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The effects of inflation target changes in an open economy with heterogeneous households*

Bernardino Adão[‡]

Isabel Correia[†]

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Abstract

When discussing the level for the target inflation in a Monetary Union typically questions of efficacy of stabilization of monetary policy or conditions for the fulfilment of an optimal monetary currency are in the forefront. Even when inequality is a well- documented fact as well as different degrees of inequality across economies this is not brought forward to the discussion. We show here that this is a consideration of first order. We build a model where this is the only fundamental that distinguishes countries in the area and find that these different degrees of inequality determine that different economies will be affected differently by a change in the target for inflation. We show how the transmission mechanism can in this case amplify the effects obtained when heterogeneity is not considered. Moreover, we show that the effects over the different agents depend on their particular characteristics and on the economy where they live in. We also obtain that a redistribution of wealth in a given country increases efficiency and equality in all countries.

*Please do not quote

[‡] Banco de Portugal

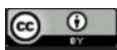
[†] Banco de Portugal, Universidade Católica Portuguesa and CEPR

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1 Introduction

The standard hypotheses in the international macroeconomic literature imply that when countries are identical aggregate shocks do not affect the terms of trade, relative consumptions, relative incomes and the current accounts of the countries. Instead, in this paper, a common shock to a set of identical countries has idiosyncratic effects. The countries are similar in the sense that they have identical preferences and technologies, and aggregate efficiency and initial aggregate wealth levels. However, the distribution of efficiency or the distribution of wealth may be different across countries. Each country is specialized in the production of a good, but households consume the same composite good.

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 do not own a checking account or do not use credit cards to perform transactions. We build a model that replicates these facts when agents are heterogeneous agents. The way inequality interacts with changes in the target for inflation can explain different aggregate outcomes across countries but also the observed correlation between inflation and inequality. Participation changes in the credit market, which happen both at the intensive as well as at the extensive margin, are important when there is an alteration in the target for inflation.

A result of this paper is that monetary policy in a monetary union is more potent than in the old view, where a common monetary policy cannot affect similar countries differently. We compute that the idiosyncratic effects of a monetary policy change, in a simple model where countries have identical aggregate initial wealth but distributed differently across countries, and conclude that the asymmetric effects have the potential to be quantitatively significant. We focus on a change in the target for inflation in a monetary union, but the conclusions extend to any other change in policy or any common shock.

We consider that in each country households can do transactions either with cash or credit. The production of credit uses scarce resources while the production of cash does not. The credit technology has increasing returns to scale which implies that richer households tend to use relatively less cash to do transactions than poorer households. The consequence of this is that the

effective price of each unit of consumption is lower for the richer households. The change to a lower inflation regime decreases the cost of using cash to do transactions and leads all households to use more cash in their transactions. As a consequence, efficiency and equity in all countries increase for all levels of inequality. The terms of trade become closer to unity for all levels of inequality, too. That is the prices of the goods produced in the countries become more similar.

Another result is that a redistribution of initial wealth in the home country has aggregate effects not only at home, but also in the other countries. In the home country, as households become more equal cash gets used in more transactions, which increases the tax base of the inflation tax and allows a substantial decrease in the consumption tax rate. The consequence is an increase in efficiency and in the terms of trade in the home country. Also, the redistribution of the initial wealth in the home country has effects in the other countries, but of a smaller magnitude. In the other countries: the effective prices of consumption decrease and consumptions increase for all households, the consumption tax rate decreases, and efficiency increases. Equity measured as the ratio between the utility level of any household and the utility level of a richer household increases as well as production. The highest levels of equity and efficiency in the other countries are achieved when the redistribution of wealth in the home country makes all households equal.

Our results are in line with the literature that finds a positive correlation between average inflation and measures of income inequality. Albanesi (2007) finds a strong correlation between inflation and the Gini coefficient for 51 industrialized and developing countries between 1966 and 1990. Romer and Romer (1998) have quantitatively similar results obtained by regressing inequality on inflation. Easterly and Fisher (2001) present indirect evidence on the distributional effects of inflation, using household pooling data on 38 countries, find that the low income households perceive inflation as more costly than high income households.

