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Inequality and Policy Changes: the Case of a Decline on Inflation in Open Economies

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Abstract

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1 Introduction

Across developed countries the prolonged decline in the average inflation rate is perhaps the most widespread, large and sustained economic policy regime change. When comparing the average inflation rate in the 80's and in the last decade for most of those economies we find an average decline of around 10 percent points. This decline is described as a very positive monetary policy change, the main reason being the gain in efficiency which is associated with the regime change. However, whether this gain can be reinforced through a significative effect on equity is an open issue.

There is some empirical evidence that there is a strong positive correlation between average inflation and measures of income inequality in the post-war period (see Albanesi (2007)). Easterly and Fisher (2001) present indirect evidence on the distributional effects of inflation. Using household pooling data on 38 countries they find that the poor are more likely to be concerned with inflation than the rich. It seems that low income households perceive inflation as more costly.

It is important however to understand what can cause such a relation, and how it is connected with more empirical cross-section evidence on portfolio holdings and payments patterns. This is the objective of this article.

Heterogeneity of households is reflected on different consumption and hours of work choices, but for the present question the main fact is that it is also reflected in wealth composition and transaction patterns. Erosa and Ventura (2002) survey some facts for households in the U.S.. First, high income individuals use cash and cash plus checks for a smaller fraction of their transactions than low income individuals. Second, the fraction of household wealth held in liquid assets decreases with income and wealth. And third, a nontrivial fraction of households does not own a checking account and/or do not use credit cards to perform transactions.

The evaluation of the welfare costs of policy changes with heterogeneous agents is in general a quite difficult task. In this article we will use as a first approach to that answer the method developed in Correia (1999). This method can be applied in a stage where it is still feasible to compute the equilibrium prices of the economy as if agents are identical, and allows for determining the qualitative effect on equity of the decline of inflation, for any given distribution of households. The use of the method implies that, although the economy is populated by heterogeneous agents, preferences and markets are such that equilibrium prices do not depend on the specific dis-

tribution of agents' characteristics. Unfortunately when we try to apply this method for the monetary model those constraints are not consistent with the cross section evidence just described above. Thus we begin by developing a model economy where the method can be applied but, although agents display the observed cross section characteristics on consumption and labor, is not able to replicate the cross section evidence on wealth composition and transaction patterns. The gain is to have a tractable fist step to get some intuition on the mechanisms through which inflation affects different agents differently. Then we will extend the model to accomplish replicating the cross section facts on payments patterns. The above method can no longer be applied here. Therefore we have to solve an heterogeneous model numerically to get the answer. How important is heterogeneity to assess the effects of a lower inflation rate? We will compare the decline in the interest rate for an economy with homogeneous agents with the one in an economy with cross section heterogeneity. In addition, since during the relevant time period most countries were open to trade and had more and more coordinated monetary policy we analyze afterwards a monetary union composed of two countries. When countries are identical including inequality results are similar to the closed economy case. The relevant question is whether the union with a country with higher (or lower) inequality alters the impact on efficiency and equity of the permanent decline in inflation.

Agents' heterogeneity has its roots on differences in labor productivity and in the initial wealth held by every agent. The effect of the policy change on equity depends on some well known and robust cross country facts of the joint distribution of these characteristics. In particular wealth is more concentrated than earnings and that these two characteristics are positively correlated in the population. in the numerical examples we will concentrate on heterogeneity coming from a given initial wealth distribution.

This article focus on a stationary economy meaning that, given constant policies, prices and allocations are constant over time. Therefore I abstract from capital, and labor is the only input in production. Given stationarity, the real interest rate is constant across policies and there is a one to one relation between changes in inflation and changes in the nominal interest rate. Monetary policy is therefore characterized either by the nominal interest rate or the inflation rate, and these two prices will be used with the same meaning.

