Inflationary Finance in a Simple Voting Model

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Abstract

Central banks typically find it difficult to turn off the “political pressure valve”. This has important consequences for the types of monetary policies they implement. This paper presents an analysis of how political factors may come into play in the equilibrium determination of inflation. We employ a standard overlapping generations model with heterogenous young-age endowments, and a government that funds an exogenous spending via a combination of nondistortionary income taxes and the inflation tax. Agents have access to two stores of value: fiat money and an inflation-shielded yet costly asset. The model predicts that the relationship between elected reliance on the inflation tax (for revenue) and income inequality is non-monotonic; in particular, the reliance on seigniorage may actually decrease as income inequality rises. We find robust empirical backing for this hypothesis from a cross-section of countries. We also find that the likelihood of non-existence of majority voting equilibria is high in economies with a sufficiently high degree of income inequality. The latter would presumably benefit the most from having a truly independent central bank.

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1 Introduction

In most monetary models in the general equilibrium tradition, monetary policy (or more specifically, the money growth rate) is either exogenously given, picked by an independent central bank/revenue-seeking government, or determined by a benevolent social planner. While such constructs have their uses, they represent clear departures from reality. After all, the inflation rate of no country is ever determined by a mythical social planner, or by the monetary authority, especially not in a vacuum. Economic agents clearly exhibit an entire spectrum of tastes for inflation and the political consensus from the different segments of society (reflecting their various likes and dislikes) most certainly weighs heavily in the decision making of the central banks. In fact, the latter routinely face overt political pressure to adhere to clearly stated mandates on the inflation rate. Even the most independent central banks, as Fed Chairman Alan Greenspan has said, are not in any position to “shut down the political pressure valve”. This paper presents one possible analysis of how political factors may come into play in the equilibrium determination of inflation in a democracy.

There are three “stylized facts” that such an analysis ought to contend with. First, the fraction of household wealth held in liquid assets decreases with income and wealth, as documented for the United States in Kennickell and Starr-McCluer (1996). The implication is that the rich hold a large fraction of their wealth in the form of interest-bearing assets and not in the form of barren money. Second, even in a country as developed as the United States, 59% of households do not hold any interest-bearing assets [Mulligan and Sala-i-Martin (2000)]. They also point out that the relevant decision for the majority

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1 Easterly and Fischer (2001) using polling data for 31869 households in 38 countries find evidence that suggests that the poor view inflation more as a problem than the rich.

2 Bob Woodward, Assistant Managing Editor, The Washington Post in an interview, January 18, 2001 put it nicely: “Obviously the job of the Federal Reserve is to keep inflation under control: It’s kind of rule one, and there’s good reason. If you go back to what happened in the ’70s when inflation got out of control, it really hurt the economy, drove millions of people out of work, [and] was a giant setback for everyone who lived in the country at the time when you really look at it historically, so that’s his [Greenspan’s] job: To fight inflation.”

3 >From ABC News: [http://204.202.137.112/sections/politics/DailyNews/greenspanbush_0001217.html]: U.S Vice President on Fed Chairman Greenspan “We want to work very closely [with Greenspan]. He is the independent chairman of the Federal Reserve. They are responsible for monetary policy, but there is a degree of cooperation required between any administration in terms of monetary policy and fiscal policy ... It would be foolish not to work closely together.”

4 “What I am striving for is the concept of policy consistency over time: a countercyclical response which is consistent with, or can be reconciled with, the FOMC’s long-run goal and which, furthermore, is seen as consistent by the public.” [Gary Stern, President Federal Reserve Bank of Minneapolis, Formulating a Consistent Approach to Monetary Policy, 1996]

5 Keister (2000) using Surveys of Consumer Finances data, documents that after housing, “the second most popular form of saving for a vast majority of Americans was cash accounts; families in the bottom 80% of the distribution kept 11 percent of their assets in checking, and savings accounts, and other highly liquid financial instruments.” Kenickell et. al (2000) report that 13.2% of US families in 1998 (down from 18.7% in 1989) did not hold even a checking account, and that 82.6% of them had annual incomes less than $25,000. Interestingly, when asked why they did not have a checking account, 12.9% of the respondents cited “not enough money” and 11% cited “service charges too high” as their “most important” reason.
of US households is “not the fraction of assets to be held in interest bearing form, but whether to hold any amount of [such] assets at all.” Moreover, this “decision to adopt the financial technology” depends largely on the opportunity cost in terms of interest-income foregone and other physical costs. This suggests that even when interest-bearing assets are available, not everyone may be able to afford them. The third and final fact is this: every country in the world relies to some extent on seigniorage as a source of revenue.\(^6\)

We produce a pure-exchange overlapping-generations model with two-period lived agents that builds upon these aforementioned facts. The model exhibits income heterogeneity among the young; the old, however, have no endowment. There are two saving instruments, fiat money (the “bad” asset) and an inflation-shielded asset (the “good” high-real-return asset). Following Bryant and Wallace (1984) and more recently, Mulligan and Sala-i-Martin (2000), we assume that the good asset can be accessed only upon payment of a fixed upfront cost. Agents choose whether to pay this cost and hold the better asset or not pay it and simply hold money. A democratically-elected government has to raise revenue to finance a fixed exogenous level of spending (that benefits no one). There are two instruments for revenue generation: a lump-sum tax on young incomes, and the inflation tax. Young agents in the economy vote on the fraction of the government’s spending that will be paid for by the inflation tax. The timing assumptions in the model are such that the old do not need to care about this election.\(^7\)

Suppose the precise policy-package combination (of the inflation and the lump sum tax) is chosen by a simple majority decision rule. Restricting attention to stationary states, would the electorate prefer that the inflation tax partly or fully pay for the spending?

