ESTUDIOS SOBRE LA ECONOMIA ESPAÑOLA

The 1628 Castilian Crydown: A Test of Competing Theories of the Price Level

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THE 1628 CASTILIAN CRYDOWN:
A TEST OF COMPETING THEORIES OF THE PRICE LEVEL

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On August 7, 1628 the Castilian government halved overnight the nominal stock of money through the 50% crydown of its copper currency. The paper argues that this helicopter lift of money is a nice historical experiment to put to the test the empirical relevance of competing theories of the price level. The experiment shows how the post-crydown behavior of the price level predicted by the *weak-form fiscal theory* (the so-called Sargent-Wallace theory) matches actual data better than the *quantity theory* (the so-called monetarist theory).

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I. Introduction

The pioneering works of Sargent and Wallace (1981) and Sargent (1982) put forward a view of the price level determination which involves a fiscal behavior driving an accommodative monetary policy, with the monetary authority using base money growth to finance a budget deficit. That *weak-form fiscal theory of the price level (WFT)* assumes fiscal dominance in the sense that the fiscal authority commits to a path of primary budget surpluses, forcing the monetary authority to generate the needed seigniorage in order to maintain governmental solvency. Therefore, the *WFT* has questioned the two more prominent propositions of the conventional *monetarist (quantity) theory of the price level (MT)*, namely that (i) money is the only government liability which can affect macroeconomic variables, and (ii) the price level varies in proportion to the current nominal money supply. Aiyagari and Gertler (1985) have made operational the *WFT* by showing how it provides a link between the current price level and the total nominal supply of government liabilities (money and debt outstanding) as a function of the specific fiscal-financial-monetary program followed by the government.

Which of those theories of the price level is empirically relevant? Unfortunately, economic researchers cannot conduct controlled experiments in an actual economy in order to see which theory fits better the data. Fortunately, history provides once in a while rare episodes that closely resemble such controlled experiments. The 1628 Castilian copper currency crydown is an incredibly good historical episode for answering the above question.

The Castilian monetary regime at the beginning of the seventeenth century was a *de iure* trimetallic one (gold, silver, and copper) but since gold did not circulate, it had become a *de facto* bimetallic one. Huge issues of copper currency from 1597 to 1608 and, mainly, from July 1617 to May 1626, drove silver almost out of Castilian monetary circulation by 1625. From that year onwards, since copper coins were far away from full-bodied[1], the Castilian economy became like a fiat copper currency one, with rising prices (in copper terms) and silver premiums (market quotations of the ratio copper maravedi/silver maravedi).. On August 7, 1628 the Castilian government implemented an overnight deflationary redenomination by reducing the legal face value of all copper currency by a proportion of one-half. After the redenomination, the demand for real copper money balances diminished, so that both the price level (in copper terms) and the silver premium fell much less than the legal face value.

The predictions for the price level behavior of both the *WFT* and the *MT* after a deflationary redenomination are obtained by adapting a Ricardian model to the 17th-century Castilian economic environment.

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[1] Though they were no purely token coins. According to Motomura (1994), the legal face value of a Castilian copper coin was almost three times higher than its intrinsic value.

We define a Ricardian fiscal-financial-monetary program (FFMP) as one that, for all prices, satisfies the government's infinite-horizon budget constraint with equality. Following Aiyagari and Gertler (1985), it can be identified a continuum of FFMPs cases which vary according to the fractions of the government debt backed by seigniorage and the budget primary surplus. A polar budget surplus FFMP is defined as one in which the government budget primary surplus backs fully the government interest-bearing debt. In addition, we define a polar seigniorage FFMP as one in which all that government debt is implicitly backed by seigniorage. In this Ricardian framework, we find that apart from the polar budget surplus FFMP, the nominal stock of government bonds matters to the economy's nominal variables so that the price level is not proportional to the nominal money stock but depends on the particular composition of the total nominal supply of government liabilities (money and bonds). In other words, the *WFT* findings are obtained if the FFMP is Ricardian and seigniorage backs either fully or partially the government debt. Furthermore, the *MT* findings need a Ricardian polar budget surplus FFMP.

Expressions for the impact on the price level of a 50% crydown of the nominal stock of copper currency are obtained under both theories of the price level (*MT* and *WFT).* Using actual fiscal and monetary data in those expressions, the effect on the price level predicted by them can be evaluated. The *MT* predicts a one-time decrease in the price level. In a purely fiduciary model, this decrease would be equal in percentage terms to the decrease in the money supply (50%). However, in a commodity-money model with free coinage of silver there exist both a minting and a melting point that impose bounds within which the price level must stay (Sargent and Velde, 1999). As a result, according to the *MT*, the 50% crydown would have reduced the price level by about one-third. The *WFT* predicts a one-time decrease in the price level smaller than the *MT* prediction, about one-fourth.

Both predicted impacts are then compared to the actual effect. It is found that the *WFT* predicted impact is closer to the actual one than the *MT* predicted effect. Our explanation why the *WFT* fits better the data runs as follows. As of 1628, the burden of Castilian nominal government debt was so heavy and the previous copper issues to obtain seigniorage had been so huge that the weight of anticipated money issues --to raise future seigniorage-- on the current price level was even higher than the weight of the current nominal money stock. Thus, a crydown that reduced the current nominal money stock --while leaving unaffected the nominal stock of government debt-- diminished significantly the current price level but much less than the proportion predicted by the monetarist theory.

The rest of the paper is organized as follows. Section II presents the historical background to the Castilian crydown of 1628. In Section III, we describe the analytical framework and derive the theoretical findings. Section IV compares those findings to actual data in order to analyze the price-level effects following from the crydown. Section V concludes.

II. Historical background

After a long and turbulent period of medieval monetary history, the Catholic Kings reformed the Kingdom of Castile's monetary system in 1497. The new system was based upon three metals: gold, silver, and an alloy of silver and copper, called billon. The (abstract) unit of account was the *maravedi* so that prices were quoted in maravedis. The gold coin was the *ducado*, representing 375 maravedis. The silver coin was the *real*, equivalent to 34 maravedis. The billon coin was named the *blanca*, corresponding to 0.5 maravedis. As a result, there were high-denomination gold coins, medium-denomination silver coins and low-denomination billon coins. The 1497 regulation forbade the operation of private mints and limited the number of royal mints to seven. It established the free coinage of gold and silver, but the circulating nominal stock of billon was quantitatively limited and its coinage remained a royal monopoly.