Since inflation is a source of revenue for central banks (and eventually to governments) comparing policy regimes associated with different inflation rates while maintaining other taxes is not a complete exercise. Different

revenues from the inflation tax should be compensated by an increase of alternative tax rates. This article develops a revenue neutral exercise where the decline of the inflation tax is accompanied with an increase of consumption (VAT) taxation. In this way we are computing a lower bound in the gains of changing inflation.

Therefore the question of the effect on equity of different inflation rates is equivalent to the comparison of the distribution across households of the burden from inflation versus the distribution of the burden of alternative taxes.

2 The closed economy model

The monetary economy is populated by agents that decide over consumption and leisure as well as over the means of payment. Households hold money because it is an alternative means of payment to costly credit. Credit services are produced by a transaction technology that uses labor as input. As discussed below, whether this technology has constant returns to scale or not is determinant for the ability of the model to replicate cross section facts, and will have an important role on the evaluation of the distributional effects of different inflation regimes.

The economy is well described by a monetary general equilibrium model where the credit technology is $s = l(m, C)$, where s is time used on transactions paid with credit, and m and C represent, respectively, real balances and consumption. There is no physical capital and the production technology of the consumption good is linear in labor with a unitary coefficient. The government must finance a constant exogenous government expenditures, and collects revenues from the inflation tax and from a tax on consumption expenditures. There is a set of households indexed by i which can be differentiated by their labor productivity and their initial financial wealth in real terms, represented respectively by E_i and A_{i0}[1].

Stationarity allows us to concentrate in momentary preferences. we choose an utility function linear in consumption[2]

$$v_i = C_i - \chi N_i^{\varphi}, \ \chi > 0, \varphi > 1. \tag{1}$$

[1]For the numerical analyis we will impose $E_i = 1$.

[2]See Correia (1999) to justify this type of preferences.

The stationary budget constraint is given by the following expression

$$(1+\tau_c)C_i + wl\left(m_{i,}C_i\right) + Rm_i = wE_iN_i + \beta A_{i0}, \tag{2}$$

where τ_c represents the tax on consumption expenditures, w the wage paid by firms, R the nominal interest rate and N_i total hours of work.

The choice of real money demand is such that the cost of an additional unity of money, R, should equalize the benefit in terms of reduction of transaction costs, measured by net wage times the decline in hours necessary for transaction with credit, which is given by $wl_m\left(m_{i,}C_i\right)$.

2.1 First stage - constant returns to scale in transactions

When the technology of transactions is constant returns to scale, CRS, we can say that for a given ratio of money to consumption, $\frac{m_i}{C_i}$, the marginal and average labor productivity on transactions do not depend on the level of consumption. As an example let us suppose that $l\left(m_{i,}C_i\right) = (k\left(1-\frac{m_i}{C_i}\right)^2)C_i$. In this case the optimal choice of money, $R = wl_m\left(m_{i,}C_i\right)$, is given by

$$\frac{m_i}{C_i} = (1 - \frac{R}{2kw}) \leq 1, (= 1 \text{ for } R = 0)$$

This expression has the basic money demand characteristics, namely that money demand increases with the amount of transactions and declines with the opportunity cost of money, the nominal interest rate[3]. We can state that:

Result 1: When transaction technologies are CRS, $\frac{m_i}{c_i}$ is the same across households. Rich and poor agents hold money as a constant to transactions.

In this case we can rewrite the budget constraint as

$$P_cC_i = wE_iN_i + \beta A_{i0}, \tag{3}$$

where $P_c \equiv (1+\tau_c) + wk\left(1-\frac{m_i}{C_i}\right)^2 + R\frac{m_i}{C_i}$.

[3]Note that for a cash in advance economy, where $\frac{m_i}{C_i} \equiv 1$, the inflation tax and the consumption tax are equivalent.