Specializing to a lognormal distribution for young-age endowments, we find a positive support for inflation. Somewhat surprisingly, the model produces a non-monotonic relationship between the winning policy-combination and the extent of income inequality. In other words, at sufficiently low levels of inequality, the winning policy-package combination involves high reliance on direct taxes and less on inflation. As the level of inequality increases, the reliance on inflation starts to increase. However, as inequality crosses a certain threshold, the elected reliance on inflation starts to fall. The intuition for this result plays off two effects, a “tax rate” and a “tax base” effect. Agents who hold only storage, vote for 100% use of the inflation tax. As income inequality rises, the number of storage holders rise, and this

\(^6\)Click (1998) documents that between 1971-90, in a wide cross-section of countries, currency seigniorage as percent of GDP ranged from 0.3% to 14% and seigniorage as percent of government spending ranged from 1% to 148%. By various measures, the United States has raised about 0.3% of real GDP via seigniorage in the post-war period, although the use of inflation as a means of funding war expenditures was not uncommon in the 19th century. See also Cukierman, Edwards, and Tabellini (1992).

\(^7\)See footnote 21 below for details.
shrinks the size of the inflation tax base. The money-holders then pit the prospect of a relatively high inflation tax (which is regressive, since it is not paid by the rich storage holders) versus the regressive lump-sum tax (which is paid by all). The non-monotonic nature of the predicted relationship is broadly supported by cross-country evidence.

What is novel here is that the inflation rate, the real money demand, and the distribution of money and storage holders, are all jointly endogenous. Changes in the inflation rate therefore bring about changes in not only the size of money demand (via the actual amount of money desired by the money holders) but also via changes in the composition of society among storage and money holders. It is this last “composition” effect that serves to increase the regressivity of the inflation tax beyond the standard effect that works off the fact that poorer people hold a larger fraction of their wealth in liquid form than richer agents. That is, as inequality continues to climb, the fact that there are more storage holders all of whom can entirely avoid the inflation tax, makes the latter even more regressive than the lump sum tax. It is this last effect that is responsible for the elected reliance on inflation to fall beyond a certain threshold of inequality.

A final result that deserves special mention is the following. We show that for some economies, for very high levels of income inequality, voting equilibria may not exist [there are Condorcet cycles, for example]; in fact, the likelihood of non-existence of majority voting equilibria increases once the level of income inequality becomes too high. This seemingly technical observation has a profound implication. An economy with a very high level of income inequality may not be able to reach a national consensus on the type of monetary policy that ought to be followed; such economies will presumably benefit most from establishing a truly independent central bank. Our analysis therefore provides another rationale for an independent central bank and paves the way for a theory on the endogenous need for an independent central bank.

Our paper may be viewed as being part of a line of work that tries to address monetary issues in models with heterogenous agents (like the overlapping generations model) using insights from political economy models. The papers that are closest in spirit to our current endeavor are those by Dolmas, Huffman, and Wynne (2000) and Bullard and Waller (2001). The former study a model very similar to our baseline model except that the electorate (only young voters) directly votes on the inflation rate. They uncover a inflation bias on the part of the median voter. However, they do not study

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8 An early important work in this area is Loewy (1988). There is a broader literature that considers, among others, issues like: a) whether monetary policy is influenced indirectly by who gets appointed by the President to the Board of Governors in the United States, b) whether political parties have an incentive to initiate “monetary surprises” that increase consumption and GDP temporarily right before an election, c) whether the median voter likes inflation because inflation erodes the cost of servicing a high debt.
the possibility of allowing the rich to avoid the inflation tax. Bullard and Waller (2001) consider the more general issue of “central bank design”. In a model with multiple assets (including bonds and capital) but no within-generation heterogeneity, they consider the welfare (and dynamic) implications of conducting monetary policy via either majority voting, or a policy board, or a constitutional rule (inspired by Azariadis and Galasso, 1996). In their setup, the real action lies in the tension between the young and the old over the desired inflation rate, and the old may veto the young. They find the presence of a inflation bias in monetary policy both in stationary and nonstationary settings under the majority-voting design. Erosa and Ventura (1999) calibrate a model that is well-equipped to handle the distributional effects of inflation to US data. Like us, they allow the rich to avoid the inflation tax. A principal finding of their paper is that “the burden of inflation is substantially higher for individuals at the bottom of the income distribution than for those at the top.” However, they do not study the concomitant political economy issues that naturally arise as a by-product of their finding. Albanesi (2000) analyzes a setup where the poor are more vulnerable to inflation than the rich. Since the former stand to lose more if there is inflation, they are the weaker party in the political process that determines the course of fiscal and monetary policy.

The rest of the paper is organized as follows. Section 2 describes the model environment and Section 3 presents the voting equilibria and their properties. Section 4 describes our main empirical findings and discusses the fitted econometric relationship between reliance on seigniorage and income inequality. Section 5 concludes.