That monetary system kept in operation fundamentally unchanged until a King Philip II's decree of December 31, 1596 removed the silver content from billon coins. Previously, the silver cost and the copper cost were each about 30% of the legal tender value of a blanca, so that the total mint fee was about 40% (brassage was 30% and net seigniorage was 10%). This decree limited the annual minting of the new copper coins to 100,000 ducados[2] and, in addition, it mandated that the same quantity of previous billon coins be retired from the domestic circulation. The nominal amount minted between 1597 and 1602 was 497,259 ducados.

A King Philip III's ordinance on June 3, 1602 reduced the weight of new copper coins by a proportion of one-half. The lighter copper currency minted between 1602 and 1606 amounted to 2,561,012 ducados. Moreover, on September 18, 1603 the King decreed to have the pre-1597 billon coins restamped at twice their original face value. The copper currency arising to domestic circulation due to the restamping operation amounted to 1,235,872 ducados. After an agreement between the government and Parliament, a decree of November 2, 1608 stopped the minting of copper coins. The nominal copper currency minted between 1607 and 1612 amounted to just 464,660 ducados, while no currency was minted between 1612 and 1616.

Nevertheless, in 1617 King Philip III requested the Parliament its consent for the minting of new copper currency, but only to approved amounts (800,000 ducados in 1617 and 1,000,000 in 1618) since the seigniorage from it was inexcusably needed to finance the 1618 budget deficit (Gelabert, 1997, p. 55). In 1619, the Parliament forbade the coinage for the currency minted had far exceeded the approved amounts. In fact, between 1617 and 1620 the copper currency minted amounted to 4,459,859 ducados. However, one of the first King Philip IV's decrees (June 24, 1621) ordered, without Parliament's approval, a new copper coinage of 4,000,000 ducados. This large-scale program of minting copper that started on July 3, 1617 was stopped by the decree of May 8, 1626. In between, the copper currency minted had amounted to 22,508,555 ducados. When the minting of copper was halted by the 1626 decree, the nominal stock of copper currency had reached 27.5 million ducados. As a consequence, it seems that Castilian monetary policy was dictated by fiscal policy or, in other words, the Castilian government implemented a Ricardian FFMP involving a fiscal dominance of the type claimed by the *WFT*. According with a 1623 official statement quoted by Gelabert (1997, p. 69):

Copper minting was the foundation, the most solid backing of budgetary operations; given the

[2] From 1535 onwards the ducado had no longer been a gold coin, but it retained its role as a unit of account, worth 375 maravedis.

current state of affairs, those operations would have been impossible without it.

The policy adopted by the Castilian government under King Philip III (1598-1621) and in the first years of the reign of King Philip IV (1621-1626) through the issue of copper currency and mandatory restampings provoked the saturation of the demand for real monetary balances by mid-1620s and largely displaced the full-bodied silver coins from domestic monetary circulation[3].

Therefore, from mid-1620s onwards the Castilian economy became a fiat money one since the intrinsic value of a copper coin (copper cost plus brassage) was almost three times lower than its legal face value. Under those circumstances, subsequent issues of copper currency were inflationary. According to Hamilton's (1934) price index (averaged for all Castile), prices in copper maravedis rose by 3% per year between 1621 and 1625. In 1626 and 1627 those prices rose by 13% and 6%, respectively.[4] Hamilton's (1934) silver premium (averaged for all Castile) jumped from 1.04 in 1620 to 1.4627 in the second quarter of 1628. The daily Madrid series for silver premium reported by Cosme Micon (1668)[5] shows that the silver premium rose from1.04 as of January 1, 1620 to 1.84 on August 7, 1628. Figure 1 summarizes those events using Motomura's (1997) data.

On August 7, 1628 the government cried down all copper coins by a proportion of one-half in order to either reduce or eliminate the silver premium[6]. The results were the following. The nominal stock of money fell overnight by 50% and the silver premium diminished from 1.4627 to 1.1345 in the fourth quarter of 1628 (Hamilton's (1934) data averaged for all Castile). It remained at that level until the third quarter of 1629.[7] According to Micon's (1668) Madrid data, the silver premium fell overnight from

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An anonymous commentator estimated on July 1625 the fraction "circulating silver money to circulating copper money" to be very small, about 1.6 percent (Manuscript 6731, p. 84, Spanish National Library). In addition, Hamilton (1934) and Urgorri (1950) report some anecdotal evidence on the rarity of circulating silver coins by mid-1620s. They also report that before early 1620s prices were quoted in maravedis, while they became quoted in *copper* maravedis after that.

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Hamilton's data pertain to the three Castilian provinces: Andalusia, New Castile and Old Castile. In Andalusia, prices in copper maravedis rose by 2% per year between 1622 and 1625. In 1626 Andalusian prices rose by 18% and they remained more or less constant in 1627. In New Castile prices rose by 3% per year between 1621 and 1625, and they rose by 15% and by 6% in 1626 and 1627, respectively. The same data for Old Castile are, respectively, 2%, 11%, and 14%.

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Manuscript 18433, pp. 126-133, Spanish National Library, Madrid. The series has recently been published by Serrano Mangas (1996). Madrid is a town inside New Castile. The discrepancies between Hamilton's series for New Castile and Micon's series are due to the fact that the former was mainly based upon Toledo quotations, a town located 43 miles southwest Madrid.

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The crydown order was published in Andalusia (Seville) on August 11.

1.84 to 1.1 and remained at that level until February 1629.

The effects of the crydown were deflationary. It reversed the inflationary path of previous years and set the stage for a fall in prices expressed in copper maravedis. According to Hamilton (1934), these prices (averaged for all Castile) fell from 1627 to 1635 at a 1.66% annual rate. Overall, the price level fell by 13.32%[8]. Figure 2 displayes Hamilton's (1934) annual price level and quarterly silver premium data for all Castile.

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The silver premium in Andalusia was 1.445 in the second quarter, 1.6 in the third quarter and fell to 1.1275 in the fourth quarter of 1628. The figures for New Castile were, respectively, 1.4733, 1.345, and 1.176. The figures for Old Castile were 1.47, 1.312, and 1.1, respectively.