Note that in this case the effective price of consumption, P_c, includes the direct tax on consumption and the indirect cost due to payments. This one depends on the opportunity cost of holding cash, R, on the cost of labor used in credit, w, as well as on the transactions technology. Given that this effective price of consumption is identical across households the budget constraint, (3) can be used, and there is still a representative agent that represents the economy.[4]

Given optimal decisions of every agent, its indirect utility can be written as

$$v_i = \left[\frac{[wE_i/P_c]^{\frac{\varphi}{\varphi-1}}}{(\chi\varphi)^{\frac{1}{\varphi-1}}}(1-\frac{1}{\varphi}) + \beta A_{i0}/P_c \right] \tag{4}$$

The representative agent of this economy, $i = r$, is characterized by E_r =1 and $A_{r0} = 0$. When welfare is computed as the utility of the representative agent, or corresponds to the efficiency level of the economy, it is well known, see Correia and Teles (1996), that:

Result 2: (Friedman Rule) In a second best environment, to maximize the utility of the representative agent governments should abstain from taxing money, i. e. the government should follow the Friedman rule and set the nominal interest rate to zero. Government expenditures should be financed with consumptions taxes and/or labor income taxes. Using (4), as well as the characteristics of the representative agent, we can write the utility of the representative agent as $v_r = \frac{[w/P_c]^{\frac{\varphi}{\varphi-1}}}{(\chi\varphi)^{\frac{1}{\varphi-1}}}(1-\frac{1}{\varphi})$. Because to decline the inflation rate increases the utility of the representative agent, it is immediate to conclude that the decline of inflation, compensated an increase in the tax on consumption, leads to an increase of the net real effective wage, w/P_c.

As was said before, in this first stage of the analysis, given that CRS transactions technologies allow for Gorman aggregation, we can use a simple method to rank policies by their effects on inequality.[5] The simplicity of the methodology allows for the development of economic intuition on the channels through which policy changes affect equity. The conditions are

[4] We say that the economy is amenable to Gorman aggregation.

[5] This methodology was developed in Correia (1999).

rather strong for the case under study. As just stated in result 1, they are obtained at the cost of imposing a degenerate distribution in the money to consumption ratio across households. Only policy measures that yield an equilibrium in which all agents face the same prices can be discussed. This rules out for example, some regressive taxes which we will show are the relevant ones for the question in this article.

It also implies some restrictions on the multivariate distribution of characteristics across agents, but we will not take this as a cost since the class of characteristics for which the methodology is valid covers the most relevant cases of heterogeneity characterization used in general equilibrium aggregate models, namely the heterogeneity in private wealth or the heterogeneity in labor efficiency.

A short description of equity evaluation The assumption of Gorman aggregation is equivalent to assuming indirect utility functions which can be represented by $v_i = \alpha(p)F(E_i) + \gamma(p)A_i$, where p is the vector of equilibrium prices faced by every household.

I have shown in (4) that $\alpha(p)F(E_i) = \frac{[wE_i/P_c]^{\frac{\varphi}{\varphi-1}}}{(\chi\varphi)^{\frac{1}{\varphi-1}}}(1-\frac{1}{\varphi})$ and that $\gamma(p) = \beta/P_c$. To rank welfare distributions by equity I use the so called relative differential concept. When agents are ordered by decreasing welfare, meaning that $i > j$ implies $v_i < v_j$, we say that policy 2 dominates policy 1 in equity terms iff

$$\frac{v_i^2}{v_j^2} > \frac{v_i^1}{v_j^1}, \text{ for } i > j \tag{5}$$

The intuition for this condition is quite simple: suppose we compare any two households in the economy, agent i and agent j, where the first is poor (meaning that has a lower welfare, or income[6]). Then $\frac{v_i}{v_j} < 1$. When by the policy change this ratio increases, it means that the poor household is less distant from the richer one, that is, their economic situation is more equal than before. When this is true for every two agents then we say that the policy change leads to a more equal society, or that inequality declined.

