Inflation, Inequality and Social Conflict

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Abstract

This paper presents a political economy model of inflation as a result of social conflict. Agents are heterogeneous in terms of income. Agents' income levels determine their ability to hedge against the effects of inflation. The interaction of heterogeneous cash holdings and preferences over fiscal policy leads to conflict over how to finance government expenditure.

The model makes a number of predictions concerning which environments are conducive to the emergence of persistent inflation. Inflation will tend to be higher in countries with higher inequality and with greater pro-rich bias in the political system. Conversely, the use of income tax will be higher in countries with lower inequality and less pro-rich bias. The model also predicts that although inequality and political bias will have an impact on the composition of revenue, it will have no effect on the overall level of government spending (assuming that spending is on public goods only). These results are largely confirmed by the empirical portion of the paper.

The paper's novel features are its simplifications at the household level which allow for richer treatment of the income distribution and political process than in the related literature. The paper also gives unequivocal comparative statics results under relatively undemanding assumptions.

Note: Preliminary Research; please do not circulate more widely without consultation with author.

1 Introduction

This paper is motivated by a stylised fact in the world economy, the fact that unequal societies tend to suffer from higher than average rates of inflation. This correlation has been noted by a number of studies, including Albanesi (2002), Easterly and Fischer (2001), Romer and Romer (1998) and Bulif (1998). This result is backed up by my own empirical findings, presented later in the paper.

Other studies based on within-country data have shown that the incidence of the inflation tax is felt particularly harshly by poorer agents (Easterly and Fischer (2001), Erosa and Ventura (2002)). Other work has attempted to simulate the impact of inflation on different groups in society, through various economic channels. Kane and Morisett (1993) argue that for Brazil the impact of inflation was felt particularly harshly for the poor and middle classes, whereas the wealthy tended to be insulated from its effect.

This paper presents a model which explains the positive relationship between inflation and inequality via political economy considerations, and which incorporates stylised facts concerning agents' differing ability to hedge against inflation. Agents' preferences over different forms of taxation are shaped

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by income and by the composition of their asset portfolios. Income tax falls heaviest on the rich, whereas seigniorage is more costly for poorer agents, as agents' substitution out of cash is positively related to exogenous labour income. The political economy environment is modelled as a probabilistic voting model in which political influence increases with income. This translates into a weighted utility maximisation problem, where richer agents are assigned a higher relative weight than poorer agents.

Policy-makers' choice of income tax versus seigniorage and the level of government spending is determined by the interaction of three competing motivations. The first is to provide the efficient level of the public good via the optimal choice of taxation. The second motivation is an equity one: to provide a degree of consumption equalisation. This biases the policy-maker towards using income taxation, the more progressive form of taxation, to finance government expenditure. However, there is a third, political bias effect, that causes the policy-maker to favour policies more beneficial to richer groups in society. This can lead to positive seigniorage in equilibrium as the burden of taxation is shifted onto the less well-off.

The model predicts that societies with more income inequality and where the pro-rich political bias is stronger will tend to suffer from higher inflation. This paper is similar in spirit to Dolmas et al. (2000), Bhattacharya et al. (2003) and Albanesi (2002). However, by simplifying the problem at the household level a more complex income distribution and more interesting policy environment can be modeled.

In particular, these simplifications allow for a superior treatment of the political economy dimension of the problem compared to that in the literature to date. For instance, the paper moves beyond the bargaining approach to the policy game taken in Albanesi (2002), adopting a probabilistic voting set-up which is more intuitive and realistic and more standard with respect to other strands of the political economy literature. The model also allows for policy preference heterogeneity going beyond a simple "rich/poor" dichotomy. Comparative statics results with respect to the impact of income inequality on the policy equilibrium are also more easily illustrated. The analytical nature of the comparative statics results is also a step forward compared to other work in this area, such as Battacharya et al. (2003), which relies on simulation. Finally, the treatment of the public finance problem and the cash-holding decision is arguably more realistic than that in Dolmas et al. (2000), where seigniorage is used to fund a lump-sum transfer and all agents hold cash (meaning that seigniorage is a pro-poor policy, contradicting empirical evidence that the inflation tax is most costly for the poor).

The rest of the paper is organised as follows. Section two discusses the existing literature. Section three presents the model of the economy. Section four solves for the first-best welfare-maximising solution, to provide a suitable benchmark. Section five introduces the political economy problem. It solves the Ramsey problem as a special case, providing a second benchmark. Finally, this section presents the full solution and undertakes some comparative statics analysis. Section six provides an empirical analysis of the relationships outlined in the theoretical portion of the paper. The empirical results are generally supportive of the paper's theoretical arguments, although there are some interesting results that merit further research. Section seven concludes.

2 Existing Literature

Traditional models of the cost of inflation – such as menu costs/shoe leather cost models and the new generation of dynamic sticky price models – have tended to place little emphasis on the distributional impact of price instability. Similarly, most of the 'political economy' literature on monetary policy-making focusses on time-inconsistency issues rather than questions of distribution and conflict. However, Kane and Morisett (1993) identify at least four channels by which inflation can affect the distribution of income. Agents tend to face differential access to anti-inflation hedging tools – such as foreign-currency denominated or interest-bearing assets. Inflation also shifts the wage profile as differential bargaining

strength or access to indexed wages results in differential rates of real wage erosion. A third channel is heterogeneity with respect to liabilities – some groups have access to subsidised loans whose nominal interest rates may fail to fully reflect inflationary pressures. Finally, fiscal drag – the so-called Tanzi-Olivera effect – reduces the real value of non- or inadequately indexed taxes and transfers, redistributing from net tax-payers to net benefit-recipients.

Kane and Morisett's analysis of Brazilian data suggests that high inflation redistributed income from the poor – who suffered real wage erosion – and the middle class – who suffered the erosion of cash balances – to the rich, worsening the country's already highly skewed distribution of income. Ferreira and Litchfield (1999) also analyse Brazilian data, and find some time-series evidence of inflation leading to higher inequality. Cardoso (1992) supports Kane and Morisett's view that inflation's impact on the poor is primarily through its effect on real wages – a result of imperfect indexation – whereas it is the middle class that pays the inflation tax on cash balances.

Romer and Romer (1998) use a cross-sectional framework to analyse the effect of macroeconomic policies on the distribution of income. They find that macroeconomic stability and low inflation are associated with improved well-being of the poor over the long-run. Bulif (1998) also uses a cross-sectional approach, regressing gini coefficients on a number of explanatory variables, including a quadratic expression in income (to test the Kuznets hypothesis) and dummies for hyperinflation, high inflation, low moderate inflation and very low inflation. He finds that higher inflation is associated with more inequality, although the result seems to exhibit a degree of non-monotonicity. In particular, hyperinflationary countries have higher inequality than other countries but at lower levels of inflation the relationship is not so clear-cut. Earlier work by the same author (Bulif and Gulde, 1995) based on a panel of developing and industrial countries also uncovered a positive relationship between inflation and inequality. Easterly and Fischer (1998) use cross-country data and find that higher inflation is associated with the lower 20% of the income distribution having a smaller share of total income, lower minimum wage rates in relative terms, and higher rates of poverty. An IMF (1996) survey of global inflationary trends found that 'high average inflation and high variability of inflation increase income inequality significantly.'

Other authors analyse the link between inflation and poverty. Datt and Ravallion (2002) analyse panel data from Indian states and find that regional differences in the inflation rate contribute positively to poverty. Conversely, Epaulard (2003) studies a cross-section of almost 100 growth and downturn episodes in developing countries and finds that very high inflation increases the responsiveness of poverty to economic slowdowns, but inflation has no direct effect on poverty.

Some papers have adopted a more rigorous theoretical approach, using a cash-credit goods framework – with an increasing returns element to the credit technology – to argue that the inflation tax is regressive. This corresponds to the 'hedging' channel outlined by Kane and Morisett. Erosa and Ventura (2002) analyse US data, showing that poorer agents are more reliant on cash holdings as a proportion of their aggregate wealth, making them more exposed to the inflation tax.[1] Calibrating a monetary growth model based on a cash-credit goods framework, they show that the welfare and redistributive effects of allowing for this agent heterogeneity are significant.

Albanesi (2002) and Sturzenegger (1992) both adopt variants of the cash-credit goods model. Sturzenegger (1992) introduces a foreign currency explicitly, whilst Albanesi (2002) uses the standard Lucas and Stokey (1983) model, in which a subset of goods must be bought with cash, subject to a cash-in-advance constraint, and the remainder can be purchased with a costly credit technology. The advantage of the latter over cash is that it allows agents to avoid the inflation tax.

Sturzenegger's model assumes that less costly goods - viewed as necessities - are more expensive to pay for using foreign currency, so that they tend to be purchased with cash. 'Luxury' goods that tend to be purchased only by richer agents are relatively easy to pay for using foreign currency. When inflation increases, agents purchase more expensive goods through foreign currency and use cash for cheaper

[1] Mulligan and Sala-i-Martin [29] report similar findings from the 1989 US Survey of Consumer Finances. Wealthier and older agents are more likely to hold interest-bearing assets.

necessities. Hence the inflation tax falls largely on goods with a lower elasticity of demand, reflecting a key finding of Ramsey's theory of optimal taxation. In this sense inflation may improve economic efficiency relative to other more distortionary forms of taxation. However, it is also regressive. In other words, policy-makers face a trade-off between fairness and efficiency, leading to predictions concerning government behaviour under different assumptions with respect to the government's objective function.