2 The model

Consider a simple pure-exchange overlapping generations model where at any discrete date $t = 1, 2, 3...$, a new generation of unit measure is born, and lives two periods. There is a considerable amount of intragenerational income heterogeneity among young agents. Each young agent draws his first period endowment, $y$, of the single consumption good from a density function, $f(.)$ with support $[y_{\text{min}}, y_{\text{max}}]$. Agents have no endowment of the good when old. The preferences of each young agent over consumption in the two periods of life are described by an atemporal additively-separable utility function, $U(c_1, c_2)$ where $c_1$ stands for consumption in the first period and $c_2$ stands for consumption in the second period.

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9The basic structure of the model follows Dolmas, Huffman, and Wynne (2000) and Bhattacharya and Haslag (2001).
For analytical tractability, we will assume a specific functional form for $U$ namely:\(^{10}\)

$$U(c_1, c_2) = \ln c_1 + \ln c_2.$$  \hspace{1cm} (1)

Because agents like old age consumption but have no old age income, they have to save. There exists two saving instruments. First, there is a sure-return linear storage technology. One unit of the consumption good invested in this technology earns a sure gross real return of $x > 1$ next period.\(^{11}\) Second, there is fiat money and $R_m$ is its stationary return. Money is the “bad” asset; it is dominated in rate of return by storage, i.e., $x > R_m$. The good storage technology is accessible only upon payment of a fixed upfront cost of $\delta > 0$.\(^{12}\) In an equilibrium, agents will hold either storage or money but never both. This split, captures, albeit in an extreme way, the notion that the rich in the real world do not store much of their wealth in the form of money. It also generates an endogenous distribution of money and interest-bearing asset holders.

When young, agents pay a lump-sum tax, $T$, to the government.\(^{13}\) Consider the problem of an individual with income $y$ who wishes to access the storage technology by paying the fixed cost. Then, her budget constraints are given by

$$c_1^s = y - S - T - \delta \quad \text{and} \quad c_2^s = xS$$ \hspace{1cm} (2)

where $S$ is her saving in the form of storage, and the superscript $s$ indicates storage. Notice that since money is dominated in rate of return by storage, individuals have no incentive to hold both money and storage. Agents maximize (1) subject to (2) to get at their optimal investment in the storage technology: $S(y) = \frac{y - \delta - T}{2}$. This implies that an agent contemplating investing in storage will enjoy first and second period consumption given by

$$c_1^s = \frac{y - \delta - T}{2}, \quad c_2^s = x\left(\frac{y - \delta - T}{2}\right)$$ \hspace{1cm} (3)

\(^{10}\)Numerical computations confirm that the general flavor of the results is retained under a more general constant elasticity of substitution specification. The additive log formulation and much of the general environment draws heavily from Dolmas, Huffman, and Wynne (2000).

\(^{11}\)The real return to storage is perfectly invariant to inflation, and hence, the voting outcome.

\(^{12}\)One may think of this as the fixed cost of accessing financial markets or the cost of adopting financial technologies that Mulligan and Sala-i-Martin (2000) and Lucas (2000) discuss.

\(^{13}\)A natural question that arises is, why are proportional income taxes not available? Since there are no labor-leisure or production decisions to be made in the current model, confronting a progressive/proportional income tax in an electoral race with the inflation tax would produce uninteresting voting outcomes, either a 100% or a 0% political support for seigniorage. As pointed out in the introduction, virtually all real world economies rely an “interior” extent on inflation. Our restriction of allowing only lump sum income taxes allows us to generate this “interiority” in a simple model.

Finally, even though pure lump sum income taxes are rare in the real world, many tax instruments that are employed share varying degrees of regressivity with the lump-sum tax. Our formulation of the lump-sum tax is therefore a simple proxy for any and all such regressive taxes.
Her indirect utility would be
\[ U^s(y) = \ln \left( \frac{y - \delta - T}{2} \right) + \ln \left( x \left( \frac{y - \delta - T}{2} \right) \right). \tag{4} \]

Now, consider a person who wishes to hold only money. Such an agent’s budget constraints are given by:
\[ c_1^m = y - T - m \quad c_2^m = R_m \cdot m \tag{5} \]
where \( m \) is the amount of real money balances held between periods, and the superscript \( m \) stands for money. Such agents maximize (1) subject to (5) to get at their optimal money holdings: \( m(y) = \frac{y - T}{2} \).

This implies that their consumption in the first and second periods will be:
\[ c_1^m = \frac{1}{2} [y - T] \quad c_2^m = \frac{1}{2} [R_m(y - T)]. \]

and their indirect utility will be:
\[ U^m(y) = \ln \left( \frac{y - T}{2} \right) + \ln \left( R_m \left( \frac{y - T}{2} \right) \right). \tag{6} \]

Obviously, agents with income \( y \) for whom \( U^s(y) \geq U^m(y) \) will not hold any money. This condition reduces to
\[ \ln \left[ x \left( \frac{y - \delta - T}{2} \right)^2 \right] \geq \ln \left[ R_m \left( \frac{y - T}{2} \right)^2 \right] \Leftrightarrow (x - R_m) (y - T)^2 - 2\delta x (y - T) + x\delta^2 \geq 0 \]

It is easy to check that this inequality is satisfied for incomes that satisfy
\[ \delta \left[ \frac{x + \sqrt{xR_m}}{(x - R_m)} \right] \leq y - T \leq \delta \left[ \frac{x - \sqrt{xR_m}}{(x - R_m)} \right] \tag{7} \]

Since
\[ \frac{x - \sqrt{xR_m}}{(x - R_m)} < 1 \]

it follows from (7) that agents with post-tax income less than \( \delta \left[ \frac{x + \sqrt{xR_m}}{(x - R_m)} \right] \) would want to use the storage technology, but could not afford to because their disposable incomes are less than \( \delta \). Define
\[ y^\dagger \equiv \delta \left[ \frac{x + \sqrt{xR_m}}{(x - R_m)} \right]. \tag{8} \]

Only agents with incomes \( y - T > y^\dagger \) will access the storage technology. All others will hold only money.