[6]Since utility is given by $\frac{[wE_i/P_c]^{\frac{\varphi}{\varphi-1}}}{(\chi\varphi)^{\frac{1}{\varphi-1}}}(1-\frac{1}{\varphi}) + \beta A_{i0}/P_c$, it can be read as a measure of income.

Therefore the question is to understand how policy changes alter equilibrium prices, and then whether that change of prices in the economy increases $\frac{v_i}{v_j}$.

Using 4 let me begin by analyzing the easier case where agents are identical in labor productivity $E_i = E_j$. In this case we can write the relative welfare between agent i and j:

$$\frac{v_i}{v_j} = \frac{\gamma(p) + A_{i0}}{\gamma(p) + A_{j0}}$$

where

$$\gamma(p) = \frac{P_c \left[w/P_c\right]^{\frac{\varphi}{\varphi-1}}}{\beta(\chi\varphi)^{\frac{1}{\varphi-1}}}(1 - \frac{1}{\varphi}) = \frac{P_c^{\frac{-1}{\varphi-1}}(w)^{\frac{\varphi}{\varphi-1}}}{(\chi\varphi)^{\frac{1}{\varphi-1}}}(1 - \frac{1}{\varphi}) \tag{6}$$

As $A_{i0} < A_{j0}$, $\frac{v_i}{v_j} < 1$ and the change in policy increase relative welfare if $\gamma(p)$ increases.

Compensating inflation with a VAT tax The decline of inflation (a lower R) is compensated by an increase of the VAT tax (or the tax on consumption) to maintain tax revenues. The net wage, w, is not affect by the change of policy. Then using result 2, which states that the net effective wage, w/P_c, increases with the decline of inflation. The reason why in this case the lower inflation tax is efficient is that it declines the effective consumption price. As $\frac{m_i}{C_i} < 1$, the base of the consumption tax is higher then the base of the inflation tax. This means that although the tax on consumption increases it increases by less than the decline of the nominal interest rate. Other way to understand this result is to see that in the limit, when the nominal interest rate is zero and credit is not used as payment, the inflation tax is equivalent to the consumption tax. But when households decide to use credit for a share of payments, it is because at the existing interest rate, the cost of transactions is lower. Again the decline in R implies a positive income effect, that to be compensated implies an smaller increase in τ_c. We can write $\gamma(p)$ as the second expression in 6, and since $\varphi > 1$, a decline on P_c increases $\gamma(p)$.

We can summarize this in:

Result 3: A decline in inflation compensated by an increase in the consumption tax rate improves welfare distribution, when $E_i = E_j$[7].

Note that the robustness of this result, that the decrease of inflation compensated with a consumption tax reduces inequality, is not obvious even in this very simple set-up without the help of the mathematical analysis. Since we know that the main effect of the change of policy is the decline of the effective price of consumption what we can immediately guarantee is that richer agents with positive levels of initial wealth would gain by two reasons: first because the value of initial wealth in terms of consumption is higher, $\beta A_{j0}/P_c$; and second because the net real effective wage increases. Therefore households with non-negative wealth, as the representative agent, increase welfare given the proposed change of policy. The same cannot be said in the extreme case for agents that have negative initial wealth. As with richer agents they benefit from the the higher net effective wage, but since they are debtors, and the effective value of debt increases with the decline of the effective price, it would not be clear, just by analyzing the expression for their utility, why the first effects would always dominate this last one, and the poor is better off given the policy change. Note however this is always true, without any other channel in addition to the ones described, because:

Result 4: A decline in inflation compensated by an increase in the consumption tax by result 3 improves equity, and leads to an increase in $\frac{v_i}{v_r}$, for every i. Given result 2 the welfare of the representative agent, v_r, increases and therefore v_i also increases for every i. Therefore the proposed policy increases welfare for every household in this economy, leads to a Pareto movement, but the poor, even when a debtor, increases more than the richer, the creditor.