A disadvantage of the Sturzenegger model is the non-standard utility function employed - which leads one to question the generality of its results - and the limited 'rich-poor' dichotomy in the assumed income distribution. The derivation of the government's policy objectives through a weighted welfare function can at best be thought of as a reduced-form expression derived from an implicit model of voting or lobbying by different groups. However, the modeling of this process is not presented explicitly.

Albanesi (2002) presents evidence of a cross-country correlation between inflation and inequality. However, she argues for – at least in part – a reverse pattern of causation running from inequality to inflation. Using a bargaining model to proxy for the political determination of policy, she shows that greater inequality heightens the political conflict over fiscal policy, leading to the adoption of inflationary financing. Agents differ in their exposure to inflation due to differing abilities to substitute out of cash. Poorer agents face a higher relative cost of adopting the alternative financial technology. The policy environment is characterised by a choice over the composition of taxation between seigniorage and income tax for a predetermined level of government spending, modelled as a bargaining game.

Albanesi shows that inflation reduces the bargaining power of the poor, since the fallback position – where expenditure is financed by inflation rather than explicit forms of taxation – is made less attractive as inflation increases. When inequality is higher, the poor are comparatively more exposed to the costs of inflation, weakening their bargaining position. This results in policy choices reflecting more closely those of the rich, leading to a greater share of revenue being raised via seigniorage.

Dolmas et al. (2000) use an overlapping generations framework, with a single tax (seigniorage) used to finance lump sum transfers. They predict that higher inequality causes higher inflation as the median voter becomes more keen to redistribute resources. One potential weakness of their approach is that the inflation tax is modeled as a progressive form of taxation, since other tax instruments are unavailable and seigniorage revenue is returned to households as a lump-sum transfer. This is contradicted by empirical evidence of the regressive nature of the inflation tax. It also makes their results vulnerable to the addition of alternative tax instruments, such as a linear income tax. The authors present empirical evidence of a positive relationship between inflation and inequality, controlling for measures of central bank independence.

Bhattacharya et al. (2003) employ an overlapping generations model similar to that in this paper, and predict an inverse-U shaped relationship between inequality and seigniorage. Unlike Dolmas et al., they allow for substitution out of cash by richer agents, making seigniorage a regressive tax. Inflation initially increases in inequality but falls for very high levels of inequality due to a tax-base effect (basically a Laffer-curve argument). They present empirical support for this finding based on cross-sectional data. The possible weaknesses of this approach are twofold. Firstly, the treatment of the political economy dimension is non-standard, because the failure of voters' preferences to meet the 'single-peakdness' criterion rules out the use of median voter theory. The approach taken, based on discretising the policy choice and assuming a series of bilateral contests, is somewhat counterintuitive and does not match the approach taken elsewhere in the political economy literature. A related problem is that the voting game can fail to yield an equililibrium under certain parameterisations. Secondly, the paper relies on simulation, making it difficult for the authors to pin down the processes driving their results.

Cukierman et al. (1992) focus on political conflict and instability – which one would expect to be linked with inequality other things being equal – rather than on inequality per se. They argue that political instability leads policy-makers to hold off from fiscal reforms for electoral reasons, leading to a greater reliance on inflationary financing. They find some cross-sectional evidence to support this hypothesis. However, Click (1998) finds that seigniorage is explained by the differential costs of different

methods of taxation and by the institutional set-up governing the central bank, but the measures of political instability in Cukierman et al. are not significant once these other factors are controlled for. Desai et al. (2002) argue that inequality and the political system interact to drive inflation performance. In high inequality countries, more democracy leads to higher inflation as a result of populist attempts at redistribution. By contrast, in low inequality countries, the main problem is parasitic governing elites that create inflation to transfer resources to themselves. In this environment more political competition will reduce inflation. Again, these authors present some empirical support for this model.

A parallel research question asks which groups in society are more inflation averse. Higher inflation-aversion amongst poorer groups would suggest that inflation is regressive in character. Fischer and Huizinga (1982) use US survey data from the 1970s to analyse how factors such as income and political affiliation affect relative preferences over inflation and unemployment (capturing the trade-off modelled in Barro and Gordon's classic (1983) paper on the time inconsistency problem in monetary policy-making). They find that for the US, richer agents appear to be more inflation-averse, although they question whether the survey questions really capture the policy trade-off – encapsulating both preferences over policy outcomes and the ability of policy to affect these outcomes. In addition, although simple analysis of sample means suggests the rich are more likely to rate inflation as more important than unemployment, regression analysis does not uncover a significant income effect. Scheve (2002) analyses UK survey data from 1995, and finds that although holders of nominal assets are more inflation averse (as one would expect), there is not a significant income effect on inflation-aversion.

In addition to their direct estimates of inflation on poverty and the income distribution, Easterly and Fischer also analyse international survey data which asks respondents to rate which of a range of possible domestic problems they feel to be of greatest concern. They find that the probability of nominating inflation as of high concern is higher for poorer and less educated respondents. Shiller (1996) presents survey data from the US, Germany and Brazil in an attempt to answer a related question: *Why* do people dislike inflation? He finds that the traditional economist's answer – with a focus on menu costs and the like – is not generally held amongst the population as a whole. Non-economists tend to view inflation as reducing real wages – although whether this is a rational response based on an experience of nominal wages failing to keep pace with prices or simply money-illusion – is not clear. The view that inflation is 'unfair' because it redistributes income in an arbitrary fashion also appears to be widely held. This indicates that for the public at large – if not for economists – the redistributive impact of inflation is central.

3 The Model

3.1 Demographics, Technology and the Household Problem

The model employs a simplified overlapping generations framework, similar in spirit to that in Bhattacharya et al. (2003) but greatly simplified to allow for analytical solutions and to facilitate a fuller treatment of the income distribution and the political environment.

Each household lives for two periods, with one cohort born each period. In the first period the household receives an endowment of the consumption good, y^i. Consumption takes place in the second period, but the good is assumed to be perishable and is destroyed after one period. Hence some transactions technology is necessary to allow the 'young' to transfer their endowment to the 'old' in exchange for purchasing power the following period. There are two assets in the economy to facilitate this exchange: cash (whose supply is controlled by the government) and a second asset in fixed supply.[2]

[2] The value of each asset depends on the availability of goods supplied by agents in the following period who wish to exchange for the asset, so that - for instance - the value of the asset falls if fewer goods are available for purchase (the price of the goods in terms of the asset increases).

This second asset can be thought of as a real asset, a foreign currency or an indexed asset. Essentially it is an inflation shelter.

Agents are heterogeneous in their labour endowment. The endowment is given by:

$$\begin{aligned} y^i &\sim \left(1, \sigma^2\right) \\ y^i &\geq 0 \\ \text{with cdf } F(y);\ f\left(y^i = 0\right) &= f\left(y^i \to \infty\right) = 0 \\ \frac{\partial}{\partial \sigma^2} \int_0^{\widetilde{y}} y f(y)\, dy &\leq 0 \forall \widetilde{y} \end{aligned}$$

The last inequality states that increases in the variance of the income distribution from, say, σ_0^2 to $\sigma_1^2 \geq \sigma_0^2$ delivers a distribution $F_1(y)$ that second order stochastically dominates the initial distribution $F_0(y)$.

Households face a utility cost of operating in the market for the second asset, denoted κ^i.[3] This cost is assumed to fall with y^i:

$$\begin{aligned} \kappa^i &= \kappa(y) \geq 0 \\ &> 0 \text{ for } y \text{ finite} \\ \frac{\partial \kappa}{\partial y} &\leq 0 \end{aligned}$$

The empirical and theoretical work on portfolio choice has posited the existence of fixed costs of participation in markets for non-cash financial assets. Luttmer (1999) [28] analyses US data on asset holdings and argues that the lower bound on the cost is 3% of monthly per capita consumption. Mulligan and Sala-i-Martin (1996) [29] argue that the fixed cost varies across agents due to individual-specific characteristics, including age, education and financial wealth. These characteristics in turn affect income. The simple inverse relationship between the cost of financial diversification and income employed here can be thought of as a reduced form of a more complex model of portfolio choice.

Utility is given by:

$$\begin{aligned} U^i &= \ln c^i + \alpha \ln g - \kappa^i D^i \\ D^i &= 1 \text{ if agent exchanges endowment for the second asset;} \\ &\quad\ 0 \text{ if exchange is for cash} \end{aligned}$$

In addition to consuming the private good, agents also consume a public good g which is funded out of taxation and seigniorage revenue. The log utility formulation is necessary for expositional simplicity. Explicit taxation is in the form of a linear income tax τ which is paid out of consumption goods immediately prior to consumption.

The nominal value of assets received in exchange for the endowment is given by:

$$a_t^i = d_t^i + m_t^i = \left[D^i q_t + \left(1 - D^i\right) p_t\right] y^i$$

where p and q are the prices of goods in terms of cash and the second asset respectively, and m and d are nominal holdings of cash and the second asset by the household following production.

[3] Households will not substitute their endowment for a mixture of both assets, because the cost of accessing the market for the second asset is a fixed cost that does not vary in the value of the fixed asset held. Hence, a corner solution is always chosen.

