the minting equation. In this estimation 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 are 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 becomes stronger and more significant at low rates of inflation, its effect at high rates of inflation is zero. Another interesting result is that the probability of stabilization becomes insignificant at low rates of inflation. This result is fairly reasonable, as at low inflation the probability of stabilization should be low.

[Insert Table 4 here]

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

At this point, we briefly return to the assumption that coins cannot be distinguished by fineness, namely that coins are traded by tale and not by weight. If indeed people have full information on the silver content of coins, then debasements would not affect consumer behavior in our model. Consumers would use mostly the old coins and there will be little demand for the new coins. As a result the amounts of minting would be zero (or close to zero). Clearly, we will not observe a negative relationship between the rate of debasement and minting. Thus, the results of our empirical analysis provide support to our basic assumption that coins circulated by tale and not by weight.

9. Summary and Conclusions

In this paper we show how inflation and even high inflation happen under a commodity money regime. The possibility of high inflation due to debasements is shown in theory and then demonstrated by hundred years of frequent debasements in medieval France. Hence, a commodity money regime is quite similar to the more modern fiat money regime in its ability to generate inflation tax.

Despite this basic similarity between commodity and fiat money, we observe two main differences between the two regimes. First, under commodity money the demand for money falls less at high rates of inflation, because coins still retain some intrinsic alternative value and can be used for reminting. The second difference between the two regimes is the effect of stabilization anticipations. While under fiat money such anticipations usually increase the demand for money, under commodity money they have an opposite effect.

We test for these two results using minting data found in French archives and we find strong evidence in their support. We show that minting declines with inflation at low rates and that shows that demand for money is indeed negatively related to inflation at low rates. We also show that minting becomes insensitive to inflation at high rates, and that holds for demand for money as well. Finally, we show that minting declines with the probability of stabilization.

Our model, findings and conclusions are not limited to France during the Hundred Years War. There were numerous periods of debasements in Europe in the early modern period, in the Low Countries, Spain, England, in Italian city-states, in 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 over a large period of time.

In this paper we assume that agents demand royal coins and trade them at face value. It could be interesting to question the origins of this very assumption itself. Is it due to the public good aspect of royal coinage? Are there economies of scale in their use? Why do people use coins at face value even when inflation is very high and seignorage rate is high as well? These are questions, which we do not address 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.

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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. Cremieu:	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. Poitier:	March 13, 1354 – March 3, 1361.
7. Romans:	February 1, 1402 – October 7, 1422.
8. Rouen:	October 7, 1354 – May 20, 1362.
9. St. Lo:	July 1, 1360 – March 11, 1362;
	February 6, 1397 – July 30, 1404.
10. St. Pourcain:	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.

Tables

Table 1

Annual Price Changes In The Dauphine, 1418-1422

Year	Silver: Mint Par	Mint Price	Gold: Gold Price	Grain: 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)

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 (-3.58)	-0.77 (-2.53)	-0.47 (-1.11)	-1.40 (-2.55)	-0.44 (-0.75)	-2.31 (-2.88)
Inflation Rate	-0.17 (-2.27)	-0.28 (-3.70)	-0.36 (-3.19)	-0.22 (-2.13)	-0.40 (-2.68)	-0.08 (-0.49)
Log (Length of Account Period)	0.52 (13.76)	0.57 (15.66)	0.55 (9.77)	0.61 11.58	0.53 (7.15)	0.71 (9.17)
R^2	0.70	0.51	0.48	0.50	0.47	0.48
D.W.	1.38	1.62	2.08	1.29	2.17	1.29
No. of Observations	539	539	248	278	159	150

Notes:

- t-values in parenthesis
- All regressions estimated using GLS procedure.

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
D.W.	0.4553
No. of Observations	506

Notes:

- 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 (-2.11)	-0.43 (-0.85)	-1.09 (-1.95)
Inflation	-0.26 (-3.13)	-0.44 (-3.75)	-0.01 (-0.05)
Log(Probability of Stabilization)	-0.18 (-2.20)	-0.1 (-0.59)	-0.37 (-3.31)
Log(Length of Account Period)	0.57 (15.10)	0.55 (9.40)	0.64 (12.66)
R^2	0.67	0.49	0.49
D.W.	1.74	2.04	1.30
No. of Observations	488	225	256

Notes:

- t-values in parenthesis
- All Regressions estimated using GLS procedure with cross section weights.