This result is fundamental since is the one from where the intuition of the rest of this article is developed.

2.2 Economies of scale

After analyzing the case where transactions technology is constant returns to scale, let us correct for the cross section evidence on payment patters. As

[7]This is not an important assumption because it can be shown that when $E_i < E_j$ the same result is obtained, as long as wealth is more concentrated than earnings, as described epiririically.

before the stationary budget constraint can be written as:

$$(1+\tau_c)C_i + wl\left(m_{i,}C_i\right) + Rm_i = wE_iN_i + \beta A_{i0},$$

Let us assume now that the transactions technology $l\left(m_{i,}C_i\right)$ is no more homogeneous of degree one, and that it can be given, for example, by:

$$l\left(m_{i,}C_i\right) = k(1-\left(\frac{m_i}{C_i}\right))^2 C_i + (1-\left(\frac{m_i}{C_i}\right))\overline{N},$$

where the main difference is the inclusion of a cost that does not depend on the total amount of transactions but uniquely on the share of transactions paid with credit. It is a fixed cost for a given share. When this technology is used to compute whether payments should be done with cash or credit we obtain that:

$$\left(\frac{m_i}{C_i}\right) = 1 - \frac{R}{2wk} + \frac{\overline{N}}{2kC_i} \tag{7}$$

It is immediate to conclude that for $\overline{N} > 0$ the larger is C_i the smaller is the share of transactions realized with cash. That is:

Result 5: When transaction technologies are increasing returns to scale, $\frac{m_i}{c_i}$ is no more constant across households. Rich agents hold a lower share of cash to transactions than poor agents.

This money demand replicates exactly the facts that we quote in the beginning of this article. Agents differ on m/C depending on the total volume of transactions. There is a group of households for which $C_s < \frac{w\overline{N}}{R}$ that do not pay with credit. They use just cash for payments and therefore

1) $m_i = C_i$, $i < s$.

The other subset of the population for which $C_j > \frac{w\overline{N}}{R}$, decide to use both cash and credit for payments. However they decide to use more credit the higher is the transactions level, that is the richer they are, and therefore the higher the wealth, the lower its cash to wealth ratio. For this group money demand is given by

2) $m_j = 1 - \frac{R}{2wk} + \frac{\overline{N}}{2kC_j}$, $j > s$.

Then we can write the budget constraint for every household as

$$P_{ci}C_i + w(1 - \left(\frac{m_i}{C_i}\right))\overline{N} = wE_iN_i + \beta A_{i0}, \tag{8}$$

The effective price of consumption is now specific to each household and given by

$$P_{ci} = (1 + \tau_c) + R\left(\frac{m_i}{C_i}\right) + wk(1 - \left(\frac{m_i}{C_i}\right))^2 \tag{9}$$

In addition we can observe that the heterogeneity of this price comes uniquely due to the share of payments done with cash, which as stated in result 5 is now different across agents.

In addition it is straightforward to compute that

$$\partial \frac{P_j}{\left(\frac{m_j}{C_j}\right)} = R - 2wk(1 - \left(\frac{m_j}{C_j}\right)) = \frac{w\overline{N}}{C_j} > 0$$

which implies the following result:

Result 6: With economies of scale in the transactions technology there is a non degenerate distribution of $\frac{m}{C}$ across households. Poor agents (i) consume less and have a higher share of money. Having a zero, or small use of credit, leads to a higher effective price of consumption. The existence of inflation with this type of technology is an additional source of inequality.

Since the main objective of this article is to understand the connection between inflation and inequality this result is quite important. It explains that, when the monetary model economy is able to replicate payments facts, the mere existence of inflation is a source of inequality. The existence of fixed costs in the use of credit implies that the effective price of consumption is higher for those agents that do not have an advantage in using credit. And for those that use it, the richer they are the lower is the effective price of consumption. Inflation amplifies the inequality due to exogenous characteristics.