There is also a theoretical literature that studies the aggregate implications of inflation when there is heterogeneity in the economy, and how this regime change affects inequality. Akyol (2004) studies optimal risk-sharing in a pure exchange economy where bonds and money are held only for precautionary purposes. Positive inflation in this model ensures maximum risk-sharing, redistributing surplus to low-income agents. In a random matching model Molico (2006) shows that some inflation can improve social welfare because higher inflation can reduce wealth and price dispersion. Boel and

Camera (2011) have a model based on Lagos and Wright (2005), where they show that the impact of inflation depends on the financial sophistication of the economy. If money is the only asset, then inflation hurts more the wealthier and more productive agents, while those poorer and less productive may even benefit from inflation. In a more sophisticated financial environment where agents can insure against consumption risk, with other assets, the opposite result holds. Erosa and Ventura (2002) in a transactions cost model show that a decline in inflation increases efficiency and improves equity.

In Adão and Correia (2018) it is shown that heterogeneity across households plays a key role in our understanding of the aggregate effects of a decline in the expected average inflation in a closed economy set-up. Here, we want to extend the analysis to a monetary union environment like the Euro area. More specifically we want to evaluate how the various countries that belong to a monetary union, i.e. share the same nominal interest rate and have the same currency are affected by a change in the inflation target. At the same time we also want to understand the effects on the heterogeneous agents that live in each of the countries. We do not focus on the questions that were raised with the recent crisis, which emphasize the ability of the policy to stabilize the economies by moving the policy interest rate given the target. We abstract from cycles, in normal or crisis periods, and as such we consider a deterministic environment. Also, we do not want to examine what is the optimal monetary union or what is the best target inflation for an area that is composed by countries at different stages of development. Instead, we assume that countries are identical in terms of fundamentals. These economies will be characterized by having heterogeneous agents but identical preferences across agents, both inside and across countries. There will be different goods produced and traded across countries but there will not be a home bias in the goods basket of any agent in the economy. Also, we will impose the same composition of public goods and the same technology across goods and countries. We will have a very simple and extreme characterization of markets. Goods are perfectly traded across the area and no trade is assumed for countries outside the monetary union. The same is assumed for the only asset that is available in this union: perfectly traded inside each country and across countries in the union but no trade outside the union. Labor markets are standard in international macro: labor is perfectly mobile across firms inside each country and immobile across economies inside the union. Therefore, as in Adão and Correia (2018) our focus is on heterogeneity across households, opening now the ability to trade and to share a currency and a

central bank, with economies identical up to the distribution of characteristics across households. Can identical countries up to those characteristics be affected differently with a change in the target inflation? And how relevant is for a particular agent to live in one or in another different economy? How is the answer to this question dependent on the specific characteristics of the agent? These are the important questions we study and that we think should be answer before those that are currently under scrutiny, when discussing the best target for the Monetary Union.

As far as we know, our paper is the first to study the impacts of an inflation regime change and of a redistribution of wealth in an open economy model with heterogenous households. We investigate how the aggregate macro variables depend on the existing degree of exogenous inequality in the economies and whether the decline in inflation can decrease inequality in the countries. We find that the aggregate effects depend on the exogenous heterogeneity, i.e. these effects would not be obtained in a representative agent framework. The increase of efficiency, due to a change to a lower inflation regime, is dependent on the existing heterogeneity. Also, the effects on equity tend to reinforce the effects on efficiency: a lower inflation increases efficiency and equity. Finally, an increase in efficiency, or equity in one country affects positively the other countries. These other countries increase their efficiency and equity too.

The remainder of the paper is organized as follows. Section 2 presents the model economy and describes the properties of the equilibrium. Section 3 discusses the solution method, and the results of the numerical exercise. Finally, Section 4 concludes.

2 Model

We consider a very simple flexible price international macroeconomic model. A world of two countries with identical tastes and technologies. The home country is denoted by H and the foreign country by F . The population of country H is denoted by S_H and the population of country F by S_F . These countries belong to a monetary union, which implies that they share a common central bank and monetary policy.