Figures

Figure 1

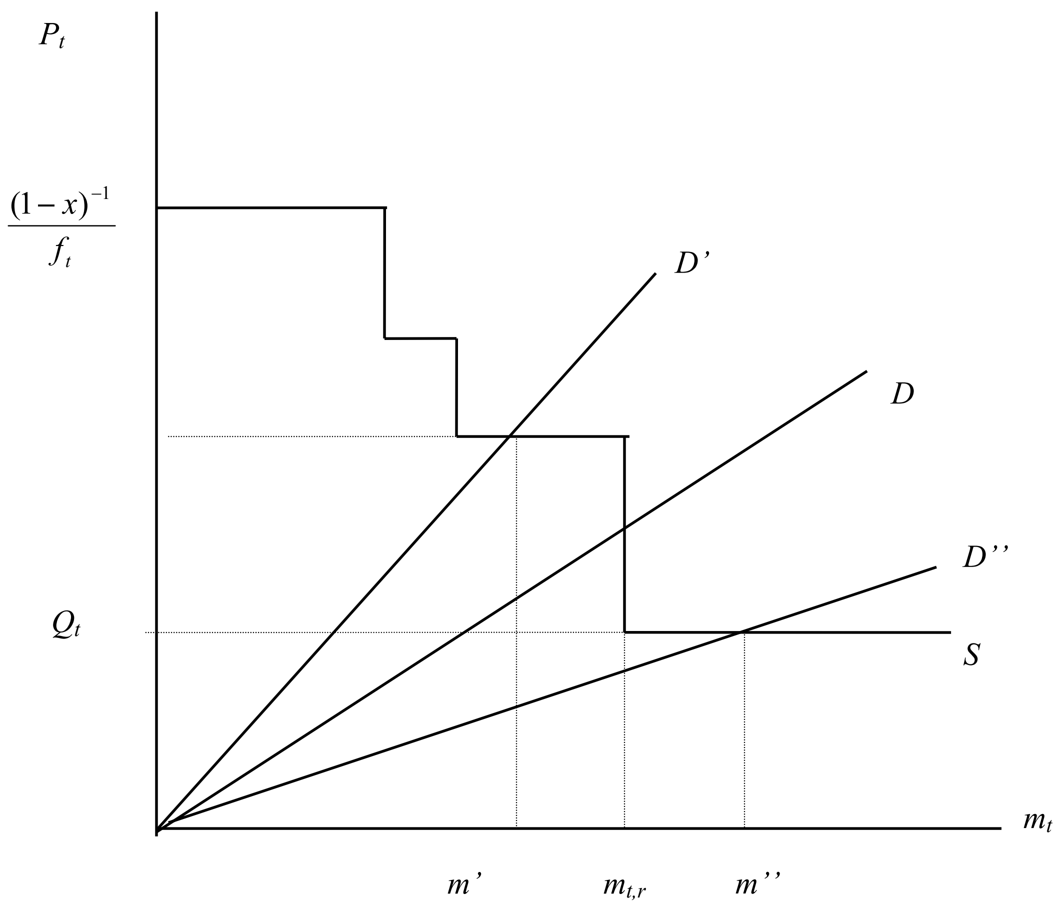

Figure 2

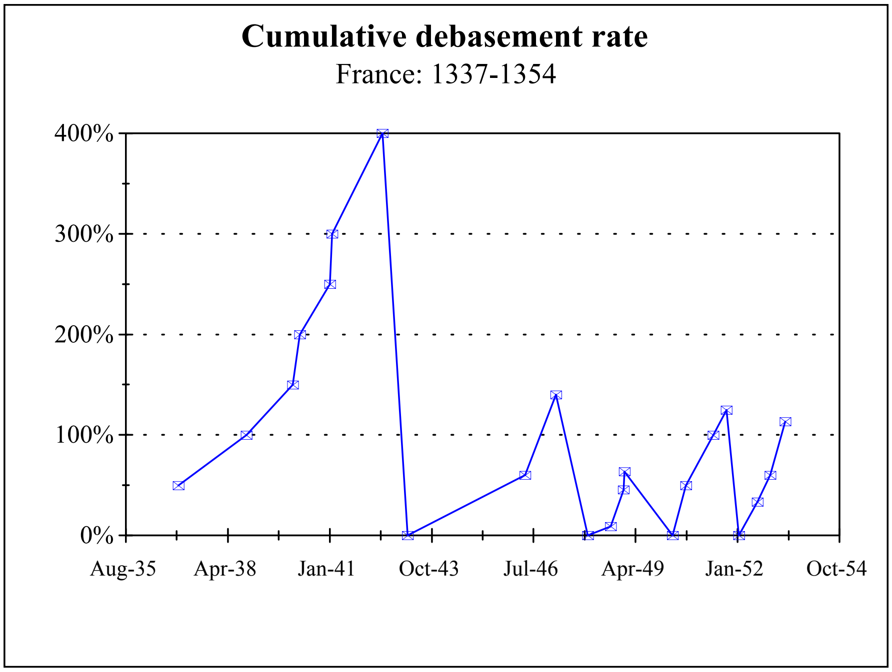