Now our question is what happens when inflation declines. It is easy to see that with this new channel, introduced through the increasing returns on transactions and which is reflected in different effective prices of consumption across agents, inequality is affected by the change of inflation.

We can see that the relative price of consumption across agents depends on the inflation level. Inflation, directly and through m/C, affects the relative effective price of consumption:

$$\frac{d\frac{P_{ci}}{P_{cj}}}{dR} > 0$$

The price for the poorer household is higher than for the richer, i.e., the relative price $\frac{P_{ci}}{P_{cj}}$, for $i < j$, is greater than one. When inflation increases both households face a higher price but because the richer households have higher advantage for substituting cash by credit the price faced by the richer households increases less than that faced by poorer households. Then we can say that:

Result 7: With economies of scale in the transactions technology, inflation acts like a regressive tax on consumption. With a higher inflation the effective tax rate on consumption increases more for poorer than for richer households.

Inflation is thus not just an additional source of inequality but the increase of inflation is regressive. As we are analyzing the effects of the decline of the inflation tax we can say that, if the rest of the analysis would be maintained, the decline of inflation would work as a progressive policy. Through the additional channel now discussed, the decline in inflation would reduce inequality.

As mentioned in the beginning, the problem associated with this transactions technology more consistent with cross section data, is that in this monetary economy it is no longer possible to aggregate households decisions and to compute equilibrium prices that do not depend explicitly on the underlying distribution. A necessary condition for aggregation is that prices faced by different agents should be identical, and we just showed that this is not the case with increasing returns, since the effective price of consumption is household' specific.

To pursue this work the construction, calibration and numerical computation of the equilibrium in this non-aggregable heterogeneous agent model is necessary. The results would be always conditional on the specific calibration, either of the parameters that command the aggregate behavior or of the proposed joint distribution of characteristics across households.

2.2.1 The numerical solution

Although being an heterogeneous non aggregable model we could construct a quite simple algoritm to solve for the general equilibrium, for a given policy. This algoritm is described in the appendix[8]. Here we present the results obtained for a given calibration of the economy. Namely we show how the heterogeneity across agents deliver different aggregate outcomes, and to what extent relative individual outcomes are also affected by initial relative characteristics.

Using the optimal choice of money given by equation (7) and substituting it in the definition of idiosyncratic consumption price given by (9), we can write the intratemporal decision of households as

$$N_i = \{\frac{1}{\epsilon}\left[\frac{wE_i}{P_{ci} + g'(C_i)C_i - w\overline{N}f'(C_i)}\right]\}^{\frac{1}{\chi}}$$

where $g(C_i) \equiv P_{ci}$ and $f(C_i) \equiv \frac{m_i}{C_i}$.

Using the budget constraint (8) we can write it as

$$g(C_i)C_i + w(1 - f(C_i))\overline{N} = wE_iN_i(C_i) + \beta A_{i0} \tag{10}$$

If markets are competitive, firms with a linear technology equate the wage, w to that constant productivity, and therefore $w = z$.

For every interest rate and tax on consumption we can use the set of equations given by (10), one for each agent, to compute the consumption in equilibrium for every agent.

Given the vector of C_i we can recover the vector for N_i, P_{ci} and $\frac{m_i}{C_i}$. Those would be the equilibrium allocation if the government budget constraint is satisfied.

2.2.2 Effects of heterogeneity on efficiency and equity

Let us suppose that the interest rate if constant and study the effect on aggregate and individual equilibruim of a change of the distribution of characteristics in the economy. That is we will maintain government expenditures, and the interest rate and change the economy from an economy where agents

[8] Also the algoritm that for each change of policy, the decline in the interest rate, computes the associated increase of the consumption tax able to finance the same government expenditure, is described in the appendix.

are identical because they have the same stock of initial wealth, to an economy where, although the aggregate wealth is maintained, its distribution is more and more unequal. That is we want to analyze the effects on equilibrium of a pure redistribution of wealth across agents in this economy. If the equilibrium reacts to the redistribution, as we will describe, the tax on consumption that satisfies the budget constraint for the same government expenditures and for a constant interest rate would change.