Each country has heterogeneous households. We will impose that these countries are identical in every dimension except on the distribution of exogenous characteristics across households, which will be reflected in different

values for the measured income or consumption inequality across countries. We will assume that goods are traded in perfect markets across these countries and the same condition applies to the bond that exists in this economy. We impose as well that labor, the only input in production, is perfectly mobile across firms inside each country but immobile across countries.

The households have to use transactions services to consume which generates an endogenous size for the credit good sector. As we are interested in studying the optimal level of inflation in the long run we assume there is no uncertainty and that inflation is fully anticipated by firms and households. As such, without loss of generality we restrict our focus on the different stationary equilibria associated with the different inflation rates. Given stationarity, the real interest rate is constant across policies and there is a one to one relationship between changes in inflation and changes in the nominal interest rate. The target for inflation will therefore characterize the monetary policy regime, which can be described by the constant nominal interest rate or the average inflation rate.

The simplicity of the described set-up allows us to focus on the role that money plays in transactions and on the characterization of heterogeneity across households, as well as on the interaction of these two blocs of the model. In order to consume households must pay the production price of the good but must also incur in transactions costs. These depend on the composition of credit services and cash. As households have the same utility function, if the transactions function is constant returns to scale then the intratemporal marginal rate of substitution between consumption and leisure, per units of efficiency, is equated among all households. This will not be consistent with the cited cross section evidence on transactions: it does not explain that high income individuals use cash and cash plus checks for a smaller fraction of their transactions than low income individuals; that the fraction of household wealth held in liquid assets decreases with income and wealth; and that a nontrivial fraction of households do not own a checking account or do not use credit cards to perform transactions. However, if the transactions technology is not of the constant returns type then, as we will show, the effective price of consumption, the one that measures the marginal cost for the consumer of adding one additional unit to its aggregate consumption basket, will be different across households, and this would imply that the marginal rates of substitution between leisure and consumption will not be equated across households. Thus, an increasing returns to scale transactions technology, which is suggested by the data, together with heterogenous

households generates a friction in the economies. Below, we first consider the constant returns to scale technology to built some intuition on some benchmark results and later extend the analysis to the increasing returns to scale technology.

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 equally across countries.

The households take decisions over consumption, labor, and the means of payments. Households hold money because it is an alternative means of payment to costly credit. Credit services are produced according to a production function that uses only labor as input. Like in Erosa and Ventura (2002), we assume that the production function of this service uses one (efficiency) unit of labor per unit of service produced. Competition guarantees that financial intermediaries will make zero profits and charge a price equal to their marginal cost.

Household i of country H does transactions according to the technology:

$$s_{i,t} = l(m_{i,t-1}, C_{i,t}), \text{ for all } i \in S_H,$$

where $s_{i,t}$, $m_{i,t-1}$, and $C_{i,t}$ represent, credit services, real balances and composite consumption of household i , respectively. Function l is decreasing in $m_{i,t-1}$ and increasing in $C_{i,t}$. In the literature, see for instance Correia and Teles (1996), it is usually assumed that $s_{i,t}$ is time spent in transactions, which is not traded in the market. Here, whether these services are produced by some firms in the financial system or are produced in-the-household is not important, since the tax on consumption is the alternative financing instrument to compensate the change of government revenues due to changes of the target inflation. The transaction technology in country F is identical:

$$s_{i,t}^* = l(m_{i,t-1}^*, C_{i,t}^*), \text{ for all } i \in S_F.$$

We adopt the convention of indexing with a star the variables concerning country F .

Firms are profit maximizers and use technologies that are linear in labor.¹ The productivity, denoted by z , is identical across goods and across countries.

¹Although similar, the countries trade because some time in the past there was a complete specialization between the two countries. We take the specialization of production as given because we assume it was determined a long time ago.