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The figures for Andalusia were 1.62% yearly and 12.93% overall. The figures for New Castile were 1.45% yearly and 11.64% overall. The figures for Old Castile were 1.92% yearly and 15.34% overall.

FIGURE 1.- Motomura's (1997) data on minting, nominal, and real stocks of copper currency

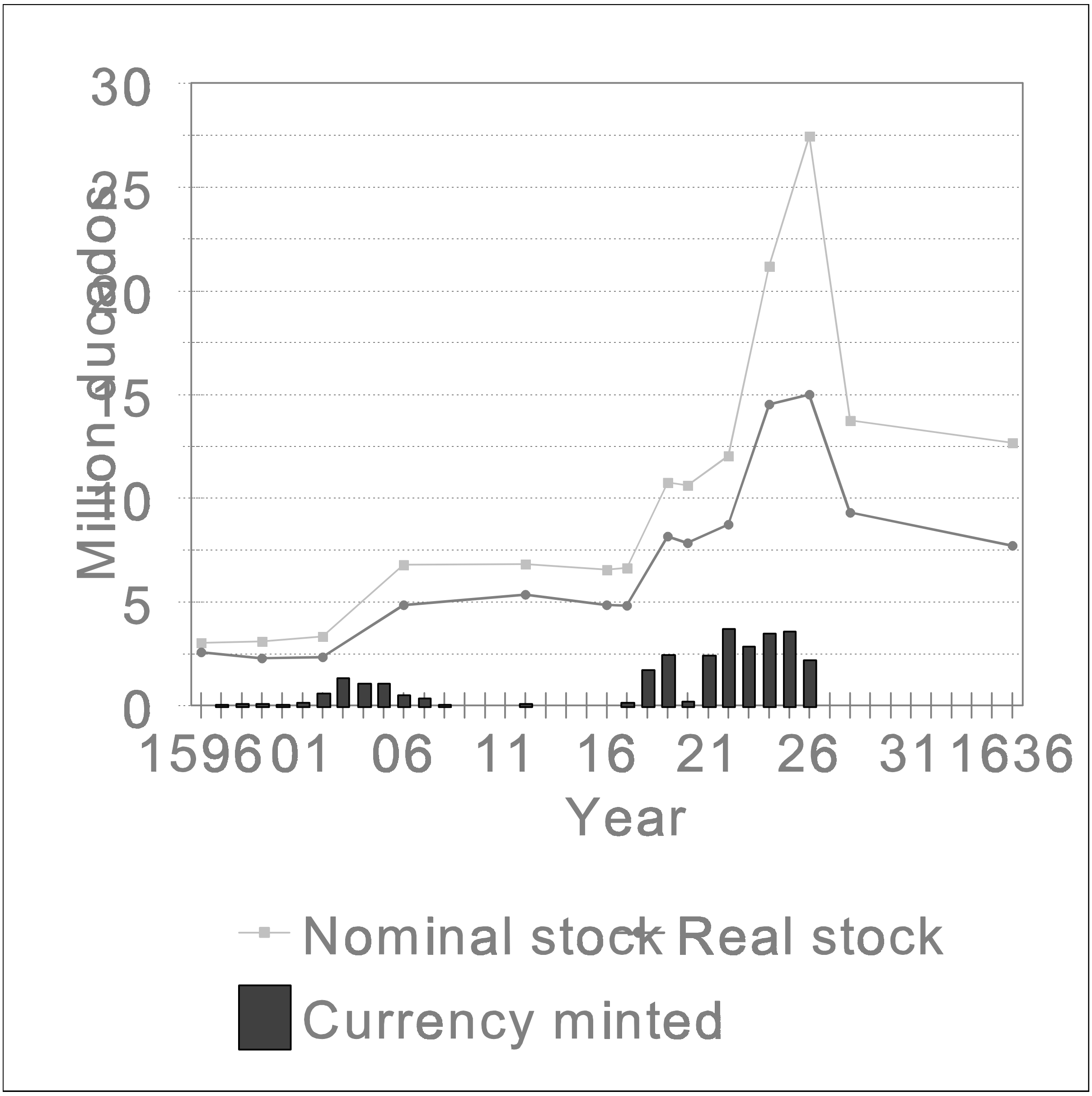
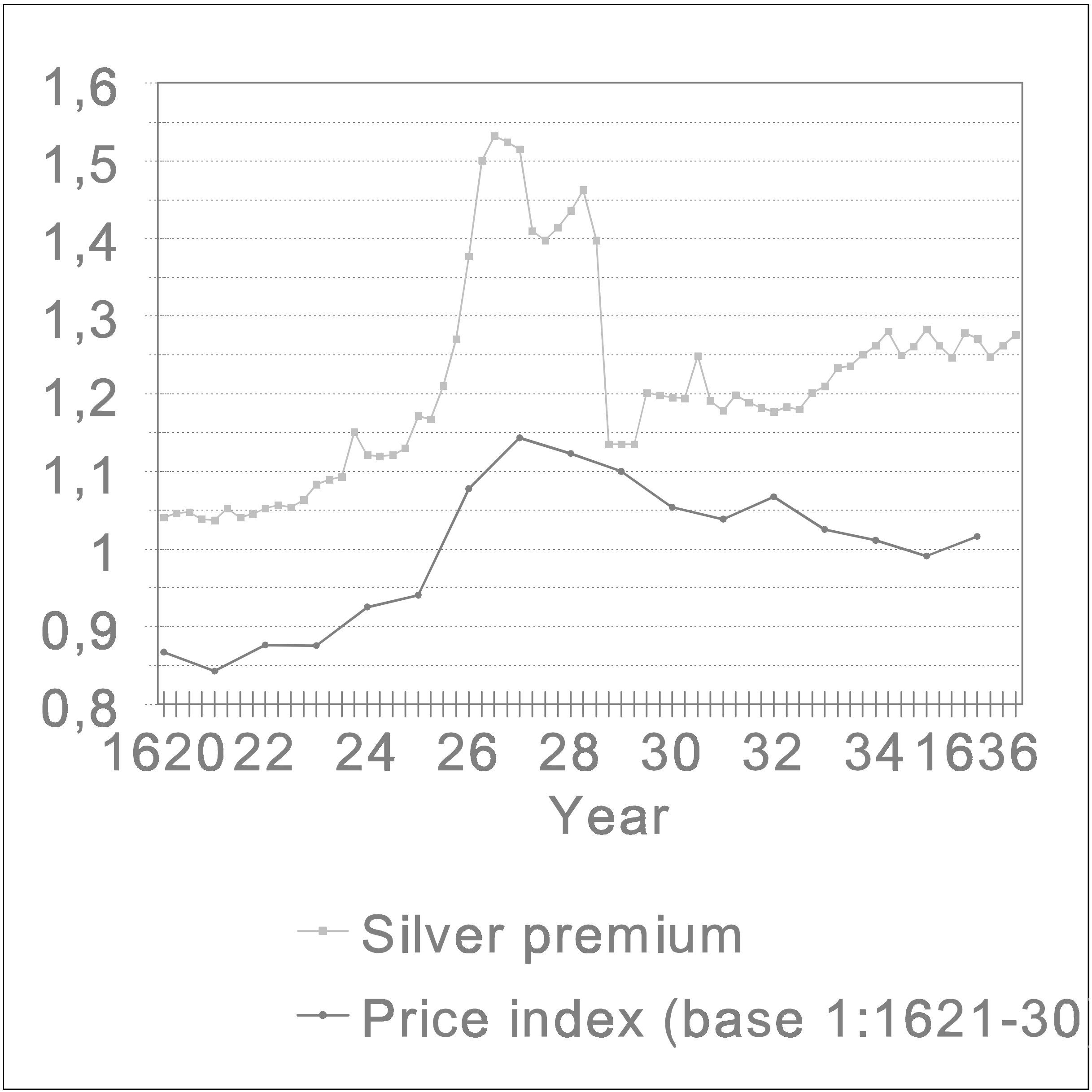