The results can be summarized in the Figure 1.

Result 8: The relation between inequality and efficiency is not monotonous. but when we compare a representative economy with an economy with a substantial degree of heterogeneity efficiency declines with inequality. A pure redistribution increase efficiency. The consumption tax rate necessary to finance government expenditures increase always with inequality.

2.2.3 The change of the inflation tax

When agents are not identical the effect of the decline of inflation associated with a decline of the nominal interest rate from a tax of around 10% to a constant level of 3% can be described in Figure 2.

Result 9: The decline in inflation has a significative effect on efficiency and a positive effect on equity. Even without a pure redistribution a more equal economy can be achieved imultaneouly with a more efficient one. The magnitude of these effects does not depend on the heterogeneity of the economy.

3 The inflation tax in open economies

How important for the questions in last sections is the hypothesis that the country was well represented by a closed economy? Here we consider a standard international macroeconomic model. Monetary policy is such that the exchange rate is fixed or, alternatively, countries belong to a monetary union. Let us assume a world of two countries with identical tastes and technologies. We denote the home country with H and the foreign country with F. The union is populated by a continuum of households, indexed by $j \in [0, 1]$. The households in the segment $[0, .5]$ live in country H and the households in the segment $(.5, 1]$ live in country F. There are economies of scale in the production of the final good and costless differentiation of the intermediate

products. Each firm produces a distinct good and each good is identified with the firm that produces it. Firms use technologies that are linear in labor, and productivity is identical across goods and across countries. We assume that there is an initial sunk entry cost for each firm, which determines simultaneously the number of firms in each of the two countries, and a given pattern of trade and specialization between the two countries, as in Krugman (1980).[9] The goods produced in the union are normalized to the unit interval, and indexed by $i \in [0,1]$. The entry costs are such that the goods in the interval $[0,.5]$ are produced in country H and the goods in the interval $(.5,1]$ are produced in country F [10].

Per capita government expenditures are identical across goods and countries. The monetary authority of the monetary union issues the common currency, that is distributed endogenously across countries in order to satisfy demand. Monetary policy sets the interest rate, which is the instrument of monetary policy. Seigniorage is divided equitatively across countries.

There are union-wide markets for the goods but the market for labor is segmented across countries. Labor is homogeneous and mobile inside each country but immobile across countries. There is a non-state contingent nominal asset traded across countries. If there was perfect mobility of labor the terms of trade channel of the monetary transmission mechanism would be closed.

Households Given the described set-up, when agents are identical in teh initial stock of wealth, there are two representative households, one for each country. Preferences are identical across these two consumers, and identical to the one in (1).Now the aggregate consumption is defined as:

$$C_t = \left[\int_0^1 c_t(i)^{\frac{\sigma-1}{\sigma}} di \right]^{\frac{\sigma}{\sigma-1}}, \tag{11}$$

[9]The aggregate production function is of the type $Y_t = \left[\int_0^\eta y_t(i)^{\frac{\sigma-1}{\sigma}} di\right]^{\frac{\sigma}{\sigma-1}}$, with $\sigma > 1$, where $y_t(i)$ is the output of firm i and $[0,\eta]$ the interval of firms operating. Under symmetry $y_t(i) = y_t$ for all i and the aggregate production is $Y_t = y_t \eta^{\frac{\sigma}{\sigma-1}}$. As this function exhibits increasing returns of scale in η, there must be some entry restriction to have the number of firms determined in equilibrium.