Figure 3

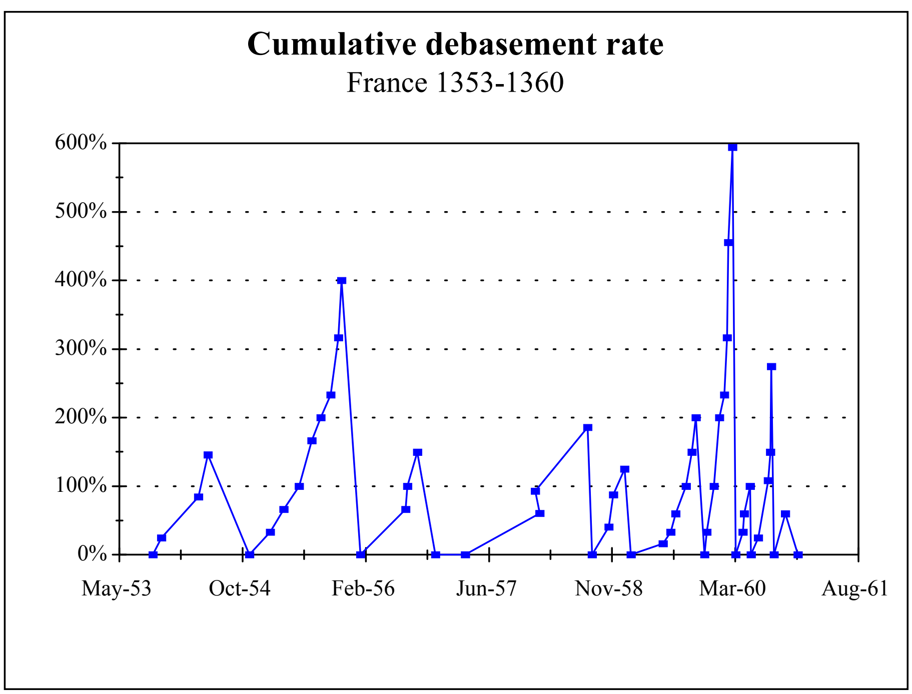

Figure 4

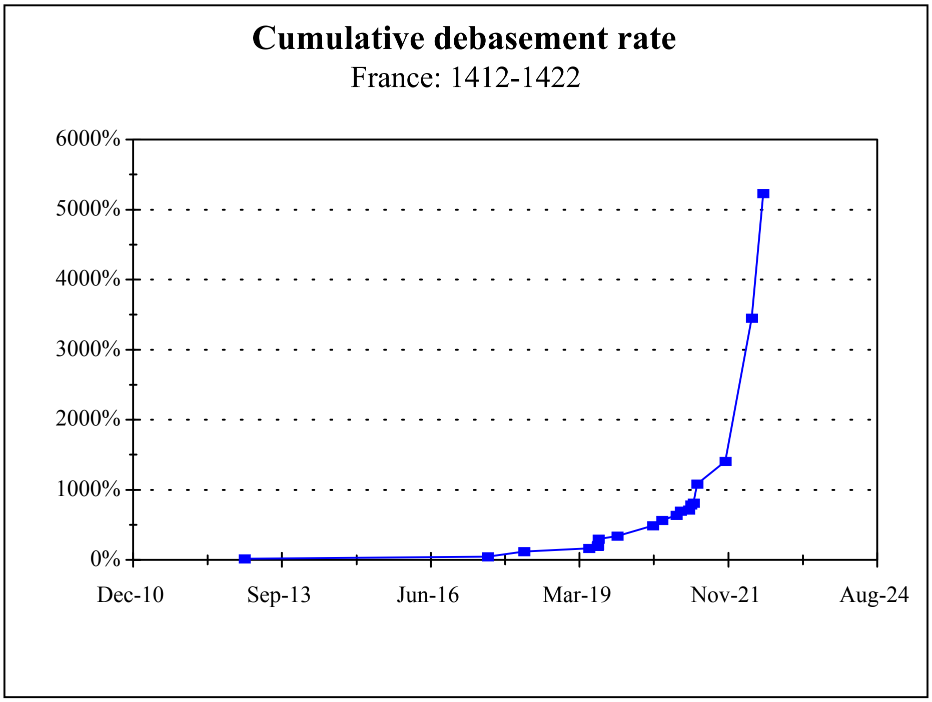