FIGURE 2.- Hamilton's (1934) annual price index and quarterly silver premium



In an important paper, Sargent and Velde (1999) present a commodity money model, a variant of which --what they call "the standard formula without convertibility"-- is used to interpret the Castilian monetary history in the period prior to the 1628 crydown. Their cash-in-advance *MT* model explains why the episodical huge increases of petty money issues (copper currency) pushed silver money out of the Castilian monetary circulation by mid-1620s. The model also provides the rationale of the 1628 crydown. In their words (p. 157):

This regime is useful in understanding certain monetary experiments, particularly that undertaken by the government of Castile in the seventeenth century... In that experiment, a conversion of full-bodied pennies [copper currency] to token..., led to a complete replacement of the [silver] money supply with pennies [copper coins], followed by redenominations as the government struggled to gain control of the price level.

The Sargent-Velde model incorporates demands for and supplies of two coins that differ in denomination and in metal content. In the "Castilian" version of Sargent and Velde's (1999) model, there are silver reales and copper blancas. In addition, the government issues huge quantities of copper blancas, which eventually lead to rising prices (in copper terms), to a premium of silver maravedis in terms of copper maravedis and to the crowding-out of silver from domestic monetary circulation. Once silver has disappeared, the Castilian economy becomes a standard cash-in-advance fiat currency one, with its price level being governed by a copper currency quantity theory. In that situation, further issues of copper currency (in order to raise seigniorage revenues for the government) result in rising prices (in copper terms) and silver premiums. If the government tries to diminish both the price level and the silver premium, it can do so by reducing the nominal stock of copper currency through an overnight crydown of the copper coins. Being a standard cash-in-advance fiduciary economy, if the government cries down the copper currency, both the nominal copper money stock and the current price level (in copper terms) should fall proportionately to the crydown, since the demand for real copper money balances do not change. In other words, in the standard cash-in-advance fiat currency Castilian version of the Sargent-Velde model, the price level varies in proportion to the nominal money supply of copper (the *MT*), with that nominal supply being the only government liability affecting the price level.

Notwithstanding, as of 1628 the nominal stock of Castilian nominal government debt outstanding was huge. Since Emperor Charles V's reign there had been important issues of long-term bonds, or *juros*, in order to finance secular budget deficits. Although the juros were essentially annuities, they came in a variety of types since some of them were life annuities, others were perpetual, and still others were perpetual but redeemable by the government at any future date. Juros were bearer certificates and though there was an active secondary market, almost all juros were owned by domestic Castilian residents (Domínguez-Ortiz, 1960, chapter 8; Conklin, 1998). Since the government honored all its debts in juros born by Castilian subjects before 1635[9], there should had been some credibility mechanism that backed juros. Conklin (1996) provided an analysis of that enforcement mechanism. According to him, there were three basic institutional features that bound the government to repay domestic holders of juros: (i) the high political standing of most juro bearers, (ii) the Castilian institutional structure that made these subjects indispensable to the Crown, and (iii) the infeasibility of a selective default due to the impossibility of knowing which juros were born by influential subjects since juros were traded in an active secondary market.

Juros were denominated in the unit of account, the maravedi. Thus, people could buy it and the government could service it by paying legal tender money (copper, silver and gold coins). However, once silver and gold had been driven almost out of domestic monetary circulation and were exchanged at a premium, the government serviced its debt by paying copper coins (indeed, since silver coins almost did not circulate in the 1620s and afterwards, the bulk of tax revenues were collected in copper coins). Therefore, the Castilian government debt as of 1628 can be considered as copper denominated (Domínguez-Ortiz, 1960, ch. 8).

Koenigsberger (1958) has estimated the nominal stock of Castilian juros to be 20, 50, and 100 million ducados in 1556, 1573, and 1598, respectively. Castillo-Pintado's (1963) estimate for 1598 debt is 85 million ducados. Domínguez-Ortiz (1960, p. 325) has reported official figures for the nominal interest paid on juros. Those yearly figures are: 4,634,293 ducados in 1598, 5,627,000 in 1623 and 6,418,746 in 1637. In addition, he (1960, p. 318) reports the nominal stock of government debt amounting to 112 million ducados in 1623, according to an information released to Parliament by the Castilian government. It can be seen that, since the government debt paid a 5% nominal interest, 112 million ducados times 5% equals 5.6 million ducados. Although in 1626 Parliament authorized the government to issue an additional principal of 10 million ducados (Gelabert, 1997, pp. 74-75), most -if not all- of these additional juros were issued after 1628 (Domínguez-Ortiz, 1960, p. 341; Gelabert, 1997, p. 80). Thus, we can be confident that the figures for the nominal stock of government debt (112 million ducados) and for the interest paid on it (5.6 million ducados per year) are rather reliable and approximately constant for the period 1617-1628.