The firms in each country produce similar goods. At date t the production of good h , $Y_{h,t}$, is done in country H , and the production of good f , $Y_{f,t}$, is done in country F . The production functions are given by

$$Y_{h,t} = z \int_{i \in S_H} (E_i N_{i,t} - l_i) di, \text{ and } Y_{f,t} = z \int_{i \in S_F} (E_i^* N_{i,t}^* - l_i^*) di,$$

where E_i is the efficiency of household i that lives in country H and $N_{i,t}$ is the labor hours of household i that lives in country H . The E_i^* and $N_{i,t}^*$ are the corresponding variables for country F .

The households and the government of each country consume a composite good. In each country there are firms that produce the composite good. At time t the composite good of country H , Y_t , can be obtained using good h , $y_{h,t}$, and good f , $y_{f,t}$, according to

$$Y_t = y_{h,t}^\alpha y_{f,t}^{1-\alpha}, \text{ with } 0 < \alpha < 1.$$

The composite good for country F , Y_t^* , is defined similarly,

$$Y_t^* = y_{h,t}^{*\alpha} y_{f,t}^{*1-\alpha}, \text{ with } 0 < \alpha < 1,$$

where $y_{h,t}^*$ and $y_{f,t}^*$ are the quantities of good h and good f used in the production of Y_t^* .

We assume that these firms that produce the composite good are perfect competitors. The price charged per each unit of the composite good is P_t , and it determined as the minimum expenditure on good h and on good f , $P_{h,t}y_{h,t} + P_{f,t}y_{f,t}$, that produces one unit of the composite good, i.e. $y_{h,t}^\alpha y_{f,t}^{1-\alpha} = 1$. It can be shown that P_t is given by

$$P_t = \Phi P_{h,t}^\alpha P_{f,t}^{1-\alpha}, \tag{1}$$

with $\Phi \equiv \left(\frac{1}{\alpha}\right)^\alpha \left(\frac{1}{1-\alpha}\right)^{1-\alpha}$, where $P_{h,t}$ is the price of the good produced in country H and $P_{f,t}$ is the price of the good produced in country F . The assumption that the goods are tradable and the assumption of identical technologies to produce the composite good imply that price for the composite good is the same in the two countries.

In equilibrium the markets for the goods of each country clear:

$$Y_{h,t} = y_{h,t} + y_{h,t}^* \text{ and } Y_{f,t} = y_{f,t} + y_{f,t}^*.$$

Also, the markets for the composite goods of each country clear:

$$Y_t = \int_{i \in S_H} C_{i,t} di + G_t \text{ and } Y_t^* = \int_{i \in S_F} C_{i,t}^* di + G_t^*,$$

where $C_{i,t}$ is the consumption of the composite good by household i that lives in country H , G_t is the consumption of the composite good by the government of country H , $C_{i,t}^*$ is the consumption of the composite good by household i that lives in country F , and G_t^* is the consumption of the composite good by the government of country F .

Each household of country H maximizes the discounted sum of future momentary utility levels, where the discount parameter is β , with $0 < \beta < 1$. That is, household $i \in S_H$ maximizes

$$\sum_{t=0}^{\infty} \beta^t u_{i,t}, \quad (2)$$

where $u_{i,t}$ is the momentary utility function. Function $u_{i,t}$ is the same across households, $u_{i,t} = u(C_{i,t}, N_{i,t})$. As in Correia (1999), Domeij and Heathcote (2004) and Floden (2009) we consider that the momentary utility function, u , belongs to the GHH class proposed by Greenwood, Hercowitz and Huffman (1988),

$$u(C_i, N_i) = \frac{1}{1-\sigma} \left(C_i - \epsilon \frac{N_i^{1+\chi}}{1+\chi} \right)^{1-\sigma}, \quad \chi, \epsilon > 0, \sigma \geq 0, \text{ and } \sigma \neq 1, \quad (3)$$

where σ is the curvature parameter, ϵ determines relative importance of leisure, $1 - N_i$, and consumption, C_i and $1/\chi$ is the Frisch elasticity of labor supply. The households of country F have a similar utility function.

The households are heterogeneous in two dimensions. They are differentiated by their efficiency level, and their initial real wealth, represented by E_i and A_i , respectively. The efficiency levels have a positive support but the initial real wealth can be negative for some households. Each household sells hours, $N_{i,t}$, in the labor market. The market real wage for each unit of $E_i N_{i,t}$ is $w_t \equiv \frac{z P_{h,t}}{P_t}$.