We now turn to the determination of \( R_m \).
2.1 Return on money

The only purpose of the government is to raise enough revenue from lump-sum taxes and from the inflation tax (seigniorage) to finance its exogenously-specified spending of $g$ per young person. We assume that this spending is entirely “purposeless” in that it does not affect agents’ utility or their budget sets. Young agents vote on the fraction of this spending that should be financed using lump-sum taxes (which we denote by $\phi$). Whatever amount is not to be raised by lump-sum taxes must be raised via seigniorage. The central bank controls the nominal money stock changing it to raise the requisite revenue.

Then, the government budget constraint implies that

$$T = \phi g, \quad SN \equiv M(1 - R_m) = (1 - \phi)g$$

(9)

where $SN$ stands for seigniorage, and $M$ stands for the aggregate money demand in the economy. Higher values of $\phi$ represent the will of the electorate to raise more of the revenue from taxes and less from seigniorage. So as to not bankrupt anyone, we will assume that $y_{\text{min}} > g$.

Aggregate money demand is computed from

$$M = \int_{y_{\text{min}}}^{y^\dagger} m(y)f(y)dy.$$ 

Then, it follows that

$$(1 - R_m)\int_{y_{\text{min}}}^{y^\dagger} m(y)f(y)dy = (1 - \phi)g \Leftrightarrow \left[\int_{y_{\text{min}}}^{y^\dagger} yf(y)dy - T\int_{y_{\text{min}}}^{y^\dagger} f(y)dy\right] = \frac{2(1 - \phi)g}{(1 - R_m)}.$$ 

Noting that $T = \phi g$, we can calculate the return to money as:

$$R_m = 1 - \frac{2(1 - \phi)g}{\int_{y_{\text{min}}}^{y^\dagger} yf(y)dy - \phi g\int_{y_{\text{min}}}^{y^\dagger} f(y)dy} = 1 - \frac{2(1 - \phi)g}{\int_{y_{\text{min}}}^{y^\dagger} yf(y)dy - \phi gF(y^\dagger)}$$

(10)

where $F$ is the cumulative. Note that the holders of the inflation tax base are young agents whose incomes lie in the interval $[y_{\text{min}}, y^\dagger]$. Since $y^\dagger$ is a function of $\phi$, it follows that both the number of agents holding money and the amount of money being held by them are both endogenous variables. Furthermore, eqs. (10) and (8) jointly determine $y^\dagger$ and $R_m$ which are both functions of $\phi$. That is, given a $\phi$, any agent can immediately use (10) and (8) to jointly compute $y^\dagger$ and $R_m$ which in turn tells her if for that value of $\phi$, she would be happier holding storage or holding money.

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14 The assumption of “purposeless” spending allows us to abstract away from considering the distributional effects of government spending.

15 The central bank is not independent. It receives a mandate from the electorate on how much seigniorage revenue it must raise. It prints new money to generate the mandated revenue.
Equations (10) and (8) embody a direct connection between the elected value of $\phi$ and the real return on money in the economy. Agents understand this connection and use it to compute the value of $\phi$ they wish to vote for. Parenthetically, note that if the nominal money stock grows at the constant gross rate $\theta$, $p$ is the price level when the agent is young and $p'$ is the price level when the agent is old, then in a stationary equilibrium, $R_m \equiv \frac{p}{p'} = \frac{1}{\theta}$ holds. In other words, the outcome of the election on $\phi$ indirectly determines the money growth rate that is to be passively implemented by the central bank.\textsuperscript{16} It is in this precise sense that the central bank is not independent.\textsuperscript{17} Higher values of $\phi$ imply more reliance on income taxes, and hence, a lower money growth rate.

The environment described above is fairly rich in the sense that the return to money as well as the distribution of storage and money holders is jointly endogenous. Any change in the return to money (inflation tax rate) would influence the size of the set of people who hold only money (or only storage), i.e., the inflation tax base, which via the government budget constraint, would again influence the return to money and taxes.

### 2.2 Voting

The timeline (see Figure 1) is as follows. Each young agent (indexed by a unique income $y$) takes part in the voting process.\textsuperscript{18} We think of agents as voting on $\phi$ before making their consumption-saving decisions.\textsuperscript{19} An agent arrives at her most-preferred choice of $\phi$ by maximizing her lifetime indirect utility with respect to $\phi$ where $\phi \in [0, 1]$. Agents vote for their most preferred $\phi$.\textsuperscript{20} Once the results of the election on $\phi$ becomes known, the central bank picks the money growth rate that implements the winning value of $\phi$. This determines the return on money that the current young will enjoy when they are old. In other words, the current old have no reason to care about the election of $\phi$ going on during the period.\textsuperscript{21} This in turn implies that the standard commitment problem of getting the future young

\textsuperscript{16}Dolmas, Huffman, and Wynne (2000) allow agents to vote directly on $R_m$. Our formulation is isomorphic to theirs.