III. The Model

The model is designed to mimic the institutional features of the Castilian monetary system as of 1628, assuming that silver had (almost) completely been driven out of domestic monetary circulation. It is a variant of the Aiyagari and Gertler (1985) overlapping generations framework, modified to include perfect foresight, a representative household and copper currency, and to express the government's FFMP in nominal terms in order to make it consistent with our dataset.
Therefore, it is a neoclassical intertemporal general equilibrium model with full price flexibility.

[9] Apart from 214,000 ducados of the interest paid in 1625 in order to save funds to help the city of Cadiz which was menaced by an English squadron. To compensate the bearers, they were given new juros.

Consider an economy consisting of a representative household and the government. The time horizon is infinite. The household obtains utility from a non-storable consumption good and leisure. To acquire the consumption good the household must expend time in shopping. The amount of time so spent depends positively on the volume of consumption but, for any given volume, it is reduced by additional money holdings since these holdings facilitate transactions. As a result, leisure in every period will be negatively related to consumption and positively related to real money holdings. Thus, from a simple shopping time model a utility function can be obtained where the household gets utility from the consumption good and real money balances
(Croushore, 1993). The government consumes, levies lump-sum taxes, and issues copper money and government bonds.

In this economy, money consists of a coin --the blanca-- made from copper. Copper coins are produced by the government at no cost, excluding the real cost of buying the copper from a foreign country, which for simplicity we assume constant. The government specifies the amount of copper in the blanca and, in turn, the real cost of coining it. The currency unit is an abstract unit of account --the maravedi-- so that the money price of the consumption good in period *t* (p_t)is expressed in maravedis. The government also specifies the legal face value of the blanca in terms of maravedis (*e*).

The household can use two financial devices if it desires to transfer wealth from the current period to the next one. The first device is the storage of copper coins. The second method is the purchase of interest-bearing government bonds.

The consumer

The representative household's utility at time *t* can be expressed as the following infinite sum:

$$\sum_{i=0}^{\infty}\left(\frac{1}{1+r}\right)^{i} U(c_{t+i};\frac{eM_{t+i}}{p_{t+i}})$$

where:

c_{t+i} : household's consumption at period *t+i*

M_{t+i} : stock of circulating copper coins at the close of period *t+i*

eM_{t+i} : nominal supply of copper currency at the close of period *t+i*

eM_{t+i} / P_{t+i} : real supply of copper currency at the close of period *t+i*

$0 < \frac{1}{1+r} < 1$: discount factor

Let B_t be the nominal stock of government bonds at the close of period *t.* At the beginning of period

t, a government bond yields a nominal interest equal to i_{t-1}. Thus, the representative household's budget constraint in nominal terms (maravedis) for period t is:

$$p_t e + eM_{t-1} + (1+i_{t-1})B_{t-1} = p_t c_t + eM_t + B_t + T_t$$

where:

e : constant endowment of the single non-storable good received every period by the household
T_t : lump-sum tax in nominal terms

The household's goal at period t is to choose values for c_t and M_t, subject to its intertemporal budget constraint so as to maximize its intertemporal utility function.

Assume a logarithmic utility function:

$$U(c_t; \frac{eM_t}{p_t}) = a \ln c_t + \ln \frac{eM_t}{p_t} \; ; \; a > 0$$

The first-order conditions yield:

i) the Euler equation:

$$c_{t-1} = \frac{(1+r)c_t}{1+r_{t-1}}$$

where r_{t-1} is the real interest rate yielding a bond at the beginning of period t.
ii) the demand function for real money balances:

$$\frac{eM_{t-1}}{p_{t-1}} = \frac{1}{a}\left(\frac{1+i_{t-1}}{i_{t-1}}\right)c_{t-1}$$

Substituting i) into ii) yields

$$\frac{eM_{t-1}}{p_{t-1}} = \frac{1}{a}\frac{(1+r)(1+p_t)}{i_{t-1}}c_t$$

where $1+p_t \equiv \dfrac{1+i_{t-1}}{1+r_{t-1}}$

Government

Each period the government consumes a fixed fraction g of the total endowment e. Thus, the government consumption in nominal terms is

$$G_t = gep_t$$

The government finances its expenditures and the copper cost of making new coins with lump-sum taxes (T_t), government bonds and gross seigniorage. Its period ***t*** budget constraint in nominal terms is:

$$i_{t-1}B_{t-1} = e(M_t - M_{t-1}) + (B_t - B_{t-1}) + S_t$$

where:

$e(M_t - M_{t-1})$ is the period t nominal gross seigniorage

z is the constant real copper cost per blanca coin, $zp_t < e$.[10]

$zp_t(M_t - M_{t-1})$ is the period t nominal cost of minting new copper coins

$S_t \equiv T_t - G_t - zp_t(M_t - M_{t-1})$ is the period t primary budget surplus.

The real cost of copper coinage, $z(M_t - M_{t-1})$ is assumed to be a foreign country's revenue.[11]

Assume that the government uses its primary budget surplus S_t to meet its debt obligation. It obeys the following Ricardian FMMP: a fraction $0 \le (1-d) \le 1$ of the debt obligation in nominal terms, $(1+i_{t-1})B_{t-1}$, including principal and interest payments, is backed by the nominal primary budget surplus. The remaining fraction $0 \le d \le 1$ of the debt obligation is backed by gross seigniorage.[12]

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[10] In the 1620s and before the 1628 crydown, $e \cong 3zp_t$. After the crydown, $e' = 0.5e \cong 1.5zp_t$.

[11] In the 1620s, the Castilian government bought copper mainly from Sweden.

[12] Observe that this FFMP is a Ricardian one since it imposes that the government's infinite-horizon budget constraint holds with equality for all prices. The present discounted value of the primary surplus backs a fraction of the debt obligation, while the complementary fraction is backed by the present discounted value of seigniorage. As a result, the debt obligation is fully backed by the present discounted value of government net revenues (including seigniorage).