Figure 5

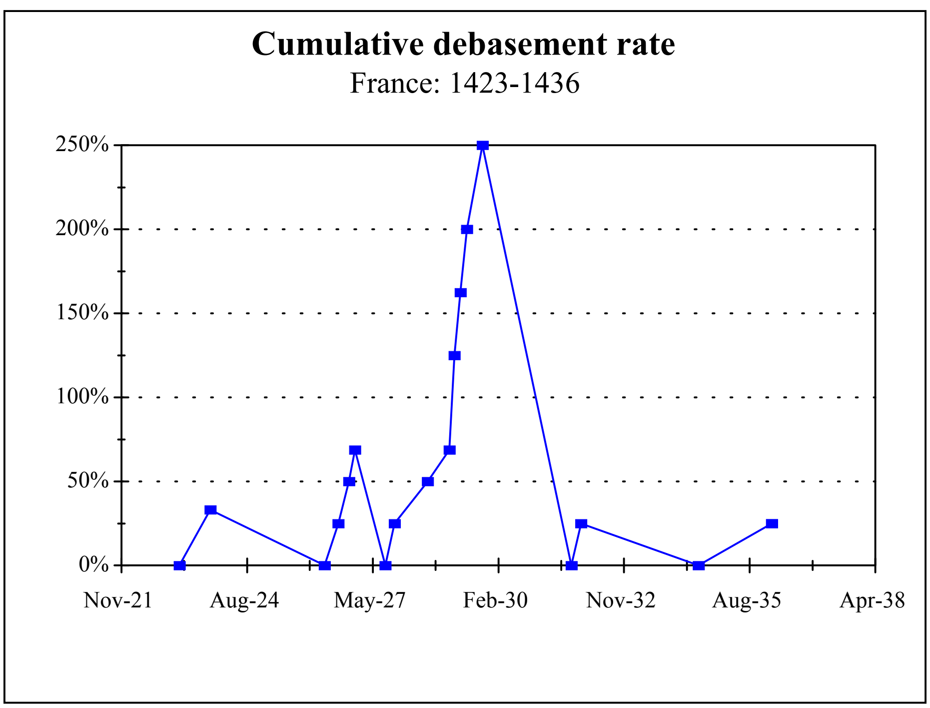

Figure 6

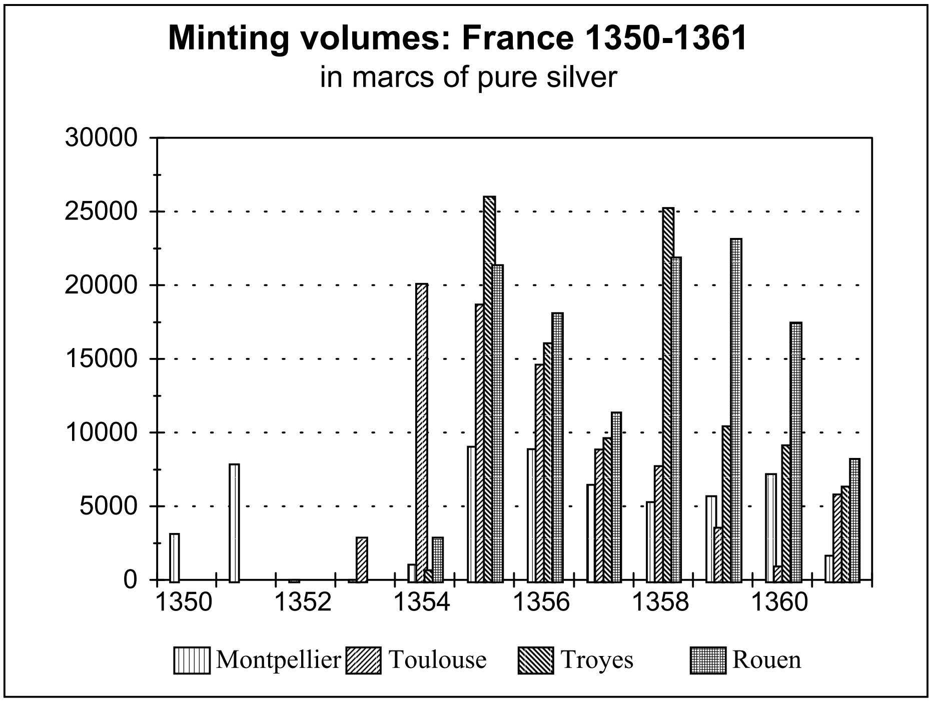