[10]The number of goods produced in each country does not have to coincide with its size, however to simplify the analysis and the notation we assumed that the exogenous fixed cost in each of the countries is such that that happens.

where $c_t(i)$ is the consumption of good i, for $i \in [0,1]$ and $\sigma > 1$ is the elasticity of substitution between the various goods. It is convenient to rewrite the aggregate consumption (11) as

$$C_t = \left[\theta^{\frac{1}{\sigma}} C_{h,t}^{\frac{\sigma-1}{\sigma}} + (1-\theta)^{\frac{1}{\sigma}} C_{f,t}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \ 0 < \theta < 1, \text{ for all } t, \tag{12}$$

where the aggregate $C_{h,t}$ corresponds to home consumption of the continuum of goods produced at home, and $C_{f,t}$ corresponds to home consumption of the continuum of goods produced in the foreign country. These bundles are defined as

$$C_{h,t} = \left[\left(\frac{1}{\theta}\right)^{\frac{1}{\sigma}} \int_0^{\theta} c_t(i)^{\frac{\sigma-1}{\sigma}} di\right]^{\frac{\sigma}{\sigma-1}}, \text{ for all } t$$

and

$$C_{f,t} = \left[\left(\frac{1}{1-\theta}\right)^{\frac{1}{\sigma}} \int_{\theta}^{1} c_t(i)^{\frac{\sigma-1}{\sigma}} di\right]^{\frac{\sigma}{\sigma-1}}, \text{ for all } t.$$

However for our world of heterogeneous agents in every country this decision are household specific.

Results Using the equilibrium conditions in the appendix we can verify that for a given interest rate heterogeneity plays a role in the equilibrium. With the interest rate equal to 10% we saw that in closed economies heterogeneity is amplified when households have different stocks of initial wealth. Here we can see that when exogenous heterogeneity, distribution of initial wealth, differs across countries the terms of trade in equilibrium is different from 1.In figure 3 we maintain the distribution of wealth of the home country and compute the general equilibrium for different distributions of the foreign country. When those distributions are identical (difference across households inside each country equal to 0.16), the equilibrium terms of trade is one and the equilibrium of of the open and closed economies coincide. When the foreign country is more unequal the terms of trade ($p \equiv \frac{p_f}{p_h}$) increases which implies a decline of efficiency in the home country. Therefore

Result 10: For a given distribution of characteristics in the home country, the more equal the foreign country the higher the efficiency of the home country. This mechanisms comes from the decline in the terms of trade associated with the increase in inequality in the foreign country.

This same result can be seen in figure 4 where, for a representative agent in the foreign country, efficiency in the home country is 4% higher then when distribution is very unequal in the foreign country.

Result 11: The effect on inequality in home efficiency has a much lower effect on efficiency at home then the same change in inequality in the foreign country. The effect on equity depends mainly on home inequality but inequality increases with inequality abroad.

0.5% (representative agent) versus 2.8%.

Result 12: The gain on efficiency of the decline on inflation is higher the more unequal is the foreign country. The same happens with equity.

0.3% (representative agent in foreign) versus 1.7%.

4 Conclusions

There is a strong connection between inflation and inequality, mainly when the change of inflation, and the associated inflation tax, is distributed unevenly across households. When the lost revenues from taxing money are substituted by revenues from a tax on consumption there are effects on the equilibrium given the fundamental roots of heterogeneity. To tax cash, when compared with this tax on consumption is worse for inequality for two reasons: first, just by increasing a common consumption price hurts the poor more; and second, when this price differs across households, penalizing the poorer, the increase of inflation increases this difference. The inflation tax is a tax that is worse for inequality than the linear tax on consumption, even when does not create different consumption prices across households, and in more realistic frameworks it is even worse given its regressive characteristics.

Therefore the decline in inflation, in addition to being able to increase the aggregate welfare, is equity improving. This means that agents in the bottom of the welfare distribution have a high probability of improving welfare due to the decline of inflation.

In addition the interaction of inequalities across countries show that the effects of a specific country, either on efficiency or on equity, are amplified the stronger is inequality in countries that share the same monetary policy.

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