Consumption is at period $t+1$ prices. Hence, the household budget constraint is given by:

$$c^i + \tau_t y^i = \frac{d_t^i}{q_{t+1}} + \frac{m_t^i}{p_{t+1}} = \left[D^i \frac{q_t}{q_{t+1}} + \left(1 - D^i\right) \frac{p_t}{p_{t+1}} \right] y^i$$

The time subscripts on the prices reflect the fact that agents receive payment for production one period before consuming themselves. The sole other consumption and production decision for the household is which asset to hold, which comes down to a choice of $D^i \in [0,1]$:

$$\begin{aligned} D^i \quad &\in \quad [0,1] = \arg\max U^i = \ln c^i + \alpha \ln g_t - \kappa^i D^i \\ & \quad s.t. \\ c^i + \tau_t y^i \quad &= \quad \frac{m_t^i}{p_{t+1}} + \frac{d_t^i}{q_{t+1}} = \left[D^i \frac{q_t}{q_{t+1}} + \left(1 - D^i\right) \frac{p_t}{p_{t+1}} \right] y^i \end{aligned}$$

Which yields the solution:

$$D^i = 0 \text{ if } \kappa^i > \ln \left[\frac{q_t}{q_{t+1}} - \tau_t \right] - \ln \left[\frac{p_t}{p_{t+1}} - \tau_t \right] = \ln \left[\frac{\frac{q_t}{q_{t+1}} - \tau_t}{\frac{p_t}{p_{t+1}} - \tau_t} \right], \ 1 \text{ otherwise}$$

Note that in the foregoing discussion and in what follows, all time subscripts refer to the period in which the cohort producing or consuming was born, except prices, which refer to the current period.

3.2 General Equilibrium

General Equilibrium is defined by the optimal asset-holding decision for each household, based on beliefs about the evolution of prices p and q, market clearing conditions for cash, the second asset, and goods, and budget constraints for each household and the government:

$$\begin{aligned} c^i + \tau_t y^i \quad &= \quad \frac{m_t^i}{p_{t+1}} + \frac{d_t^i}{q_{t+1}} = \left[D^i \frac{q_t}{q_{t+1}} + \left(1 - D^i\right) \frac{p_t}{p_{t+1}} \right] y^i, \forall i \\ D_t^i \quad &= \quad 0 \text{ if } \kappa^i > \ln \left[\frac{\frac{q_t}{q_{t+1}} - \tau_t}{\frac{p_t}{p_{t+1}} - \tau_t} \right], \ 1 \text{ otherwise}, \forall i \\ q_t \int_i y^i D_t^i f\left(y^i\right) di \quad &= \quad d_t \equiv d \\ p_t \int_i y^i \left(1 - D_t^i\right) f\left(y^i\right) di \quad &= \quad m_t \\ \int_i c_t^i f\left(y^i\right) di + g_t \quad &= \quad \int_i y^i f\left(y^i\right) di \equiv 1 \\ g_t \quad &= \quad \tau_t + \frac{m_{t+1} - m_t}{p_{t+1}} \end{aligned}$$

The first equation above gives the household budget constraint. The second equation gives the optimal choice for each household in terms of exchanging its endowment for cash or the second asset. The third and fourth equations equate supply and demand for the second asset and cash respectively (market clearing conditions for the asset market). In these equations the terms d_t $(= d)$ and m_t without superscripts represent aggregate quantities.

The fifth equation gives market clearing conditions in the goods market. Note that total period t consumption (that is, consumption by cohort t) is equal to the total endowment of the period $t+1$ cohort. The final equation gives the government balanced budget constraint. It shows that the public good must be funded out of tax revenue and seigniorage.

4 Planner Problem

The planner problem provides us with a benchmark against which to judge the political economy outcome derived in the following section. The planner is constrained by the economy's resource constraint but not by the constraints imposed by individual behaviour, since all allocations can be imposed centrally by assumption. The planner problem can therefore be expressed as:

$$\begin{aligned} \max_{c_t^i, D_t^i, g_t} W_t &= \int_i \left[\ln c_t^i + \alpha \ln g_t - \kappa^i D_t^i\right] f\left(y^i\right) di \\ & s.t. \\ \int_i c_t^i f\left(y^i\right) di + g_t &= 1 \qquad (\phi_{0t}) \end{aligned}$$

The sole constraint is the economy-wide resource constraint: that total period t public and private consumption is equal to total period $t+1$ production, which is equal to unity by construction.

First order conditions are given by:

$$\begin{aligned} \frac{1}{c_t^i} &= \phi_{0t} \qquad (c_t^i) \\ \frac{\alpha}{g_t} &= \phi_{0t} \qquad (g_t) \end{aligned}$$

Hence, all agents consume the same level of private consumption:

$$c_t^i = \overline{c}, \forall i, t$$

Since consumption is equalised via transfers, the authorities can circumvent the equity-efficiency trade-off. Substituting into the economy-wide resource constraint gives the optimal (efficient) level of the public good:

$$g_t = \overline{g} = 1 - \overline{c}$$

Using the FOC for g_t:

$$\begin{aligned} \overline{g} &= \alpha \overline{c} \\ 1 - \overline{c} &= \alpha \overline{c} \\ \overline{c} &= \frac{1}{1+\alpha} \\ \overline{g} &= \frac{\alpha}{1+\alpha} \end{aligned}$$

Differentiating with respect to D_t^i yields:

$$\frac{\partial W_t}{\partial D_t^i} = -\kappa^i < 0$$

which implies that $D_t^i = 0, \forall i, t$.

Note that **the choice of seigniorage versus income tax is orthogonal to the planner problem** because all redistributive effects on private consumption can be offset by individual taxes and transfers.

5 Political Economy Equilibrium

The political economy environment of the economy is introduced in this section. I also analyse the Ramsey problem here - a benign policy-maker choosing optimal welfare-maximising policies in a decentralised setting - since it is easily incorporated as a special case of the political economy game. The first subsection outlines the political economy environment. The second analyses the Ramsey solution, whilst the third analyses the general solution.

Before describing the political economy problem in detail, I introduce some further notation. Dividing by the relevant price level, real balances and the real stock of the second asset can be expressed as:

$$\begin{aligned} \widehat{m}_t &\equiv \frac{m_t}{p_t} = \int_i y^i \left(1 - D_t^i\right) f\left(y^i\right) di \\ \widehat{d}_t &\equiv \frac{d_t}{q_t} = \int_i y^i D_t^i f\left(y^i\right) di = 1 - \widehat{m}_t \end{aligned}$$

Note that, from the second-order stochastic dominance assumption on the income distribution,

$$\frac{\partial\left(1-\widehat{m}\right)}{\partial\sigma^2} \geq 0$$

I also introduce the following notation for price level inflation, measured in terms of the 'inflation tax':

$$\begin{aligned} \frac{p_t}{p_{t+1}} &\equiv \frac{p_t}{p_t\left(\pi_t+1\right)} = 1 - \frac{\pi_t}{\pi_t+1} \equiv 1 - \widehat{\pi}_t \\ \frac{q_t}{q_{t+1}} &\equiv 1 - \widehat{q}_t \end{aligned}$$

Finally, I define a variable γ_t that summarises the policy stance in terms of τ_t and price changes:

$$\gamma_t = \frac{1 - \widehat{q}_t - \tau_t}{1 - \widehat{\pi}_t - \tau_t}$$

Substituting this into the decision rule for D_t^i yields the following:

$$\begin{aligned} D_t^i &= 0 \text{ if } \kappa^i > \ln\gamma_t, 1 \text{ otherwise} \\ i.e. \text{ if } y &< \widehat{y} \equiv \kappa^{-1}\left(\ln\gamma_t\right), 1 \text{ otherwise} \\ \frac{\partial\widehat{y}}{\partial\gamma_t} &\leq 0 \end{aligned}$$

5.1 Political Economy Environment

I adopt the probabilistic voting model originally due to Lindbeck and Weibull (1987). I adopt the formulation of Persson and Tabellini (2000). The usefulness of the probabilistic voting model over alternative models (such as the simple Downes-Hotelling median voter theory) is its additional tractability, as the introduction of uncertainty in the voting function removes the non-continuities associated with the earlier median-voter models. This greater tractability is particularly important when agent heterogeneity makes the political economy environment more complex.

It also introduces a greater degree of realism to the model, as in reality votes over party platforms are determined not only by the particular issue or issues under analysis, but by a variety of other issues. One way of dealing with this is to label extraneous factors as 'ideology' and model preferences over this

factor as essentially random, as in the probabilistic voting model. Finally, the model has the additional advantage that it can easily be applied to multidimensional contests, such as the one analysed here. By contrast, the median voter model can only be generalised to multidimensional problems if they can be rendered essentially unidimensional by making simplifying assumptions about how policies map into voters' preferences.

5.1.1 The Probablistic Voting Model

Policy-makers are elected for one period, and choose a level of government expenditure g_t, a single income tax rate τ_t, and an expansion in the money supply $(m_{t+1} - m_t)$. The latter is equivalent to choosing a rate of inflation π_t or more conveniently a rate of the inflation tax (seigniorage) $\widehat{\pi}_t$. Policy-makers derive utility only from being elected, and therefore adopt a policy vector $G_t \equiv \{g_t, \tau_t, \widehat{\pi}_t\}$ to maximise their probability of being elected.[4] There are two policy-makers seeking election, and the electoral rule is simple majority voting. For simplicity, it is assumed that policy positions are announced and the election occurs after agents have made their asset-holding choices. That is, only the 'old' vote, with the vote taking place at the start of their second period of life.