The sequence of budget constraints of household i is:

$$P_t(1+\tau_c)C_{i,t} + w_t P_t s_{i,t} + M_{i,t} + B_{i,t} \leq w_t P_t E_i N_{i,t} + M_{i,t-1} + (1+R)B_{i,t-1}, \text{ for } t = 0, 1, 2, \dots \quad (4)$$

where P_t is the price of the composite good at date t , τ_c is the tax on consumption, and R is the net nominal interest rate. The initial nominal wealth level of household i , P_0A_i , is $M_{i,-1} + (1 + R)B_{i,-1}$, where $M_{i,-1}$ is the initial nominal money holdings, and $B_{i,-1}$ is the initial nominal bonds.

In a stationary equilibrium the intertemporal marginal rate of substitution for consumption implies:

$$\frac{P_{t+1}}{P_t(1 + R)} = \beta. \quad (5)$$

From (4) we can write the intertemporal budget constraint of household i as

$$\sum_{t=0}^{\infty} Q_t [M_t \mathcal{R} + P_t(1 + \tau_c)C_{it} + P_t w s_{i,t} - P_t w E_i N_{i,t}] = P_0 A_i, \quad (6)$$

where $Q_t = \frac{1}{(1+R)^t}$, $\mathcal{R} \equiv \frac{R}{1+R}$ and $A_i \equiv \frac{M_{i,-1} + (1+R)B_{i,-1}}{P_0}$.

Dividing (6) by P_0 , and using the fact that in a stationary equilibrium condition (5) is satisfied, we obtain the stationary budget constraint of household i ,

$$(1 + \tau_c)C_i + wl(m_i, C_i) + \mathcal{R}m_i = wE_i N_i + (1 - \beta) A_i, \quad (7)$$

where we have dropped off the index t to simplify the notation.

The optimal choice of money holdings satisfies:

$$-wl_{m_i} = \mathcal{R}, \text{ for } \frac{m_i}{C_i} < 1. \quad (8)$$

This equation says that the choice of real money is such that the cost of one additional unity of money, \mathcal{R} , should equalize the benefit in reducing the transaction costs, which is the decline in hours spent with credit transactions that the additional unit of money allows, l_{m_i} , times the wage, w .

2.1 Constant returns to scale in transactions

We start by considering the case when the transaction technology is constant returns to scale. It is a useful benchmark case. According with the evidence, later it will be assumed that the transactions technology has increasing returns, but the comparison with the increasing returns to scale case is instructive.

Let function l be homogeneous of degree 1, i.e. constant returns to scale CRS. It can be written as $l(m_i, C_i) = L(m_i/C_i)C_i$. Function L is characterized by $L' < 0$ and $L'' > 0$, so that an increase in the real quantity of money decreases the time spent with transactions at a decreasing rate. For a given ratio of money to consumption, $\frac{m_i}{C_i}$, the marginal and the average labor productivities on transactions do not depend on the level of consumption. For a general CRS function, condition (8) implies

$$-L' \left(\frac{m_i}{C_i} \right) = \frac{\mathcal{R}}{w},$$

or

$$\frac{m_i}{C_i} = \frac{m}{C} = - (L')^{-1} \left(\frac{\mathcal{R}}{w_t} \right), \text{ for all } i \in S_H. \quad (9)$$

It follows from (9) that when the transaction technology is CRS, $\frac{m_i}{C_i}$ is identical across households. The quantity of money that a rich household maintains, as a fraction of its transactions, is the same as the one held by a poor household. This implies that this type of technology is not consistent with the cross section evidence on transactions. As said above, we consider this case to be used as a benchmark. The budget constraint can be rewritten as

$$\mathcal{P}C_i = wE_iN_i + (1 - \beta) A_i, \quad (10)$$

where the effective price of consumption, \mathcal{P} , is

$$\mathcal{P} \equiv (1 + \tau_c) + wL \left(\frac{m_i}{C_i} \right) + \mathcal{R} \frac{m_i}{C_i}. \quad (11)$$

It follows that \mathcal{P} is constant across households, and includes the direct tax on consumption, τ_c , and the indirect cost associated with the means of payment, $wL + \mathcal{R} \frac{m}{C}$. This indirect cost depends on the opportunity cost of holding cash, \mathcal{R} , the unitary cost of labor used in credit, w , and the transactions technology, L .