$d = 0$ corresponds to the polar budget surplus FFMP, while $d = 1$ is the polar seigniorage FFMP.

Let g_t be the present discounted value of the nominal primary budget surplus from t to ∞. As a result,

$$g_t = (1-d)(1+i_{t-1})B_{t-1}$$

To obtain the current value of the primary budget surplus, S_t, we realize that g_t must satisfy

$$g_t = S_t + \frac{g_{t+1}}{1+i_t}$$

Thus:

$$(1-d)(1+i_{t-1})B_{t-1} = S_t + (1-d)B_t$$

Rearranging:

$$S_t = (1-d)[(1+i_{t-1})B_{t-1} - B_t]$$

and

$$e(M_t - M_{t-1}) = d[(1+i_{t-1})B_{t-1} - B_t]$$

These expressions show that the nominal primary budget surplus equals, each period, $(1-d)$ times the difference between the current nominal interest obligation on the debt and a term which corrects for the adjustment in the nominal stock of government debt. In addition, gross seigniorage equals d times that difference.

Equilibrium

The representative household's period t budget constraint in nominal terms is:

$$p_t e + eM_{t-1} + (1+i_{t-1})B_{t-1} = p_t c_t + eM_t + B_t + T_t$$

When expressed in real terms:

$$e + \frac{eM_{t-1}}{p_{t-1}} \frac{1}{1+p_t} + (1+r_{t-1})b_{t-1} = c_t + \frac{eM_t}{p_t} + b_t + t_t$$

where

$$t_t \equiv \frac{T_t}{p_t} \quad \text{and} \quad b_t \equiv \frac{B_t}{p_t}$$

Since

$$t_t \equiv \frac{T_t}{p_t} \equiv \frac{S_t + G_t + zp_t(M_t - M_{t-1})}{p_t} = \frac{S_t}{p_t} + ge + z(M_t - M_{t-1}),$$

we find, after substituting and rearranging:

$$t_t = (1-d)(1+r_{t-1})b_{t-1} - (1-d)b_t + ge + z(M_t - M_{t-1})$$

Thus, the representative household's budget constraint in real terms is:

$$e + \frac{eM_{t-1}}{p_{t-1}} \frac{1}{1+p_t} + (1+r_{t-1})b_{t-1} =$$
$$c_t + \frac{eM_t}{p_t} + b_t + (1-d)(1+r_{t-1})b_{t-1} - (1-d)b_t + ge + z(M_t - M_{t-1})$$

After rearranging:

$$(1-g)e + (1+r_{t-1})[\frac{eM_{t-1}}{p_{t-1}} + db_{t-1}] =$$
$$c_t + (\frac{eM_t}{p_t} + db_t) + \frac{i_{t-1}}{1+p_t} \frac{eM_{t-1}}{p_{t-1}} + z(M_t - M_{t-1})$$

Substituting into the right-hand-side the previously obtained value for

$$\frac{eM_{t-1}}{p_{t-1}} = \frac{1}{a} \frac{(1+r)(1+p_t)}{i_{t-1}} c_t$$

yields:

$$(1-g)e - z(M_t - M_{t-1}) + (1+r_{t-1})(\frac{eM_{t-1}}{p_{t-1}} + db_{t-1}) =$$

$$c_t + (\frac{eM_t}{p_t} + db_t) + \frac{1}{a}(1+r)c_t$$

Consolidating the household's budget constraint and the government's budget constraint, we find the good market clearing condition:

$$c_t = (1-g)e - z(M_t - M_{t-1})$$

Substituting the market clearing condition in the above expression and rearranging yields:

$$(1+r_{t-1})(\frac{eM_{t-1} + dB_{t-1}}{p_{t-1}}) = \frac{1}{a}(1+r)c_t + (\frac{eM_t + dB_t}{p_t})$$

Since Obstfeld and Rogoff (1983) it is well known that monetary model economies have a large number of equilibrium price paths. The conventional selection device is the bubble-free or "fundamentals" device that rules out equilibria with purely speculative time trends in velocity by choosing the stationary equilibrium price. We use this selection device that does not include any self-justifying bubble or bootstrap components. Therefore, we look for a stationary solution where the real interest rate is constant and given by $r_{t-1} = r_t = r$.

Since

$$c_{t-1} = \frac{(1+r)c_t}{1+r_{t-1}}$$

consumption is also constant: $c_{t-1} = c_t = c$.

Thus:

$$\frac{eM_{t-1} + dB_{t-1}}{p_{t-1}} = \frac{1}{a}c + \frac{1}{1+r}(\frac{eM_t + dB_t}{p_t})$$

In the equilibrium steady-state:

$$\frac{eM + dB}{p} = \frac{eM_t + dB_t}{p_t} = \frac{eM_{t-1} + dB_{t-1}}{p_{t-1}}$$

Substituting and rearranging, the equilibrium price level is obtained:

$$p = \frac{a\, r\,(eM + dB)}{(1 + r)c}$$

As a result:

$$p_t(BS) = \frac{a\, r\, eM_t}{(1 + r)c_t} \leq p_t = \frac{a\, r\,(eM_t + dB_t)}{p_t} \leq p_t(SR) = \frac{a\, r\,(eM_t + B_t)}{p_t}$$

where *BS* and *SR* denote, respectively, the polar budget surplus and seigniorage FFMPs.

It can be seen that a *MT* relationship between money and the price level emerges only in the polar *BS* case ($d = 0$). Otherwise, government bonds matter. Their influence on the price level increases with d, the commitment they represent to mint copper money. The resulting anticipated rise in future currency minting associated with an increase in d lowers the current demand for nominally denominated assets, which in turn induces a higher price level. Thus, if gross seigniorage backs a positive fraction of the bond liability of the government, the nominal stock of government debt matters for the price level determination.

IV. Analysis of the 1628 crydown

The redenomination policy implemented overnight in 1628 by the Castilian government provoked a fall of the legal face value of the copper currency *e* to one-half of the previous one ($e' = 0.5e$). In this sense, it corresponds exactly to the traditional conceptual experiment of an overnight helicopter lift of purely fiat money, leaving untouched both the nominal stock of government bonds and the stock of circulating copper coins.