\textsuperscript{17}Alesina and Summers (1993) define the notion of “economic independence” as follows: “Economic independence is defined as the ability [of the central bank] to use instruments of monetary policy without restrictions. The most common constraint imposed upon the conduct of monetary policy is the extent to which the central bank is required to finance government deficits.” In other words, the central bank in our model is not economically independent.

\textsuperscript{18}Azariadis and Galasso (1996) provide some evidence to suggest that the age of the median voter in many elections in the United States has been below 45. In other words, they lend credence to the usual assumption that is made (just as we indirectly do) that the median voter is young.

\textsuperscript{19}As Dolmas, Huffman, and Wynne (2000) note, this is the most interesting case to look at.

\textsuperscript{20}Given the assumption of a continuum of voters, we assume that voting is sincere, that is, there are no strategic considerations that concern any voter.

\textsuperscript{21}Recall that elections are held before young agents make their consumption-saving decisions. We assume that the price level for the period ($p_t$) is known at the start of the period. After the election is declared, the $\phi$ becomes known, and so does $R_m (= p_t/p_{t+1})$. Following the election, the current old and the young (who now know how much money they want in equilibrium) trade goods for money at the known price level ($p_t$). In effect then, when the young elect a $\phi$ at date $t$, they
to implement the election outcomes reached by the current young does not arise here.\textsuperscript{22} It is important to note that the median voter theorem cannot be used to move from individual decisions to policy outcomes. To see this, consider an agent who is holding only storage. Such a person has a most preferred $\phi = 0$. If this person is asked to choose between $\phi = 0.3$ and $\phi = 0.5$, the single-peakedness condition in the median voter theorem requires that she chooses the $\phi$ nearest to 0, i.e., he ought to vote for $\phi = 0.3$. But, in the current model, it is possible that in the equilibrium with $\phi = 0.5$, this same agent would switch from holding storage to holding money and as a result may actually prefer $\phi = 0.5$ to $\phi = 0.3$. The link between incomes of agents and their votes is lost. As such, we resort to “counting votes” in a manner described below.

The space of possible values of $\phi$ is divided into a discrete grid, and elections are held between pairwise competing values of $\phi$. Then, for any two values of $\phi$, say $\phi_a$ and $\phi_b$, an agent can determine if she gets more utility under $\phi_a$ or $\phi_b$ and votes for the one that gives her more utility. Votes are tallied up, and the value of $\phi$ which is selected by the majority, wins that election. The winning $\phi$ (among $\phi_a$ and $\phi_b$) is then pitted against another feasible choice of $\phi$, and so on. If there is a single value of $\phi$ that remains undefeated in \textit{every pairwise} election with every other feasible value of $\phi$, it is declared the winner. This is what we will call the voting equilibrium or the political equilibrium. Such an equilibrium specifies the exact fraction of government spending that must be financed by direct taxes, and indirectly, pins down, the money growth rate and the distribution of storage and money holders in the economy.

As is well-known, in models of this type, voting equilibria may not exist. Similarly, the possibility of Condorcet cycles emerges [$\phi_a$ wins against $\phi_b$ and $\phi_b$ wins against $\phi_c$ but $\phi_c$ wins against $\phi_a$]. Following standard practice, we quickly resort to numerical computations.

\textsuperscript{22} Bullard and Waller (2001) produce a model similar in some respects to ours where the real action lies in the tension between the young and the old over the desired inflation rate in the economy. In their model \textit{[theirs is a model with capital and no intragenerational heterogeneity]}, elections to determine the value of the money growth rate take place near the \textit{end} of a period. At that time, the soon-to-be old want low inflation \textit{[high real interest rates]} so as to maximize the return on their past predetermined saving, while the soon-to-be born young want high inflation \textit{[via a Tobin-type effect, produces higher capital and hence, higher wages for them]}. 

3 Computational Experiments

We start by choosing $f(y)$ to be a lognormal distribution with mean $\mu = 3.606$ and standard deviation $\sigma = 0.615$. Bearse, Glomm, and Janeba (2000) argue that such a choice does a good job of capturing the actual US household income distribution in 1992 if income is measured in thousands of dollars. In our experiments, we will change $\sigma$ and this, in turn, will change the Gini coefficient. Higher $\sigma$ will correspond to higher inequality numbers. Draws of 25,001 people are taken from this distribution. The unit interval for $\phi$ is converted into a grid of 101 points. We set $x = 4.5$, $\delta = 55$, and $g = 8$. The corresponding Gini is 0.34. For this baseline set of parameters, the voting equilibrium has the following features. In this equilibrium, only 4.76% of the electorate ends up accessing the storage technology. The winning policy-combination is given by $\phi = 0.69$ which implies that the electorate votes for 31% of the government’s revenue to be raised via seigniorage. The implied elected inflation rate is 17.9%. The equilibrium also has the feature that the seigniorage to real GDP (GDP in the example is measured by adding up the real endowments $y$ of all the young) ratio is about 5%, and the government expenditures to GDP ratio is 18%.