In addition to their utility derived from consuming public and private goods, agents have some intrinsic bias towards one or other of the candidates, which is uncorrelated with other aspects of their individual characteristics, notably their income. The bias has two components, an individual-specific bias and an economy-wide bias, both of which vary over time. If the two candidates are denoted $\{A, B\}$, then the biases are denoted as a bias in favour of candidate B, so that a negative value implies a bias towards candidate A. The individual-specific bias is denoted ε^i, whilst the economy-wide bias is denoted δ. ε^i is uniformly distributed as:

$$\varepsilon^i \sim U\left[-\frac{1}{2\phi}, \frac{1}{2\phi}\right]$$

I make a critical assumption that agents differ in their political 'weight' w^i, where the weight is increasing monotonifcally in income. This reduced-form formulation is designed to account for the observed greater political participation by richer agents (see Benabou, 2000 for a similar model and comprehensive evidence of the influence of income on political activity and influence). It can be rationalised by introducing lobbying (see Persson and Tabellini, 2000) or by simply making richer agents more likely to vote, or by making the variance of the noise in agents' voting rules vary inversely with income.

Formally, I assume that agents' weight maps into income monotonically, with the relationship in-

[4] Although the set of policy instruments includes three separate instruments, the government balanced-budget constaint implies that only two can be independent.

dexed by a 'pro-rich bias' term $\theta \geq 0$ such that:

$$\begin{aligned} w^i &= w\left(y^i, \theta\right) \geq w^{\min}, \frac{w^{\min}}{y^{\min}} > 0 \\ \frac{\partial w\left(y^i\right)}{\partial y^i} &\geq 0 \\ E\left(w^i\right) &= 1 \\ w^i &= y^i \text{ for } \theta = 0 \\ \frac{\partial\left(1-A\right)}{\partial\theta} &\geq 0 \\ \frac{1}{\left(1-\widehat{m}\right)}\frac{\partial\left(1-\widehat{m}\right)}{\partial\sigma^2} &\leq \frac{1}{\left(1-A\right)}\frac{\partial\left(1-A\right)}{\partial\sigma^2} \\ \text{where } \widehat{m} &= \int_0^{\widehat{y}} yf\left(y\right)dy \text{ and } A \equiv \int_0^{\widehat{y}} w\left(y\right)f\left(y\right)dy \end{aligned}$$

Hence the political weight is monotonically increasing with income (yielding **greater political influence to agents higher up the income scale)**. Since $w^i = y^i$ for $\theta = 0$ and $\frac{\partial A}{\partial\theta} \leq 0$, the distribution of weights second-order stochastically dominates income.[5]

Finally, note that the elasticity of the *income* of non-cash-holders (or their real holdings of the non-cash asset) with respect to the inequality parameter is assumed to be lower than the elasticity of their *weighted mass* with respect to the same parameter. This condition essentially says that the degree to which the distribution of weights second-order stochastically dominates the distribution of income is increasing in inequality. This assumption is critical to the result that increasing inequality leads to greater seigniorage. It ensures that greater income inequality generates a decrease in the effective inflation-averse electorate that outweighs the reduction in the tax base of the inflation tax.[6]

The economy-wide random bias towards candidate B distributed as:

$$\delta \sim U\left[-\frac{1}{2\psi}, \frac{1}{2\psi}\right]$$

Voter i prefers candidate A if:

$$U^i\left(G_t^A\right) > U^i\left(G_t^B\right) + \varepsilon_t^i + \delta$$

Therefore, an agent of type i is a swing voter (indifferent between the two candidates) if:

$$\varepsilon_t^i = U^i\left(G_t^A\right) - U^i\left(G_t^B\right) - \delta$$

Candidate A's probability of winning is therefore given as:

$$p_t^A = \frac{1}{2} + \int_i w^i f\left(y^i\right)\left[U^i\left(G_t^A\right) - U^i\left(G_t^B\right)\right]di$$

[5] The assumption that the distribution of weights second-order stochastic dominates the distribution of income is necessary to generate interesting results. This is because the log-linear specification for utility implies that $\frac{\partial U}{\partial C}$, the marginal utility of consumption, equals $\frac{1}{C}$. When the weights are distributed with less inequality than income, the lobbying effect is insufficient to outweigh the utility-equalisation effect implied by the diminishing marginal utility associated with log utility. If utility had a linear specification, then any positive relation between income and political weight would be sufficient to overcome the utility-equalisation effect, because marginal utilities would already be equal across agents (equal to unity) by assumption.

[6] This assumption essentially requires that the weighting function $w\left(y^i, \theta\right)$ should be sufficiently elastic with respect to income.

5.1.2 Solving the Model

Each candidate maximises his probability of winning the election, which is equivalent to maximising a weighted social welfare function subject to the government budget constraint. The solution is given formally for candidate A but as discussed above candidate B faces a symmetrical problem and arrives at the same policy solution.

Formally, candidate A's problem is given by:

$$\begin{aligned}
\max_{G_t^A} p_t^A &= \frac{1}{2} + \int_i w^i f\left(y^i\right)\left[U^i\left(G_t^A\right) - U^i\left(G_t^B\right)\right] di \\
&\quad s.t. \\
G_t^A &\equiv \{g_t, \tau_t, \widehat{\pi}_t\} \\
U^i &\equiv \ln c_t^i + \alpha \ln g_t - \kappa^i D_t^i, \forall i \\
g_t &= \tau_t + \widehat{m}_{t+1} - \widehat{m}_t\left(1 - \widehat{\pi}_t\right) \qquad (\phi_{0t}) \\
c_t^i &= \left[\left(1 - \widehat{q}_t - \tau_t\right) D^i + \left(1 - \widehat{\pi}_t - \tau_t\right)\left(1 - D^i\right)\right] y^i, \forall i \\
D_t^i &= 0 \text{ if } y < \widehat{y} \equiv \kappa^{-1}\left(\ln \gamma_t\right), 1 \text{ otherwise}, \forall i
\end{aligned}$$

The solution to this policy problem is derived from three first order conditions, one each for $\widehat{\pi}_t$, τ_t and g_t. The three conditions are given below.

$$\frac{1}{1 - \tau_t - \widehat{\pi}_t} \int_0^{\widehat{y}} w^i f\left(y^i\right) - \phi_{0t}\widehat{m}_t = 0 \qquad (\widehat{\pi})$$

$$\frac{1}{1 - \tau_t - \widehat{\pi}_t} \int_0^{\widehat{y}} w^i f\left(y^i\right) + \frac{1}{1 - \tau_t - \widehat{q}_t} \int_{\widehat{y}}^{\infty} w^i f\left(y^i\right) - \phi_{0t} = 0 \qquad (\tau)$$

$$\frac{\alpha}{g_t} - \phi_{0t} = 0 \qquad (g)$$

The first two first order conditions can be combined as:

$$\frac{1}{\widehat{m}_t} \int_0^{\widehat{y}} w^i f\left(y^i\right) = \int_0^{\widehat{y}} w^i f\left(y^i\right) + \frac{1}{\gamma_t} \int_{\widehat{y}}^{\infty} w^i f\left(y^i\right)$$

This assumes that both financing instruments are used in equilibrium and that the marginal costs are therefore equal at the margin. Hence we arrive at the following implicit solution for γ_t:

$$\gamma_t = \frac{1 - A}{A} \frac{\widehat{m}}{1 - \widehat{m}} \geq 1$$

Assuming that this solution is unique, then the solution for γ_t has to be time invariant. Hence, agents' production sector decisions are also time invariant, which implies that q_t is constant and $\widehat{q}_t = 0, \forall t$. This implies that:

$$\gamma = \frac{1 - \tau}{1 - \tau - \widehat{\pi}} \geq 1$$

5.2 Ramsey Solution

The Ramsey problem is to maximise aggregate welfare through the optimal choice of instruments available to the policy-maker and subject to all the behavioural constraints imposed by equilibrium behaviour on the part of the private sector. The Ramsey solution can be thought of as the solution to the probabilistic model without the pro-rich bias that enters into the policy-maker's objective function. This is because, absent this bias, the policy-maker simply maximises aggregate welfare. In other words, the Ramsey solution equals the general solution with $w^i = 1 \forall i$.

The key characteristic of the Ramsey solution is that there is **no seigniorage in equilibrium**. To see this, note that if $w^i = 1 \forall i$ then:

$$\gamma = \frac{1 - F(\widehat{y})}{F(\widehat{y})} \frac{\widehat{m}}{1 - \widehat{m}} \leq 1$$

With $\gamma \leq 1$, $F(\widehat{y}) = \widehat{m} = 1$ (all agents hold cash). Hence $\gamma = 1$ and $\widehat{\pi} = 0$. The rationale for this is simple. Absent political-economy considerations, the policy-maker faces a standard trade-off between efficiency (optimal public good provision) and equity (consumption-equalisation). Since seigniorage is the more regressive of the two tax instruments, it worsens the trade-off and is therefore not utilised in equilibrium. Another way to interpret the result is the standard Ramsey tax argument: to tax inelastic factors. Since agents can substitute out of cash-holding (at a cost), cash-holding is tax-elastic. By contrast the tax base for the income tax is fixed.

Note as well that the level of the public good g is equal to the first-best level. This is demonstrated in the following section for the general political economy solution (but obviously holds for the special case Ramsey solution as well).