The price level after the crydown resulting from the *WFT* is given by:

$$p_t' = \frac{a\, r\,(0.5eM_t + dB_t)}{(1 + r)c_t}$$

so that the deflationary effect provoked by the redenomination policy is:

$$\frac{p'_t}{p_t} - 1 = \frac{-0.5eM_t}{eM_t + dB_t}$$

Now, the value of d must be found. As Figure 1 shows, from the beginning of the large-scale issues of copper currency in 1597 to its stopping in 1626, there were three very different phases, all of them lasting about ten years. The first one (1597-1608) witnessed the issue of 4,679,558 ducados. Between 1608 and 1617, the Castilian government decided to halt the copper coinage. Thus, there was no copper minting, apart from a very small issue of 79,250 ducados in 1612. However, after almost ten years of no copper issues, on July 3, 1617 the Castilian government decided the resumption, with renewed energies, of the copper coinage. As a result, the nominal volume of copper minted in the third phase (July 3, 1617-May 8, 1626) was almost five times larger than the one issued in the first phase. 22,508,555 copper ducados were coined --the gross seigniorage-- and the net seigniorage obtained from that coinage amounted to 15,489,313 ducados. We assume that the value of d is the one obtained from the third phase copper issues.

Since the expression for gross seigniorage as a fraction of the government debt burden is

$$e(M_t - M_{t-1}) = d[(1+i_{t-1})B_{t-1} - B_t]$$

and we assume that $B_{t-1} \cong B_t = 112$ million ducados, we can write

$$d \cong \frac{e(M_t - M_{t-1})}{i_{t-1}B_{t-1}}$$

Thus, the ratio "gross seigniorage/interest paid on juros" in the eleven-year period 1617-1627 corresponds to the parameter d:

$$d \cong \frac{22{,}508{,}555/11}{5{,}600{,}000}$$

The nominal stock of copper currency before the 1628 crydown fell very likely in the range 27-30 million ducados, according to governmental sources and contemporary estimates (Domínguez-Ortiz, 1960). Motomura (1997) estimates 27,439,963 ducados at the end of 1626 by assuming 1% annual loss from wear and tear of coinage (see Figure 1). Thus, as of August 1628, the stock should have fallen to 27 million ducados. If no depreciation is assumed, his estimate before the crydown is 30,267,357 ducados. Thus, we can be confident that the range 27-30 million ducados is very reliable.

Therefore, the deflationary effect on the price level resulting from the *WFT* would be given by:

$$\frac{p_t'}{p_t} - 1 \Big| WFT = \frac{-13.5}{27 + (0.365 \times 112)} = -19.88\%$$

$$\frac{p_t'}{p_t} - 1 \Big| WFT = \frac{-15}{30 + (0.365 \times 112)} = -21.16\%$$

Therefore, since seigniorage had been backing more than one-third of the government debt burden and the nominal stock of government bonds was four times higher than the nominal stock of copper currency, the *WFT* predicts that the weight of the current nominal stock of government debt on the current price level was heavier than the weight of the current nominal stock of copper money. Thus, the 1628 crydown that diminished overnight the nominal stock of copper money by a proportion of one-half should have reduced the current price level by a proportion of one-fifth.

The *MT* corresponds to the polar budget surplus FFMP ($d = 0$). In such a case, the model predicts that the price level should have fallen by 50%. However, even in such a case, since in the 1628 actual Castilian economy silver currency was still legal tender and there was free coinage of silver, an effective floor to the fall in prices expressed in copper maravedis was binding. If we use Hamilton's data for all Castile, a [(1/1.4627) - 1] = 31.6% fall in prices would have driven the silver premium to zero and a slightly larger fall would have triggered the minting of silver coins and their return to the domestic monetary circulation, thus preventing additional price falls. As a result, the 50% crydown would have reduced the price level by about one-third. That effective floor to the fall in prices expressed in copper maravedis would have been slightly larger than [1/1.84)- 1] = 45.65%, if Micon's Madrid data are used.

Now, we can compare those theoretical effects on the price level resulting from both theories of the price level to the impact felt in practice. Using Hamilton's (1934) data for the silver premium before and after the redenomination, the overnight impact on the price level can also be obtained. Indeed, since the model is a flexible price one and silver coins were quoted in terms of copper coins in free markets, the immediate change of the silver premium after the redenomination decree is the true empirical mirror of our theoretical expression[13]

$$\frac{p'_t}{p_t} - 1$$

Hamilton's silver premium data for all Castile (copper maravedi/silver maravedi) are 1.4627 (second quarter, 1628), 1.4190 (third quarter, 1628), and 1.1345 (fourth quarter, 1628). Since the redenomination policy was implemented overnight on August 7, and Hamilton's quarterly data are

[13]Note that silver coins were still legal tender and that their legal face value did not change (in fact, it remained unaltered between 1497 and 1643). Thus, the overnight copper crydown neither modified the purchasing power of silver coins nor the price level expressed in silver maravedis. As a result, a change in the silver premium just reflected the change in the purchasing power of the copper coins or, in other words, the change in the price level expressed in copper maravedis.

averages of several observations during the quarter, there are two relevant comparisons: the one between the third and fourth quarters and the one between the second and fourth quarters. These two values for the deflationary impact provoked by the crydown are:

$$\frac{p_t'}{p_t} - 1\bigg|actual = \frac{1.1345}{1.4190} = -20.05\%$$

$$\frac{p_t'}{p_t} - 1\bigg|actual = \frac{1.1345}{1.4627} = -22.4\%$$

The same calculations can be performed for Andalusia, New Castile and Old Castile using Hamilton's (1934) data and for Madrid using Micon's (1668) data.