We are particularly interested in the relationship between the winning policy-combination and the extent of income inequality. Figure 2 plots the elected $\phi$ against the Gini coefficient. As is clear from the figure, the relationship is non-linear. Of particular interest is the U-shaped nature of the plot. This suggests that for sufficiently low levels of inequality, the winning policy-package combination involves high reliance on direct taxes and less on inflation. As the level of inequality increases, the reliance on inflation starts to increase. However, as inequality crosses a certain point, the elected reliance on inflation starts to fall. People start to elect governments that rely more and more on direct taxes and less and less on inflation. The intuition for the upward sloping portion of Figure 2 is as follows. As the level of inequality continues to rise, the number of people who earn less than the mean income rises. If however, the number of storage holders rise, the size of the inflation tax base will fall. The money-holders will then face the prospect of a relatively high inflation tax rate (which is regressive, since it is not paid by the rich) versus the regressive lump-sum tax which is paid by all. The equilibrium may then shift toward greater use of lump-sum taxes. The extent of redistribution achieved is captured

23 It is easy to generate examples where a much higher percentage of the electorate uses the storage technology. In fact, ceteris paribus, using a utility function $U(c_1, c_2) = \ln c_1 + \beta \ln c_2$ where $\beta < 1$, we have been able to generate examples where the percent of people holding only storage is as high as 20%.

24 This U-shaped feature of the plot is quite robust to changes in parameters.

25 This is exactly to be expected, for example, in a political economy model similar to ours with money as the sole asset. See Bhattacharya, Bunzel, and Haslag (2001) for details.
in Figure 3 which tracks the fraction of \( g \) paid for the richest 10\% vis-a-vis the poorest 10\%.

We now turn to some welfare comparisons. Recall that the efficient monetary policy is to hold the money stock fixed and raise the revenue required through person-specific lump-sum taxes. We construct a measure of aggregate welfare which is a weighted sum of the steady-state lifetime utilities of all the electorate computed at the winning policy-package combination. We then compare this number to the weighted sum of the utilities of all the electorate computed at \( \phi = 1 \) (the zero inflation rate). The “welfare cost of inflation” ratio is the ratio of aggregate welfare under the winning \( \phi \) to welfare under \( \phi = 1 \). Figure 4 plots this “welfare cost of inflation” ratio (as a percent) against levels of income inequality. The ratio is 100\% when the elected \( \phi \) is 1 (when all the revenue is raised through direct taxes). Whenever this ratio exceeds 100\%, it implies that aggregate welfare is higher with some positive inflation when compared to zero inflation. As is clear from the figure, there is a range of ginis (0.35-0.5) in which society, as a whole, is “better off” with some positive inflation rather than with zero inflation.

3.1 Nonexistence of voting equilibria

Consider an alternative example using the same lognormal distribution that was employed earlier. Once again, draws of 25,001 agents are taken from this distribution. Now, suppose we set \( x = 3.8, \delta = 40, \) and \( g = 8. \) For this set of parameters, the voting equilibrium has the following features. In this equilibrium, about 10\% of the electorate ends up accessing the storage technology. The winning policy-combination is given by \( \phi = 0.78 \) which implies that the electorate votes for 22\% of the government’s revenue to be raised via seigniorage. The implied elected inflation rate is 14.3\%. The seigniorage to real GDP ratio is about 3.9\%, and the government spending to GDP ratio is 18 \%. Figure 5 plots the elected inflation rate against the Gini. Notice that the slope of the inflation-inequality relationship is positive all the way to a Gini of about 0.38. Beyond this level of inequality, there are no voting equilibria. This is presumably because for this set of parameters, once the degree of income inequality becomes “too high”, there are many people who hold no money. The inflation tax base shrinks to a point where the inflation tax rate needed to raise the government’s revenue is too high. This changes the composition of money versus storage holders and so on. No equilibrium can be reached. In other words, the electorate cannot give a clear mandate to the central bank on the type of monetary policy it should implement.

There is an important policy implication that we wish to draw from this example. One way to

\[26\] Just to clarify further, we are not comparing the average steady state utility under the voting equilibrium with inflation with the average steady state utility under the first best (no inflation and person-specific lump sum income tax). We are, however, comparing utility in an equilibrium with inflation with another with no inflation.
interpret the non-existence of a political equilibrium is to say that under a certain range of parameters, the electorate, if allowed to decide on monetary policy, would not be able to reach any consensus. More specifically, a lesson from this example is that once the level of income inequality reaches a certain threshold, a democracy operating under a majority rule may not be able to come to a decision on what type of monetary policy should be followed. It is possibly in this setting that an independent central bank is most needed. Our analysis therefore paves the way for a theory on the endogenous emergence of a central bank.

4 Empirics

The model has produced a causal relationship between income inequality and an electorate’s preference for inflationary finance. In particular, the relationship is predicted to be non-monotonic. Below, we test this powerful implication of the model using cross-country data.\(^{27}\)

The analog of an electorate’s preference for inflationary finance is our variable $\phi$ which we compute as follows: from the government budget constraint, total seigniorage revenue collected must satisfy $SN = (1 - \phi)g$, and so,

$$\frac{seigniorage}{GDP} = (1 - \phi).$$

Table 1 reports the summary statistics for the tax-reliance variable, $\phi$, and the Gini coefficient. The data used for this purpose is from a cross-country sample with 69 countries. Unless otherwise indicated, the data are sample means for the period 1974-89.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gini</td>
<td>42.06</td>
<td>9.12</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.91</td>
<td>0.099</td>
</tr>
</tbody>
</table>

For this sample period, 91% of the expenditures come from direct income taxes. Thus, across the countries in the data set, seigniorage accounts for an average of 9% of government expenditures.\(^{28}\)

---

\(^{27}\)Our exercise is in line with Cukierman, Edwards, and Tabellini (1992) who find cross-country empirical backing for their central hypothesis: countries with more polarized systems rely more heavily on seigniorage as a source of revenue than do more homogeneous societies.