5.3 General Political Economy Solution

The concavity of the utility function makes the policy-maker disinclined to use seigniorage, since it worsens inequality. However, the political economy environment makes the policy-maker more inclined to use seigniorage, since it transfers resources to his more favoured constitutency, richer agents. Hence, the optimal mix of tax and seigniorage is that which balances these two effects. When seigniorage is low relative to total government expenditure, the authorities can increase its use, transfering more resources to richer agents. However, as seigniorage increases and the consumption of better-off agents rises and that of poorer agents falls, the marginal utilities of the less well-off become weighted more heavily in the policy-maker's objective function. Hence, the political bias effect becomes less important relative to the redistribution effect. Eventually, the two effects counter-balance each other, giving the optimal mix of tax and seigniorage.

Hence, when $\theta \geq 0$:

$$\gamma = \frac{1 - A}{A} \frac{\widehat{m}}{1 - \widehat{m}} \geq 1$$

5.3.1 Existence and Uniqueness of Political Economy Equilibrium

A solution for γ always exists for $\theta > 0$. To see this, re-arrange the first order conditions to give an expression for the marginal costs and benefits of seigniorage:

$$\begin{aligned} h &\equiv MC - MB \\ \frac{h}{F(\widehat{y})(1 - F(\widehat{y}))} &= \gamma \underline{w} \overline{y} - \underline{y} \overline{w} \\ &\quad \text{where } \underline{w} \equiv E[w \mid y \leq \widehat{y}], \ \overline{w} \equiv E[w \mid y > \widehat{y}] \\ &\quad \text{and } \underline{y}, \overline{y} \text{ are similarly defined.} \end{aligned}$$

When $\gamma \to 1$, then $\widehat{y} \to \infty$, $\underline{y} \to 1$, $\underline{w} \to 1$ and $\overline{w} > \overline{y}$. Hence:

$$\frac{h}{F(\widehat{y})(1-F(\widehat{y}))} \to -(\overline{w}-\overline{y}) < 0$$

Therefore, for γ close to 1, $MC - MB \leq 0$.

Now consider $\gamma \to \infty$. In this case, $\widehat{y} \to 0$, $\overline{y} \to 1$, $\overline{w} \to 1$. Hence:

$$\frac{h}{F(\widehat{y})(1-F(\widehat{y}))} \to \gamma\underline{w} - \underline{y} > 0$$

Therefore, for very high γ, $MC - MB \geq 0$. Since the expressions are continuous, at least one solution with $MC = MB$ must exist for $\gamma \in [1, \infty]$.

Moreover, since $MC \leq MB$ for $\gamma \to 1$ and $MC \geq MB$ for $\gamma \to \infty$, then at least one of the solutions also satisfies the second-order condition for the political economy maximisation problem ($\frac{\partial[MC-MB]}{\partial\gamma} > 0$). Simulations using various functional forms for $F(y), w\left(y, \theta, \sigma^2\right)$ and $\kappa(y)$ suggest that the FOC does generally describe a unique solution. Figure 1 gives a graphical exposition of equilibrium that sheds more light on this issue. It plots the MC and MB functions, $\gamma A(1-\widehat{m})$ and $(1-A)\widehat{m}$ respectively, against the cdf $F(\widehat{y}(\gamma))$.[7]

Although a unique solution to the FOC is not guaranteed for general functional forms, a restriction can be introduced to guarantee a unique solution. Re-arranging the two functions gives us ($MC = MB$): $(\gamma - 1) = \frac{1}{1-\widehat{m}}\left(\frac{\widehat{m}}{A} - 1\right)$. A **sufficient condition** to guarantee a single crossing point is therefore that, for any value of $\gamma = \gamma^*$ satisfying the FOC:[8]

$$\frac{\partial}{\partial\widehat{y}}\left[\ln(\gamma-1) \mid \gamma = \gamma^*\right] = \frac{\gamma^*}{\gamma^*-1}\kappa'(\widehat{y}) \leq \frac{\partial}{\partial\widehat{y}}\ln\left(\frac{\widehat{m}}{A} - 1\right)$$

In other words, the function κ should have a sufficiently steep (negative) gradient and the ratio $\frac{\widehat{m}}{A}$ should not be too greatly affected by incremental changes in $\widehat{y}$ (requiring that both the underlying distribution $F(y)$ and the mapping $w(y;\theta)$ should be relatively smooth). For the rest of the paper I assume that this condition holds and that the FOC therefore describe a unique solution for γ.

5.3.2 Comparative Statics

The key comparative statics result is that $\frac{d\gamma}{d\sigma^2} > 0$. That is, as income inequality increases, the optimal mix of seigniorage versus income tax shifts towards the former. To show this formally, note that (using the implicit function theorem):

$$\begin{aligned} \gamma^* &= \gamma \mid [h(\gamma) \equiv \gamma A(1-\widehat{m}) - (1-A)\widehat{m} = 0] \\ \Longrightarrow \quad \frac{d\gamma^*}{d\sigma^2} &= -\frac{\frac{\partial h\left(\gamma^*;\sigma^2\right)}{\partial\sigma^2}}{\frac{\partial h(\gamma^*;\sigma^2)}{\partial\gamma}} \end{aligned}$$

[7] The specific functional forms used to generate the diagram are as follows: $y = 0.7 + 0.3\varepsilon$; $\varepsilon \sim \Lambda\left(1, e^2 - 1\right)$; $w = 3y - 2$; $\kappa = \frac{3}{y}$; where Λ denotes a log-normal distribution. See Aitchison and Brown (1957) for details of the calculations using the log-normal distribution. These functional forms meet the model's key assumptions.

[8] The other term in the (log-transformed) MB function, $-\ln(1-\widehat{m})$ has $\frac{\partial(-\ln(1-\widehat{m}))}{\partial\widehat{y}} = \frac{1}{1-\widehat{m}}\frac{\partial\widehat{m}}{\partial\widehat{y}} \geq 0$.

From the second order condition for the maximisation problem, $\frac{\partial h\left(\gamma^*;\sigma^2\right)}{\partial \gamma} > 0$. Hence, $\frac{d\gamma^*}{d\sigma^2} \geq 0$ if $\frac{\partial h\left(\gamma^*;\sigma^2\right)}{\partial \sigma^2} \leq 0$. This condition does indeed hold in equilibrium:

$$\begin{aligned}
\frac{\partial h\left(\gamma^*;\sigma^2\right)}{\partial \sigma^2} &= \frac{h\left(\gamma^*;\sigma^2\right)+\widehat{m}}{A}\frac{\partial A}{\partial \sigma^2} - \frac{h\left(\gamma^*;\sigma^2\right)+1-A}{1-\widehat{m}}\frac{\partial \widehat{m}}{\partial \sigma^2} \\
&= \frac{\widehat{m}}{A}\frac{\partial A}{\partial \sigma^2} - \frac{1-A}{1-\widehat{m}}\frac{\partial \widehat{m}}{\partial \sigma^2} \\
&= -\frac{\widehat{m}\left(1-A\right)}{A}\left[\frac{1}{\left(1-A\right)}\frac{\partial\left(1-A\right)}{\partial \sigma^2} - \frac{1}{\left(1-\widehat{m}\right)}\frac{\partial\left(1-\widehat{m}\right)}{\partial \sigma^2}\right] - \frac{\left(1-A\right)\left(\widehat{m}-A\right)}{A\left(1-\widehat{m}\right)}\frac{\partial\left(1-\widehat{m}\right)}{\partial \sigma^2} \leq 0
\end{aligned}$$

Hence:

Hypothesis 1(a): Inflation increases with income inequality

Hypothesis 2(a): Income tax decreases with income inequality

The rationale for these results is that higher inequality increases the relative weight of richer agents in the quasi-welfare maximisation problem resulting from the probabilistic voting set-up. This then tilts the policy-maker towards greater inflation finance and away from income tax as a source of revenue.

Similarly, increasing the political bias (by increasing θ) also increases relative use of the inflation tax:

$$\begin{aligned}
\frac{\partial h\left(\gamma^*;\theta\right)}{\partial \theta} &= \frac{h\left(\gamma^*;\theta\right)+\widehat{m}}{A}\frac{\partial A}{\partial \theta} \\
&= \frac{\widehat{m}}{A}\frac{\partial A}{\partial \theta} \leq 0 \\
\Longrightarrow \quad \frac{d\gamma^*}{d\theta} &= -\frac{\frac{\partial h\left(\gamma^*;\theta\right)}{\partial \theta}}{\frac{\partial h\left(\gamma^*;\theta\right)}{\partial \theta}} \geq 0
\end{aligned}$$

Hence:

Hypothesis 1(b): Inflation increases with the pro-rich bias

Hypothesis 2(b): Income tax decreases with the pro-rich bias

5.3.3 Effect on Government Spending

Changing inequality and pro-rich bias have no effect on government spending in this model. This is a result of the log-linear additively separable utility specification and the fact that all spending is in the form of a public good. Essentially, distributional considerations matter for the composition of taxation and its incidence but not for aggregate revenue or expenditure. To see this formally, rewrite the three FOCs (the FOC for τ has been simplified using the first FOC):

$$\begin{aligned}
\frac{1}{1-\tau-\widehat{\pi}}\frac{A}{\widehat{m}} &= \phi_0 \qquad (\widehat{\pi}) \\
\frac{1}{1-\tau}\frac{1-A}{1-\widehat{m}} &= \phi_0 \qquad (\tau) \\
\frac{\alpha}{g} &= \phi_0 \qquad (g)
\end{aligned}$$

Substituting the government budget constraint and the third FOC into the first two FOCs yields:

$$\begin{aligned}
A &= \phi_0\left[1-\left(1-\widehat{m}\right)\widehat{\pi}\right]\widehat{m} - \alpha\widehat{m} \\
1-A &= \phi_0\left[1+\widehat{m}\widehat{\pi}\right]\left(1-\widehat{m}\right) - \alpha\left(1-\widehat{m}\right)
\end{aligned}$$

Adding the two together then gives us:

$$1 = \phi_0 - \alpha$$

which implies that $\phi_0 = 1 + \alpha$, a constant, and hence that $g = \frac{\alpha}{1+\alpha}$, the first-best level of government spending. Hence:

Hypothesis 3: Government final expenditure is unrelated to both **(a)** inequality; and **(b)** pro-rich bias.