The problem of household i can be rewritten as maximizing $u(C_i, N_i)$ subject to (10). Among the first order conditions we have

$$\frac{\partial u}{\partial C_i} = \lambda \mathcal{P} \text{ and } \frac{\partial u}{\partial N_i} = -\lambda w E_i, \quad (12)$$

where λ is the Lagrange multiplier of (10). These two conditions imply that the intratemporal marginal rate of substitution between leisure and

consumption is equal to the relative price of leisure

$$-\frac{u_{N_i}}{u_{C_i}} = \frac{wE_i}{\mathcal{P}}. \quad (13)$$

Inflation imposes two types of welfare costs: the cost of misallocation of resources from the good sector to the credit sector and a distortion between the relative price of leisure and its intratemporal marginal rate of substitution with consumption. A decrease in inflation diminishes these two costs, while a decrease in the consumption tax only reduces the distortion between the relative price of leisure and its intratemporal marginal rate of substitution with consumption.

Using (10) and replacing (3) in (13) allows to solve for N_i and C_i :

$$N_i = \left[\frac{wE_i}{\epsilon \mathcal{P}} \right]^{\frac{1}{\chi}}, \text{ for all } i \in S_H \quad (14)$$

and

$$C_i = \frac{wE_i}{\mathcal{P}} N_i + \frac{(1-\beta)}{\mathcal{P}} A_i, \text{ for all } i \in S_H. \quad (15)$$

Given that the effective price of consumption is identical across households, there is a representative household for each country. The aggregation property is confirmed as the labor supply, (14), is independent of the wealth distribution.

The indirect utility of household i in country H is obtained when (14) and (15) are replaced in (3)

$$v_i = \frac{\chi}{1+\chi} \left[\frac{1}{\epsilon} \right]^{\frac{1}{\chi}} \left[\frac{wE_i}{\mathcal{P}} \right]^{\frac{1+\chi}{\chi}} + \frac{(1-\beta)}{\mathcal{P}} A_i. \quad (16)$$

The representative agent of country H , $i = r$, is characterized by $E_r = 1$ and $A_r = 0$. The efficient equilibrium allocation corresponds to the one that maximizes the utility of the representative household, subject to the budget constraints, of the government and the representative household, and first order conditions of the household problem. It is well known that the efficient allocation satisfies the Friedman rule, i.e. $R = 0$, see Correia and Teles (1996).

The indirect utility of the representative household in country H , v_r , is obtained buy letting in (16) $E_r = 1$ and $A_r = 0$,

$$v_r = \frac{\chi}{1+\chi} \left[\frac{1}{\epsilon} \right]^{\frac{1}{\chi}} \left[\frac{w}{\mathcal{P}} \right]^{\frac{1+\chi}{\chi}}. \quad (17)$$

Since the indirect utility of the representative household, (17), is inversely related to \mathcal{P} , then the smallest \mathcal{P} that allows a given public consumption is the one associated with the efficient allocation. Since the smallest value of \mathcal{P} involves $R = 0$, then the maximization of the representative household utility implies that money should not be taxed, i.e. the government should follow the Friedman rule and set the nominal interest rate to zero. The gain from reducing inflation does not depend on the specific joint distribution of wealth and labor productivity that characterizes country H . The same conclusion is valid for country F .

This implies that government expenditures should be financed with the consumption tax. Revenue neutral policies that involve declines in inflation and tax expansions increase welfare. It follows, from (17), that the net real effective wage, w/\mathcal{P} goes up as a result of such policies.