Figure 7

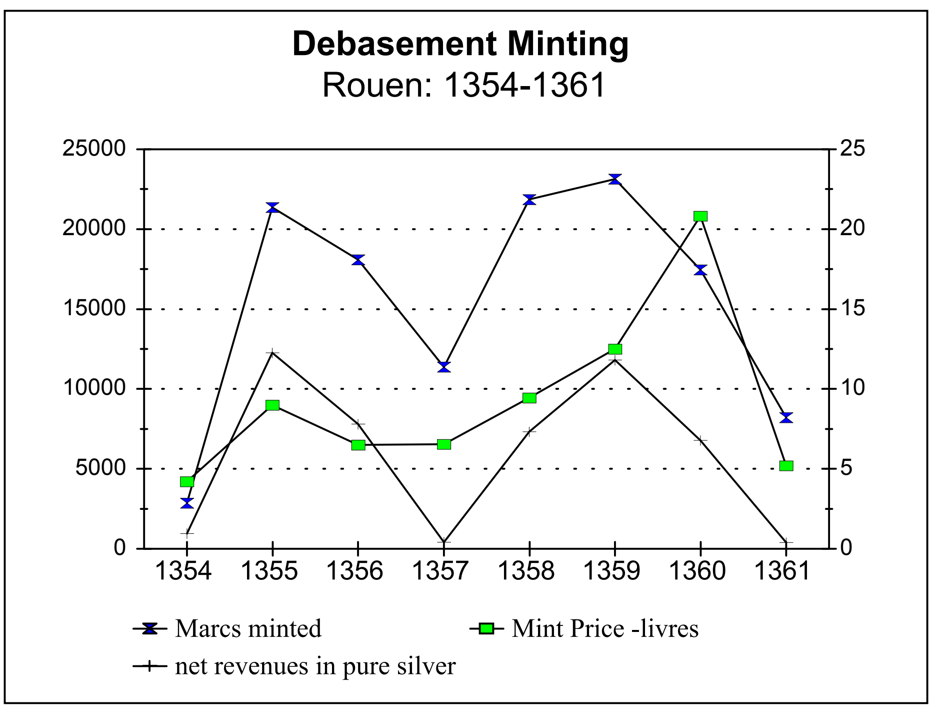

Figure 8

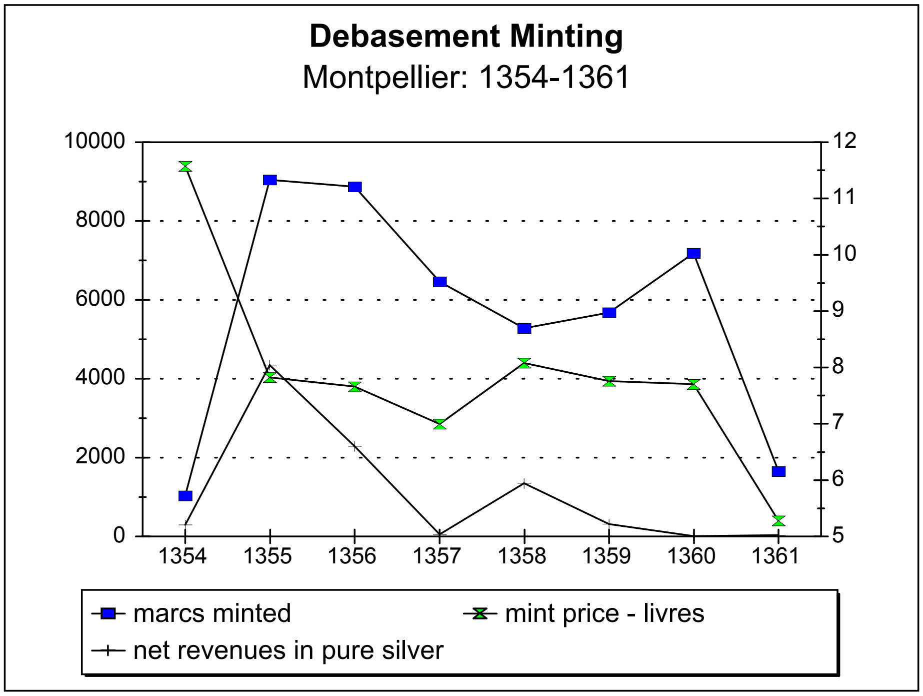

Figure 9