Note that this hypothesis results largely from the assumption of additive separability in the utility function with respect to private good and public good consumption. This is a simplifying assumption of the model and is not central to the analysis; in this sense hypothesis 3 is not central to the paper. However, if the inequality and bias terms are found to affect tax and seigniorage choices then the test of the effect on spending is essentially a check that the model's emphasis on the revenue side rather than the expenditure side is correct.

6 Empirical Analysis

This empirical section tests the central hypotheses derived in the theoretical portion of the paper:

1. Higher seigniorage results from:
   (a) greater income inequality; and
   (b) greater pro-rich bias in policy-making;
2. Higher income tax revenue results from:
   (a) less income inequality; and
   (b) less pro-rich bias in policy-making;
3. Government final expenditure (excluding transfers) is unrelated to both:
   (a) income inequality; and
   (b) pro-rich bias.

The results are strongly supportive of propositions 1(a) and 1(b). Hypothesis 3 (a) is strongly supported although results with respect to Hypothesis 3 (b) are mixed. There is some evidence supporting Hypotheses 2(a) and 2(b), although again the evidence is mixed. The first section describes the methodology employed and the data used. The second section discusses the results of the empirical analysis, and the third section offers a brief discussion of the results.

6.1 Methodology and Data

This paper analyses inflation as the result of a political conflict over financing public expenditure. The key linkages are between the government budget constraint and seigniorage, and between money creation and inflation. Both linkages should be conceived as long term phenomena. In the short run, the gap between expenditure and tax revenue can be made up by borrowing; recourse to seigniorage is not necessary until the costs of borrowing outweigh the benefits, which may not occur until a substantial degree of borrowing has occured. Similarly, although Friedman's assertion concerning inflation's monetary genesis is not to be doubted, the short run relationship between the money supply and inflation is notoriously difficult to pin down (except during hyperinflationary periods).

Hence, I have taken the long run as the appropriate time frame for analysis. This precludes the use of a panel approach to the problem, and I therefore adopt a simple cross-section framework. Data availability makes the 1981-2000 period the most fruitful for analysis.

I obtain data from a range of sources. Inequality data is obtained from the UNU/WIDER World Income Inequality Database (WIID) in the form of Gini coefficients.[9] The quality of the observations and the survey method is coded in the data: I use only the highest quality data where the sample used is representative of the country's full population, and adjust observations to take into account the survey method (gross versus net and income versus expenditure).[10] The data is presented in annual format, although with a substantial number of missing observations for most countries. In order to maximise the number of observations, data are averaged over the period (i.e. data may be unavailable for the first year of the period, but available for subsequent years). To control for the endogeneity of income inequality I use a measure of inequality from the previous twenty-year period (similarly calculated) as an instrument and undertake Two-Stage Least Squares (2SLS).

I use a variety of variables from the Polity IV database, as controls and as a proxy for the pro-rich bias term (each variable is taken at the start year of the relevant period, i.e. 1981). The key variable is the "Competitiveness of Political Participation," *parcomp*, defined in the Polity IV *Users Manual* (2000) as 'the extent to which alternative preferences for policy and leadership can be pursued in the political arena.' The variable takes on an integer value between 0 and 5. I assume that a lower value for this variable can be taken as a greater pro-rich bias, under the assumption that a lack of political competition implies greater political power for the rich.[11]

I include *parcomp*'s counterpart variable, "Competitiveness of Chief Executive Recruitment," *xrcomp*, as a control. This variable is similar to *parcomp*, except that it refers specifically to the process of selecting the Chief Executive, and takes on an integer value between 0 and 3. I include three other political variables as further controls: the "Regulation of Participation," *parreg*, the "Regulation of Chief Executive Recruitment," *xrreg*, and a variable measuring the instability of the political system, denoted *unstable*.[12]

The *parreg* and *xrreg* variables measure the degree of regulation of the political system as a whole and the selection of chief executive respectively. The former takes on an integer value between 1 and 5, the latter an integer between 1 and 3. Regulation refers to the degree of institutionalisation of power transfers (*xrreg*) or the degree to which binding rules apply to the timing and procedures of the exercise of the political process (*parreg*).

In a sense, the Regulation variables *parreg* and *xrreg* should be thought of as more fundamental measures of the political system than the Competitiveness variables. They indicate whether there are *any* properly institutionalised rules governing the political process and the transfer of power. If either takes the value 1 (unregulated) then the corresponding Competitiveness variable takes the value 0 (undefined). That is, if there are no rules governing the process, then the process *by definition*

[9] The starting point for the database (contributing to around half the total observations) is the more widely-used Deininger and Squire (World Bank, 1997) dataset (used, for instance, in Bhattacharya et al. (2003)).

[10] The appropriate adjustment is calculated by regressing the high quality observations on dummy variables for Expenditure vs. Income and Gross vs. Net measures, interacted with a dummy for Industrial vs. Developing/Transition economies to proxy for the substantial structural differences between tax and transfer systems between the two groups of countries. This gives an estimate of the average difference between Gini coefficients based on the different measurement techniques, which is unbiased as long as the choice of methodology for the inequality survey is exogenous.

[11] Historically, restrictions on participation such as rules governing the franchise have included a lower limit on income or property holdings, but never (to my knowledge) an upper limit. Hence, restrictions on participation can be taken as indicators of pro-rich bias.

[12] The latter variable is a dummy variable which takes on a value of 1 if the existing political system has substantially changed in the last 10 years. This variable is derived from the "Durable" variable in the Polity IV dataset which measures the number of years since the last significant change in the political system, defined as an absolute change of more than 3 points in the "Polity" variable which codes countries on a -10 to +10 (autocratic to democratic) scale. The instability dummy then takes a value of 1 if "Durable"<10, implying that the existing system is less than 10 years old, and 0 otherwise.

cannot be considered competitive. When the Regulation variables take on a value of 2 or above, then the corresponding Competitiveness variable takes on a strictly positive value, indicating successively greater levels of competitiveness. The Competitiveness variables then tell us that, given that there are some rules or institutions governing te political process, to what extent the process is open to universal participation. Clearly, the Regulation variables are important conditioning variables governing the operation of the Competitiveness variables.

The dependent variables are the average of the "inflation tax" transform ($\widehat{\pi}$) over the period (the average of the annual rates, taken from the IMF's *International Financial Statistics*) and the average ratios of income tax revenue and government final consumption spending to GDP (both taken from the World Bank's *World Development Indicators*). I also include a number of control variables, including dummies for industrial countries, former Eastern Block countries and South American countries, measures of trade openness and real (PPP) GDP per capita taken from the Penn World Tables (PWT 6.1), and a measure of urbanisation (% of the population living in urban areas, taken from the World Bank *World Development Indicators).* As with the political variables, these controls are taken for the first year of the period to denote initial conditions.

6.2 Results

The Results are presented in Tables 1-3 in the Appendix. In each Table, the first three regressions have the full range of control variables for robustness purposes. The last three regressions in each Table give the preferred specification, including only controls that are individually statistically significant. Within each group of three regressions, the first is for the largest available sample; the second has only Developing and Transition economies, whilst the third regression drops only former Communist countries in Eastern Europe.

The results in Table 1 are strongly supportive of **Hypothesis 1(a)**. Only in the second equation is the estimated coefficient on the Gini statistically insignificant, and even in this equation it has the correct (positive) sign. In all other specifications it is significantly positive at the 5% level, and in all the parsimonious (minimum controls) specifications it is significant at the 1% level.

The results are also strongly supportive of **Hypothesis 1(b)**: in each specification the variable *parcomp*, acting as a proxy for the (inverse of) pro-rich bias, has the predicted negative sign. The caveat to this result is that the *xrcomp* variable - a political control related to the *parcomp* variable - has a positive and significant sign, suggesting that with respect to executive recruitment, it is *less* competitive systems (*greater* pro-rich bias) that produce lower inflation.

Table 2 presents the results with respect to **Hypotheses 2(a)-(b)**. Here the results are more ambiguous. In the full sample specifications neither the inequality nor the political bias terms are individually significant, although they carry the predicted sign. However, most of the control variables are similarly insignificant (suggesting that the equation including the controls is mis-specified). Once only individually significant controls are included, the inequality and bias terms are generally statistically significant. Both are significant in the full sample, whilst for the developing/transition economies the inequality term is significant but the political bias term is not. When the Eastern European countries alone are dropped, the political bias term retains its significance whilst the inequality term does not.