The assumption of a CRS transactions technology offers the possibility of using a simple method to rank policies by their effects on inequality. The equity ranking of policies can be done by resorting to a relative differential concept like the one described in Correia (1999). Let households be ordered by decreasing utility, i.e. $i > j$ implies $v_i < v_j$. According to this concept, in equity terms policy 2 dominates policy 1 if and only if

$$\frac{v_i^2}{v_j^2} > \frac{v_i^1}{v_j^1}, \text{ for any } i \text{ and } j, \text{ such that } i > j. \quad (18)$$

This condition is quite intuitive. Consider any two households in the economy, household i and household j , where the first has a lower utility than the second, i.e. $i > j$ and $\frac{v_i}{v_j} < 1$. If a policy change increases this ratio of utilities, it means that the "poorer" household becomes less distant (in terms of utility) from the "richer" household, that is, their economic situation becomes more equal than before. When this is true for any two agents then the policy change is one that leads to a more equal society; it is a policy that reduces inequality.

Therefore, determining if a policy change reduces inequality involves checking whether the ratio $\frac{v_i}{v_j}$ increases. When households are identical in labor productivity, $E_i = E_j = 1$, the relative welfare between agent i and j can be written, using (16), as

$$\frac{v_i}{v_j} = \frac{\gamma(\mathcal{P}) + A_i}{\gamma(\mathcal{P}) + A_j},$$

where

$$\gamma(\mathcal{P}) = \frac{\chi}{1 + \chi} \frac{w^{\frac{1+\chi}{\chi}}}{(1 - \beta)} \left(\frac{1}{\epsilon \mathcal{P}} \right)^{\frac{1}{\chi}}. \quad (19)$$

If $i > j$ it is because $A_i < A_j$. Thus, a change in policy increases equity if $\gamma(\mathcal{P})$ increases as a result.

Consider now a decline in the inflation, i.e. a lower R , that is compensated by an increase in the tax on consumption, so that the tax revenues are maintained. The real wage, w , is not affected by this change of policy, but as we saw above the net real effective wage, $\frac{w}{\mathcal{P}}$, increases. The lower inflation tax is efficient because it allows a smaller effective consumption price, \mathcal{P} . As $\frac{m_i}{C_i} \leq 1$, and $\frac{m_r}{C_r} < 1$, the base of the consumption tax is higher than the base of the inflation tax. This means that although the tax on consumption, τ_c , increases, it increases by less than the decline in the nominal interest rate, R .²

The conclusion is that a decline in inflation compensated by a revenue neutral increase in the consumption tax rate improves equity, or the welfare distribution, when all households have the same productivity, $E_i = E_j$ for all i and j . Typically, both wealth and income are highly concentrated and very unequally distributed, but income is less concentrated than wealth.³ Thus, this conclusion can be extended to the case, where the distribution of productivities, the E_i 's, is less concentrated than the distribution of wealth, the A_i 's.

A revenue neutral decline of inflation increases the welfare of all households; i.e. it is a Pareto movement. The richer households are better off because both their initial wealth, in terms of consumption, and the net real effective wage increase. The poorer households are also better off too. That happens because as a result of this change in policy, the welfare of the representative agent, v_r , increases. Since $\frac{v_i}{v_r}$ increases for every i poorer than

²Whenever households use credit for a share of their payments, it is because at the existing interest rate, it is not optimal to use exclusively money as the mean of payment. In this case, a decline in R implies a positive income effect, that to be compensated implies a smaller increase in τ_c . In the limit, when the nominal interest rate is zero and credit is not used as mean of payment, the inflation tax is equivalent to the consumption tax.

³For instance, Díaz-Giménez et al. (1997) report Gini indices for labor earnings, income (inclusive of transfers) and wealth in 1992 of 0.63, 0.57, and 0.78, respectively, while for 1995 Budria et al. (2002) report values 0.61, 0.55 and 0.80. Moreover, it is well known that economic models have had difficulties in quantitatively generating the observed degree of wealth concentration from the observed income inequality, see Cagetti and De Nardi (2008).

r , where r refers to the representative household, then v_i increases for every $i > r$. Thus, the proposed policy change increases welfare for every household in this economy, i.e. is a Pareto movement, and the poorer, even when they are debtors, increase welfare by more than the richer, the creditors.