\(^{28}\)Seigniorage to GDP ratio is measured as the average ratio of the change in the monetary base to GDP. The taxes to GDP ratio is the average ratio of conventional tax revenue to GDP for the sample period. The data are taken from Click (1998). The Gini data are time-averages computed from Deininger and Squire’s (1996) high-quality inequality data set.
Since seigniorage-reliance is defined as $1 - \phi$, the relationship between the tax-reliance variable and the Gini coefficient will be opposite in sign to the relationship between seigniorage-reliance and the Gini. The simple correlation coefficient between $\phi$ and the Gini coefficient is -0.20. In other words, there is a positive, albeit small, correlation between the level of income inequality and the reliance on seigniorage revenue across countries. This correlation coefficient is quantitatively in line with what others have reported in the inflation-inequality literature (see, for example, Dolmas, Huffman, and Wynne, 2000, and Albanesi, 2000).

The complete set of countries used for the regressions below are listed in Table 4. The exact number of countries used in any given regression varies from 64 to 78 depending on the availability of data on different variables across countries. The number of countries included in any given regression is reported in Table 2 and 3. The initial control variables employed includes the level of real GDP in 1960 and level of literacy in 1960 (taken from Barro, 1991) to capture differences in “initial” human and physical capital stocks. The literacy variable was also inspired by Easterly and Fischer (2000) who found evidence in polling data that the likelihood of citing inflation as a concern is inversely related to the educational attainment of the respondents. In addition, we include political economy measures, such as Barro’s (1991) measure of mixed government (MIX), a dummy variable for a socialist government (SOC), Gastil’s index of democratic rights (DEMOC 70), an index of political freedom, and an index of civil liberties (CIVIL) (to measure the importance and overall power of democratic institutions). In addition, we included the average ratio of conventional tax revenue to GDP (T/Y), the time-averaged fraction of people at or above the age of 65 before 1970 (Old) to capture the differences in initial demographics and the resultant bias toward redistribution, and the bank deposit rate (Drate), a measure of the return on a safe asset. These control or conditioning variables serve to capture inherent differences between the countries that are not included in our model.\(^{29}\)

Table 2 presents OLS estimates of the relationship between $\phi$ and income inequality along with the control variables mentioned above. The usual standard errors are reported in parenthesis.\(^{30}\) In an attempt to capture any non-linearity in the relationship as suggested by our results in Section 3, we included both the Gini-coefficient, and the square of the Gini-coefficient. Thus, we are approximating the functional form by a second degree polynomial, an acceptable procedure if the functional form is reasonably smooth. We also considered adding in the cube of Gini, but it turns out that that does not

---

\(^{29}\)The data are from readily available World Bank sources. See http://www.worldbank.org/research/growth/paauthor.htm

\(^{30}\)We also calculated White’s heteroscedasticity-consistent standard errors. These are similar in magnitude to the OLS standard errors; therefore, they are not reported here.
add any explanatory power to the regression.\textsuperscript{31}

Tables 2 and 3 reports a negative coefficient on the Gini and a positive coefficient on the square of the Gini. These coefficients are always significant at the 1% or the 5% level; moreover, the magnitudes of the coefficients are the same across all sets of control variables that we have employed. These results are quite robust to inclusion of additional conditioning variables. Literacy rates, the index of civil liberties and T/Y turn out to be mostly significant, while all other control variables are consistly insignificant. Adjusted $R^2$ varies between 0.12 and 0.27 in the regressions, which is substantially higher that the values typically reported in the inflation-inequality literature cited above, with $T/Y$ adding significantly to adjusted $R^2$. The nonlinearity in Gini accounts for about 20% of the explanatory ability of the model, yet another indication that the non-linear component of the econometric model is essential.\textsuperscript{32}

As additional, unreported, robustness checks, we carried out weighted least squares, weighting each observation with $1/CBI$, where CBI is a measure of central bank independence, the idea being that countries with very independent central banks would likely behave very differently from the model’s predictions, as these central banks would be subject to little political pressure. Weighting the observations by $1/CBI$ did not change the results, and furthermore did not seem to be eliminate any heteroscedasticity. In addition, we checked for influential observations and outliers by calculating the leverage and the influence of the individual countries.\textsuperscript{33} This resulted in the removal of Argentina, Sierra Leone, South Africa and Zimbabwe from the dataset. Removal of these countries did not in any way affect the results of the regressions.\textsuperscript{34}

The fitted econometric model implies that the relationship between $\phi$ and the Gini index of income inequality is given by

$$
\phi = 1.6 - 0.03 \cdot \text{Gini} + 0.0003 \cdot \text{Gini}^2 + \text{other variables}. \tag{11}
$$

The relationship is illustrated in Figure 6.\textsuperscript{35} To get a rough sense of the magnitudes implied by (11), consider the fact that the US Gini index increased from 34.4 in 1975 to 37.26 in 1985. A change

\textsuperscript{31}In fact, in a regression of Gini$^3$ on a constant, Gini and Gini$^2$, the $R^2$ turns out to be 0.99. This implies that the data on Gini$^3$ does not contain any information that is not already included in the second degree polynomial. Adding Gini$^3$ would therefore cause severe multicollinarity and invalidate the regression.

\textsuperscript{32}For example, if regression IV in Table 3 is carried out without Gini$^2$, adjusted $R^2$ drops to around 0.2. It is interesting to note that Dolmas, Huffman, and Wynne (2000) and Albanesi (2000) do not include a squared-gini term in their inflation vs. inequality regressions.