Finally, Table 3 presents tests of **Hypotheses 3(a)-(b)**. When all controls are included in the regression, the results back up the theoretical model: neither inequality nor the pro-rich bias terms affect government consumption spending (our proxy for public good provision). For **Hypothesis 3(a)** the parsimonious specifications confirm this result: inequality has no effect on expenditure. However, the parsimonious specifications find that - for the full sample and the non-Eastern Europe sample - the political bias term does affect expenditure. As pro-rich bias increases (represented by a lower value for parcomp) expenditure falls. However, the developing countries only sample does not pick up any effect, confirming the model's predictions.

6.3 Discussion

Table 4 summarizes the quantitative effects of changes in inequality on the inflation rate, income tax revenues and government spending. According to our preferred specification (fourth column of results, corresponding to parsimonious controls and the full sample), the inequality measure has a quantitatively significant positive effect on inflation. The range of the inequality parameter in the 50-country sample of model 1 is 22% to 54%. Given the coefficient estimate of .009, the estimated effect of increasing inequality from the lowest inequality observation to the highest would be to add an additional 0.24 to the inflation tax transform. If inflation were initially at zero, this would translate into an increase in the inflation rate to around 31%. Similarly, there is a quantitatively and statistically significant negative effect (as predicted by theory) on income tax revenues as a % of GDP, estimated at -6%. Finally, there is a quantitiatively small and statistically insignificant effect on government consumption spending (as a % of GDP). The insignificance of this effect also backs up the theoretical portion of the paper.

The political variable *parcomp* has the expected negative (and statistically significant) effect on inflation. Quantitatively, moving from the highest value for *parcomp* to the lowest (from 5 to 1) would increase the predicted value of $\widehat{\pi}$ by 22%. Starting with price stability, this would translate into an increase in the rate of inflation of 27%.[13] The estimated effect on income tax revenues is also quantitatively significant: moving from minimum bias ($parcomp = 5$) to maximum bias ($parcomp = 1$) would add around 3.5 percentage points to the ratio of income tax revenue to GDP. The effect on government consumption spending, predicted to be zero in the model, is actually statistically and quantitatively significant. The estimated effect of moving from minimum to maximum pro-rich bias would be to reduce spending by more than 5% of GDP.[14]

7 Conclusions

This paper presents a model to account for a stylised fact noted in a number of studies: that more unequal societies tend to face higher inflation. The model uses a simplified overlapping generations framework to capture the essential features of a cash economy with politically-motivated monetary expansions. Consumption is subject to a one-period delay. Agents have a choice of two financial assets to allow for trade with their neighbouring cohorts: cash (subject to the inflation tax) and a second asset which can be thought of as an indexed asset, a real asset or a foreign currency asset. The ability to substitute from cash to the second asset is assumed to be correlated with income.

This then generates the feature that seigniorage is a more regressive form of taxation than income tax, matching arguments made elsewhere in the literature. Introducing an electorally-motivated policy-maker and a political environment subject to a pro-rich bias, the model predicts that higher inequality and greater pro-rich bias both lead to greater recourse to seigniorage compared to income tax in equilibrium. The result with respect to the pro-rich bias is obvious, the result with respect to inequality less so. Note that positive seigniorage is the result of the political process alone: pure welfare-maximisation implies zero seigniorage (as shown by the solution to the Ramsey problem).

The model's strengths lie in its simplifications at the household level. These allow for analytical solutions and greater realism in both the income distribution and the political environment, compared to the related literature, notably Albanesi (2002) and Bhattacharya et al. (2003). Although the model is micro-founded and agents are fully rational, the treatment of the household could be strengthened. But the purpose of this paper is to analyse economy-wide political phenomena, and a realistic treatment of

[13] However, the counterpart variable *xrcomp*, which one would expect to have the same sign, actually has a positive and significant coefficient estimate. This suggests that there are aspects of the relationship between the political environment and money creation, notably the process of executive recruitment, which are not captured in the simple theoretical framework.

[14] This suggests that government consumption spending may in reality be targeted at poorer agents, rather than being a pure public good as in the model.

political processes and the income distribution is more important than attention to micro-foundations. Analytical solutions and unequivocal comparative statics results are other significant advantages of this approach.

The model's predictions are brought to the data and are broadly supported for the limited (fifty-country) cross-section dictated by data availability constraints. However, there is some evidence that the simple political economy model may be missing some important relationships, particularly between the pro-rich bias in the political system overall and the openness of the selection process for the executive. There is also evidence that the regulation of the political system in addition to its openness or competitiveness plays a role, again with differing results between the overall political system and the selection of chief executive.

Possible extensions to the model include the analysis of dynamics (although the analysis of dynamic political economy models is highly complex - see for instance Krusell and Rios-Rull (1999), Krusell (2002) and Hassler et al. (2003)), and further empirical work to analyse the predicted relationships. A panel data approach to the problem would be a desirable next step. However, data availability constraints - particularly due to the long-run nature of the relationships under analysis and the limited availability of good inequality series - make useful panel analysis difficult.

References

[1] Albanesi, S. (2002), "Inflation and Inequality," Discussion Paper No. 3470, Centre for Economic Policy Research, July

[2] Aitchison, J. and A. Brown (1957), The Lognormal Distribution, Cambridge: University of Cambridge Department of Applied Economics

[3] Barro, R. and D. Gordon (1983), "A positive theory of monetary policy in a natural rate model," Journal of Political Economy, 91 (4), pp. 589-610

[4] Benabou, R. (2000), "Unequal Societies: Income Distribution and the Social Contract," The American Economic Review 90 (1), pp. 96-129

[5] Bhattacharya, J., H. Bunzel and J. Haslag (2003), "Inflationary Finance in a Simple Voting Model," Working Paper Np. 03012, Iowa State University Department of Economics, March

[6] Bulif, A. and A. Gulde (1995), "Inflation and Income Distribution: Further Evidence on Empirical Links," IMF Working Paper 95/86

[7] Bulif, A. (1998), "Income Inequality: Does inflation matter?" IMF Working Paper WP/98/7, January

[8] Cardoso, E. (1992), "Inflation and Poverty," NBER Working Paper 4006, March

[9] Click, R. (1998), "Seigniorage in a Cross-Section of Countries," Journal of Money, Credit and Banking 30 (2), pp. 154-71

[10] Cukierman, A., S. Edwards and G. Tabellini (1992), "Seigniorage and Political Instability," The American Economic Review 82 (3), pp. 537-55

[11] Datt, G. and M. Ravallion (2002), "Why has Economic Growth Been More Pro-Poor in Some States of India Than in Others?" Journal of Development Economics 57, pp. 259-87

[12] Desai, R., A. Olofsgard and T. Yousef (2002), "Democracy, Inequality and Inflation," Mimeo., May

[13] Dolmas, J., G. Huffman and M. Wynne (2000), "Inequality, Inflation and Central Bank Independence," Canadian Journal of Economics 33 (1), pp. 271-87

[14] Easterly, W. and S. Fischer (2001), "Inflation and the Poor," Journal of Money, Credit and Banking, 33 (2), pp. 160-78

[15] Edwards, S. and G. Tabellini (1991), "Political Instability, Political Weakness and Inflation? An Empirical Analysis," NBER Working Paper No. 3721, May

[16] Epaulard, A. (2003), "Macroeconomic Performance and Poverty Reduction," IMF Working Paper No. WP/03/72, April

[17] Erosa, A. and G. Ventura (2002), "On inflation as a regressive consumption tax," Journal of Monetary Economics, 49, pp. 761-95

[18] Ferreira, F. and J. Litchfield (1999), "Education or inflation? the roles of structural factors and macroeconomic instability in explaining Brazilian inequality in the 1980s," Distributional Analysis Research Programme Discussion Paper 41, STICERD, LSE

[19] Fischer, S. and J. Huizinga (1982), "Inflation, Unemployment, and Public Opinion Polls," Journal of Money, Credit and Banking 14 (1), pp. 1-19

[20] Hassler, J., P. Krusell, K. Storesletten and F. Zilibottie (2003), "The Dynamics of Government: A Positive Analysis," Mimeo.

[21] International Monetary Fund (1996), "The Rise and Fall of Inflation - Lessons from the Postwar Experience," World Economic Outlook October 1996

[22] Kane, C. and J. Morisett (1993), "Who would vote for inflation in Brazil?" World Bank Policy Research Working Paper WPS 1183, September

[23] Krusell, P. and J. Rios-Rull (1999), "On the Size of U.S. Government: Political Economy in the Neoclassical Growth Model," The American Economic Review 89 (5), pp. 1156-81

[24] Krusell, P., "Time-consistent Redistribution," European Economic Review 46, pp. 755-69

[25] Kydland, F. and E. Prescott (1977), "Rules rather than discretion: the inconsistency of optimal plans," Journal of Political Economy, 85 (3), 473-91

[26] Lindbeck, A. and J. Weibull (1987), "Balanced-budget Redistribution as the Outcome of Political Competition," Public Choice 52, pp. 273-97

[27] Lucas, R. and N. Stokey (1983), "Optimal Fiscal and Monetary Policy in an Economy without Capital," Journal of Monetary Economics 12, pp. 55-93

[28] Luttmer, E. (1999), "What Level of Fixed Costs Can Reconcile Consumption and Stock Returns," Journal of Political Economy 107 (5) pp. 969-97

[29] Mulligan, C. and X. Sala-i-Martin (1996), "Adoption of Financial Technologies: Implications for Money Demand and Monetary Policy," NBER Working Paper 5504, March

[30] Persson, T. and G. Tabellini (2000), "Political Economics: Explaining Economic Policy," Cambridge, Massachusetts: MIT Press

[31] Romer, C. and D. Romer (1998), "Monetary Policy and the well-being of the poor," NBER Working Paper No. 6793, November

[32] Scheve, K. (2001), "Public Demand for Low Inflation," Mimeo.