For Andalusia, we have:

$$\frac{p_t'}{p_t} - 1\bigg|actual = \frac{1.1275}{1.6} = -29.53\%$$

$$\frac{p_t'}{p_t} - 1\bigg|actual = \frac{1.1275}{1.445} = -21.97\%$$

For New Castile, we have:

$$\frac{p_t'}{p_t} - 1\bigg|actual = \frac{1.176}{1.345} = -12.56\%$$

$$\frac{p_t'}{p_t} - 1\bigg|actual = \frac{1.176}{1.4733} = -20.18\%$$

For Old Castile, we have:

$$\frac{p_t'}{p_t} - 1\bigg|actual = \frac{1.1}{1.312} = -16.16\%$$

$$\frac{p_t'}{p_t} - 1\bigg|actual = \frac{1.1}{1.47} = -25.17\%$$

For Madrid (Micon's daily data), we have:

$$\frac{p_t'}{p_t} - 1|actual = \frac{1.1}{1.84} - 1 = -40.22\%$$

Despite our model is free of price rigidities, another possibility would be to look at actual commodity prices, but taking into account that these prices were probably sluggish to adjust. According to Hamilton's (1934) price data (base period 1621-1630), the price index for all Castile was 114.28 in 1627. After the 1628 crydown it fell until 99.06 in 1635. Therefore, another figure for the deflationary impact of the 1628 redenomination would be:

$$\frac{p_t'}{p_t} - 1|actual = \frac{99.06}{114.28} = -13.32\%$$

These figures were -12.93% for Andalusia, -11.64% for New Castile and -15.34% for Old Castile.

Overall, the silver premium data data show that the actual deflationary impact of the 1628 crydown fell between 12.56% and 40.22%. The price index data suggests the magnitude of that deflationary impact falling between 12.93% and 15.34%.

The *WFT* predicted effect falls within the interval for the silver premium and is stronger than the actual impact computed from commodity prices. In addition, the actual impact (whether on silver premium or commodity prices) was significantly smaller than the predicted one by the *MT*, the silver premium remained far away from unity and silver did not return to domestic monetary circulation. Thus, we can conclude that the data do not support the *MT*. Therefore, at this particular historical episode, our findings provide evidence more favorable to the *WFT* than to the *MT*.

V. Conclusion

We show how the *monetarist theory* and the *weak form fiscal theory* offer different explanations of the price level behavior after a once-and-for-all decrease in the money supply. We have then used the exceptional experiment the Castilian government put forward in 1628 through the reduction of the legal face value of all copper currency by a proportion of one-half in order to see which theory fits better actual data..

At the time of implementing the crydown, the stock of nominal government debt and its annual interest burden amounted to 112 million ducados and 5.6 million ducados, respectively. In the eleven-year period prior to the crydown the Castilian government had issued 22.5 million copper ducados in order to obtain seigniorage so that, as of 1628, the nominal stock of copper currency had reached 27-30 million ducados. As a result, gross seigniorage through the minting of copper currency had backed about 36.5% of the interest burden of government debt. Therefore, according to the *weak-form fiscal theory*, the weight of anticipated copper issues --to raise future seigniorage-- on the current price level was about 60%, being about 40% the weight of the current nominal copper stock. Thus, a redenomination policy that reduced the legal face value of copper currency by a proportion of one-half while leaving unaltered the nominal stock of government debt could just provoke a reduction of the price level by a proportion of one-fifth. The *monetarist theory* predicts a 50% decrease of the price level, but since silver could be freely coined in the Castilian economy, there existed a floor to the price level decrease (about one-third).

Existing data shows that in an economy like the Castilian one as of 1628, with a long trajectory of monetization of budget deficits and a heavy burden of interest-bearing government debt, the *weak-form fiscal theory* provides a better explanation of the price level behavior after the crydown than the *monetarist theory*.

References

Aiyagari, S. Rao, and Gertler, Mark. "The Backing of Government Bonds and Monetarism." *Journal of Monetary Economics* 16 (1985): 19-44.

Castillo-Pintado, Alvaro. "Los Juros de Castilla: Apogeo y Fin de un Instrumento de Crédito." *Hispania* 23 (1963): 43-70.

Conklin, James A. "The Theory of Government Debt and Spain under Philip II". *Journal of Political Economy* 106 (1998): 483-513.

_____. "Institutional Foundations of Commitment: Domestic Sovereign Debt in Imperial Spain." Manuscript. Austin: University of Texas, Department of Economics, 1996.

Croushore, Dean. "Money in the Utility Function: Functional Equivalence to a Shopping-Time Model." *Journal of Macroeconomics* 15 (1993): 175-182.

Domínguez-Ortiz, Antonio. *Política y Hacienda de Felipe IV*. Madrid: Editorial de Derecho Financiero, 1960.

Gelabert, Juan E. *La Bolsa del Rey: Rey, Reino y Fisco en Castilla (1598-1648).* Barcelona: Editorial Crítica, 1997.

Hamilton. Earl J. *American Treasure and the Price Revolution in Spain, 1501-1650*, Cambridge, Mass.: Harvard University Press, 1934.

Koenigsberger, Helmut G. "The Empire of Charles V in Europe." In *The New Cambridge Modern History*, vol. 2. Cambridge: Cambridge University Press, 1958.

Motomura, Akira. "The Best and Worst of Currencies: Seigniorage and Currency Policy in Spain, 1597-1650." *Journal of Economic History* 54 (1994): 104-127.

_____. "New Data on Minting, Seigniorage, and the Money Supply in Spain (Castile), 1597-1643." *Explorations in Economic History* 34 (1997): 331-367.

Obsfeld, Maurice, and Rogoff, Kenneth. "Speculative Hyperinflations in Maximizing Models: Can We Rule Them Out?." *Journal of Political Economy* 91 (1983): 675-687.

Sargent, Thomas J. "The Ends of Four Big Inflations" in Robert Hall (ed.), *Inflation: Causes and Effects*. Chicago, Il.: University of Chicago Press., 1982.

Sargent, Thomas J., and Wallace, Neil. "Some Unpleasant Monetarist Arithmetic." *Federal Reserve Bank of Minneapolis Quarterly Review* 5 (Winter 1981): 1-17.

Sargent, Thomas J., and Velde, François R. "The Big Problem of Small Change." *Journal of Money, Credit, and Banking* 31 (1999): 137-161.

Serrano Mangas, F. "Vellón y Metales Preciosos en la Corte del Rey de España (1618-1668), Banco de España, Servicio de Estudios, Estudios de Historia Económica 36 (1996).

Urgorri Casado, F. "Ideas sobre el Gobierno Económico de España en el Siglo XVII. La Crisis de 1627, la Moneda de Vellón y el Intento de Fundación de un Banco Nacional Exclusivo." *Revista de la Biblioteca, Archivo y Museo del Ayuntamiento de Madrid* 19 (1950): 123-230.23