\textsuperscript{33}For a formal description of such tests, see Davidson and MacKinnon (1993) pg. 32-39.

\textsuperscript{34}Albanesi (2000) eliminates Morocco, Tunisia, Malaysia and Honduras for “being low inflation but very high inequality” countries. Our outlier and “influential observations” tests did not pick these countries.

\textsuperscript{35}The results from Table 3, Regression III is used. Only significant variables were used. The coefficients on CIVIL, Lit and T/Y were multiplied by their means.
in income inequality of this magnitude alone would have been associated with an additional 2.6% of
government spending (roughly 0.5% of US GDP) being financed via seigniorage.

From (11), it follows that:
\[
\frac{\partial \phi}{\partial \text{Gini}} = -0.03 + 0.0006 \cdot \text{Gini}
\]

This implies that when the Gini is less than 50 (the post-war average Gini for the US is around 36),
the derivative is negative, but for higher values of Gini it becomes positive.\footnote{It is important to note that the predicted positive relationship between \( \phi \) and Gini for Gini greater than 50 is not necessarily at odds with the standard results in the literature on inflation-inequality. While there is a theoretical one-to-one correspondence between \( \phi \) and seigniorage in this specific model, and there is a generally accepted link between seigniorage and inflation, the correlation in our data between \( (1 - \phi) \) and inflation is 0.6, and the correlation in the data between inflation and our measure of seigniorage [see Click, 1998] is only 0.4. As such, our results do not contradict those of the inflation-inequality literature.}

In other words, the data suggests that the relationship between \( \phi \) and the Gini index of income inequality is non-monotone. In
particular, beyond a certain threshold, the reliance on seigniorage falls with further increases in income
inequality. This evidence is consistent with the findings reported in Section 3, especially Figure 3.

5 Concluding remarks

This paper attempt to answering the question: if central banks face stiff political pressure from the
electorate, what kind of monetary policies are they likely to implement? We employ a standard over-
lapping generations model with heterogenous young-age endowments, and a government that funds an
exogenous spending via a combination of lump-sum income taxes and the inflation tax. In the base-
line model with money as the sole asset, we find that elected reliance on seigniorage increases (at a
decreasing rate) as the extent of income inequality increases. When the baseline model is augmented to
allow for costly access to a fixed real return asset, we find that the relationship between elected reliance
on the inflation tax and income inequality becomes non-monotonic; in particular, the winning inflation
rate may actually decrease as income inequality rises. We demonstrate strong empirical backing for
this hypothesis from a cross-section of countries. We also find that the likelihood of non-existence of
majority voting equilibria is high in economies with a sufficiently high degree of income inequality. Our
claim is that these economies would presumably benefit the most from a truly independent central bank.

\footnote{It is important to note that the predicted positive relationship between \( \phi \) and Gini for Gini greater than 50 is not necessarily at odds with the standard results in the literature on inflation-inequality. While there is a theoretical one-to-one correspondence between \( \phi \) and seigniorage in this specific model, and there is a generally accepted link between seigniorage and inflation, the correlation in our data between \( (1 - \phi) \) and inflation is 0.6, and the correlation in the data between inflation and our measure of seigniorage [see Click, 1998] is only 0.4. As such, our results do not contradict those of the inflation-inequality literature.}
Table 2
(standard errors in parentheses)

<table>
<thead>
<tr>
<th>Variable</th>
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<th>III</th>
<th>IV</th>
<th>V</th>
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<td>78</td>
<td>78</td>
<td>78</td>
<td>69</td>
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<td>1.55***</td>
<td>1.58***</td>
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<td>-0.028***</td>
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<td>-</td>
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<td>-0.023*</td>
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Legend: *** indicates significant at the 1% level
** indicates significant at the 5% level
* indicates significant at the 10% level
Table 3
(standard errors in parentheses)

<table>
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<th>III</th>
<th>IV</th>
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<td>Number of countries</td>
<td>78</td>
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<td>67</td>
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<tr>
<td>Adjusted $R^2$</td>
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<td>1.601***</td>
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<td>(0.265)</td>
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<td>(0.259)</td>
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<td>-0.026**</td>
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<td>(0.010)</td>
<td>(0.011)</td>
<td>(0.010)</td>
<td>(0.012)</td>
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<td>Gini$^2$</td>
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<td>0.0003**</td>
<td>0.0003**</td>
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<td>(0.0001)</td>
<td>(0.0001)</td>
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<td>(0.0001)</td>
</tr>
<tr>
<td>Lit</td>
<td>-0.133**</td>
<td>-0.130**</td>
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<td>-0.023**</td>
<td>-0.017</td>
</tr>
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<td>(0.010)</td>
<td>(0.011)</td>
<td>(0.010)</td>
<td>(0.011)</td>
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<tr>
<td>Drate</td>
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<td>-9.1×10$^{-6}$</td>
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<td></td>
<td>-</td>
<td>($-5.54 \times 10^{-6}$)</td>
<td>-</td>
<td>-</td>
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<td>T/Y</td>
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<td>0.248*</td>
<td>0.234*</td>
<td>0.212*</td>
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Legend: *** indicates significant at the 1% level
** indicates significant at the 5% level
* indicates significant at the 10% level
### Table 4 (List of Countries Used)

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<tr>
<th>Argentina</th>
<th>Ecuador</th>
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<th>New Zealand</th>
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References