[33] Shiller, R., "Why do People Dislike Inflation?" NBER Working Paper No. 5539, April

[34] Sturzenegger, F. (1992), "Inflation and social welfare in a model with endogenous financial adaptation," Department of Economics, UCLA Working Paper 658, April

Table 1: 2SLS Regressions with Inflation Tax Transform [$\pi/(1+\pi)$] (1981-2000 average) as DV

	Full Controls			Minimum Controls		
	Full Sample	Dev/Trans Economies	Excluding E. Europe	Full Sample	Dev/Trans Economies	Excluding E. Europe
Gini	**.00753** (.00305)**	**.00606 .00382**	**.00781** (.00302)**	**.00740*** (.00240)**	**.00610*** (.00217)**	**.00900*** (.00293)**
Parcomp	**-.0446** (.0202)**	**-.0561** (.0225)**	**-.0441** (.0201)**	**-.0538*** (.0175)**	**-.0567*** (.0169)**	**-.0470** (.0192)**
Parreg	.0336** (.0151)	.0362* (.0177)	.0330** (.0151)	.0328** (.0175)	.0375** (.0140)	.0296** (.0140)
XRComp	.124*** (.0377)	.131*** (.0373)	.123*** (.0378)	.129*** (.0335)	.134*** (.0341)	.123*** (.0346)
XRReg	-.0829* (.0430)	-.0877* (.0453)	-.0810* (.0433)	-.0841** (.0389)	-.0884** (.0383)	-.0823* (.0428)
Unstable	.0211 (.0330)	-.00528 (.0398)	.00224 (.0331)			
Indust	-.103* .0564		-.105* (.0567)	-.170*** (.0253)		-.159*** (.0258)
E. Eur	.0988* (.0564)	.0168 (.0881)				
S. America	.0492 (.0526)	.0366 (.0597)	.0515 (.0521)			
Openness	-.00117*** (.000304)	-.00184*** (.000411)	-.00110*** (.000317)	-.00159*** (.000311)	-.00203*** (.000287)	-.00140*** (.000360)
Urbanisation	.00189** (.000869)	.00217 (.00199)	.00175* (.000886)	.00187*** (.000567)	.00258*** (.000616)	.00167*** (.000593)
Real PC GDP	-5.43×10^{-6} (5.03×10^{-6})	-4.5×10^{-8} (.0000169)	-4.64×10^{-6} (5.17×10^{-6})			
Constant	-.145 (.133)	-.0594 (.150)	-.158 (.133)	-.0945 (.108)	-.0687 (.101)	-.155 (.125)
R^2	.71	.72	.70	.67	.71	.64
F-Statistic	11.17***	6.27***	11.21***	12.66***	9.47***	11.60***
Observations	50	32	48	50	32	48

Gini (1981-2000) instrumented by Gini (1961-80). SEs reported are robust. 'Minimum Controls' regressions contain only controls that are individually statistically significant themselves. 'Full Control' regression results shown for robustness purposes.
Significance level of individual regressors and of the overall equation denoted by ***:1%; **:5%; *:10%.

Table 2: 2SLS Regressions with Income Tax Revenues [% GDP] (1981-2000 average) as DV

	Full Controls			Minimum Controls		
	Full Sample	Dev/Trans Economies	Excluding E. Europe	Full Sample	Dev/Trans Economies	Excluding E. Europe
Gini	**-.00134 (.00143)**	**-.00263 (.00164)**	**-.00133 (.00142)**	**-.00188** (.000821)**	**-.00245*** (.000821)**	**-.00154 (.00114)**
Parcomp	**.00936 (.00805)**	**.00174 (.0118)**	**.00936 (.00800)**	**.00868*** (.00300)**	**.00774 (.00498)**	**.0100*** (.00364)**
Parreg	.00216 (.00664)	.00158 (.00887)	.00215 (.00661)			
XRComp	.0112 (.0105)	.0053 (.0123)	.0112 (.0105)			
XRReg	-.0266** (.0130)	-.0127 (.0157)	-.0266** (.0130)			
Unstable	-.0207 (.0125)	-.0258 (.0178)	-.0207 (.0125)	-.0176* (.00950)		-.0166* (.00931)
Indust	.0170 (.0342)		.0170 (.0340)			
E. Eur	.0156 (.0263)	-.0381 (.0451)				
S. America	-0.208 (.0237)	.00378 (.0288)	-.0207 (.0238)			
Openness	-.000149 (.000197)	-.000309 (.000257)	-.000148 (.000204)			
Urbanisation	.00117** (.000476)	-.000287 (.000843)	.00117** (.000490)	.000776*** (.000256)	.000749** (.000305)	.000755*** (.000252)
Real PC GDP	-2.53×10^{-6} (2.51×10^{-6})	.0000113 (7.05×10^{-6})	-2.52×10^{-6} (2.58×10^{-6})			
Constant	.0854 (.0715)	.145 (.0946)	.0853 (.0713)	.00667 (.0294)	.0796** (.0313)	.0513 (.0448)
R^2	.59	.46	.58	.52	.30	.54
F-Statistic	12.55***	3.49***	5.49***	12.52***	5.01***	12.59***
Observations	49	31	47	50	32	47

Gini (1981-2000) instrumented by Gini (1961-80). SEs reported are robust. 'Minimum Controls' regressions contain only controls that are individually statistically significant themselves. 'Full Control' regression results shown for robustness purposes.
Significance level of individual regressors and of the overall equation denoted by ***:1%; **:5%; *:10%.

Table 3: 2SLS Regressions with Government Final Consumption [% GDP] (1981-2000 average) as DV

	Full Controls			Minimum Controls		
	Full Sample	Dev/Trans Economies	Excluding E. Europe	Full Sample	Dev/Trans Economies	Excluding E. Europe
Gini	**.000241 (.00157)**	**-.00145 (.00228)**	**.000360 (.00157)**	**-.000737 (.000856)**	**-.000038 (.000865)**	**-.000842 (.00136)**
Parcomp	**-.000128 (.0110)**	**-.0115 (.0151)**	**.0000941 (.0110)**	**.0130*** (.00408)**	**-.00046 (.00762)**	**.0121** (.00549)**
Parreg	-.00450 (.00819)	-.00397 (.0102)	-.00472 (.00812)			
XRComp	-.0201 (.0203)	-.0182 (.0205)	-.0207 (.0204)			
XRReg	.0296 (.0318)	.0319 (.0330)	.0304 (.0318)			
Unstable	-.0353** (.0470)	-.0575** (.0223)	-.0348** (.0146)	-.0397*** (.0123)	-.0409*** (.0145)	-.0413*** (.0131)
Indust	.0302 (.0470)		.0294 (.0469)			
E. Eur	-.0390 (.0368)	-.119 (.0743)				
S. America	-.0196 (.0304)	-.0142 (.0355)	-.0187 (.0305)			
Openness	-.0000403 (.000335)	-.000567 (.000415)	-.0000127 (.000348)			
Urbanisation	.000623 (.000585)	.000102 (.00100)	.000564 (.000597)			
Real PC GDP	2.00×10^{-6} (3.79×10^{-6})	.0000116 (.0000111)	2.33×10^{-6} (3.90×10^{-6})			
Constant	.0854 (.0769)	.184 (.119)	.0801 (.0774)	.147*** (.0321)	.147*** (.0279)	.155** (.0610)
R^2	.53	.45	.52	.36	.17	.37
F-Statistic	4.82***	1.17	5.10***	11.75***	2.77*	12.05***
Observations	50	32	48	52	33	49

Gini (1981-2000) instrumented by Gini (1961-80). SEs reported are robust. 'Minimum Controls' regressions contain only controls that are individually statistically significant themselves. 'Full Control' regression results shown for robustness purposes.
Significance level of individual regressors and of the overall equation denoted by ***:1%; **:5%; *:10%.

Table 4: Estimated Quantitative Effects of Changes in Inequality and Bias Terms from Minimum in Sample to Maximum in Sample

	Full Controls			Minimum Controls		
	Full Sample	Dev/Trans Economies	Excluding E. Europe	Full Sample	Dev/Trans Economies	Excluding E. Europe
Inflation Rate (%)						
Gini	31.7**	24.1	33.3**	31.0***	24.3***	40.4***
Bias	21.7**	28.9**	21.4**	27.4***	29.3***	23.2**
Income Tax Revenue (% GDP)						
Gini	-4.3	-8.4	-4.3	-6.0**	-7.8***	-4.9
Bias	-3.7	-0.7	-3.7	-3.5***	-3.1	-4.0***
Government Consumption Spending (% GDP)						
Gini	0.8	-4.6	1.2	-2.4	-0.1	-2.7
Bias	0.1	4.6	-0.0	-5.2***	0.2	-4.8**

'Minimum Controls' regressions contain only controls that are individually statistically significant themselves (See Tables 1-3). 'Full Control' regression results shown for robustness purposes.
Individual effects significantly different from zero at the following levels: ***:1%; **:5%; *:10%.
Inequality: Change is from Gini of 22% to Gini of 54%
Bias: Change is from *parcomp*=5 to *parcomp*=1
Maxima and Minima taken from full sample.
For Inflation Rate, effects assume an initial inflation rate of zero.

Figure 1: Illustrative MC/MB Functions