2.2 Economies of scale in transactions

So far the transactions technology was assumed to be constant returns to scale. However, this assumption is at odds with the cross section evidence on payment patterns. By imposing a transaction technology that is consistent with the cross section evidence our results change radically. We do not have aggregation at each country level. As we lose Gorman aggregation at each country level we open up the terms of trade channel, as we also lose aggregation at the union wide level.

We begin by showing that the effective consumption price is now idiosyncratic to each household when the technology is increasing returns to scale. Assume the credit technology $l(m_i, C_i)$ is given by,

$$l(m_i, C_i) = k \left(1 - \frac{m_i}{C_i}\right)^2 C_i + \left(1 - \frac{m_i}{C_i}\right) \bar{N}, \text{ for any } i \in S_H. \quad (20)$$

Households in country F have a similar transactions technology,

$$l(m_i^*, C_i^*) = k \left(1 - \frac{m_i^*}{C_i^*}\right)^2 C_i^* + \left(1 - \frac{m_i^*}{C_i^*}\right) \bar{N}, \text{ for any } i \in S_F.$$

The credit technology (20) has increasing returns to scale. The term $\left(1 - \frac{m_i}{C_i}\right) \bar{N}$ is a fixed cost for a given share of transactions with credit, $\left(1 - \frac{m_i}{C_i}\right)$.

When this transactions technology is used in the first order condition (8), the optimal decision on money holdings is obtained,

$$\begin{aligned} \frac{m_i}{C_i} &= 1 - \frac{R}{2wk} + \frac{\bar{N}}{2kC_i} \text{ if } C_i > \frac{w\bar{N}}{R}, \text{ and} \\ \frac{m_i}{C_i} &= 1 \text{ if } C_i \leq \frac{w\bar{N}}{R}, \text{ for any } i \in S_H. \end{aligned} \quad (21)$$

It is immediate that, for any $\bar{N} > 0$, the larger is the volume of consumption, C_i the smaller is the share of transactions realized with cash, $\frac{m_i}{C_i}$. It follows

that the share of cash used in transactions is not constant across households. Richer households carry a lower share of their transactions with cash than poorer households.

This money demand is in line with the facts reported in the beginning of this paper. The portion of transactions paid with cash depends on the total volume of transactions carried out by the household. Households with different C_i 's have different $\frac{m_i}{C_i}$'s. For instance if household i is such that $C_i \leq \frac{w\bar{N}}{R}$, then household i only uses cash to pay for his transactions. Let household s be the richest household that only uses cash to pay for his transactions, i.e. one that has a level of transactions C_s , such that $C_s = \frac{w\bar{N}}{R}$. According to our ordering of the households then all households i , such that $i \geq s$, have $C_i < C_s$.

The money demand for the households $i \geq s$ is $m_i = C_i$. The other subset of the population, i.e. $i < s$, use both cash and credit to make payments. However, they use a higher share of credit, the larger are their transactions, that is the richer they are. Therefore the higher the household's wealth, the lower is his cash to wealth ratio. For this group of households, those such that $i < s$, the money demand is given by $m_i = (1 - \frac{R}{2wk}) C_i + \frac{\bar{N}}{2k}$.

The budget constraint of household i can be written as

$$\mathcal{P}_i C_i + w \left(1 - \frac{m_i}{C_i}\right) \bar{N} = w E_i N_i + (1 - \beta) A_i, \quad (22)$$

where

$$\mathcal{P}_i \equiv (1 + \tau_c) + R \frac{m_i}{C_i} + wk \left(1 - \frac{m_i}{C_i}\right)^2. \quad (23)$$

The effective price of consumption, \mathcal{P}_i , is now specific to each household, includes an average cost of holding money, $R \frac{m_i}{C_i}$, and an average cost of using credit, $wk \left(1 - \frac{m_i}{C_i}\right)^2$. Note that not only this price is dependent on the specific characteristics of each household, the values of C_i and of $\frac{m_i}{C_i}$, but also on the value of w , which will be different from w^* if the terms of trade are different from 1. And the terms of trade will be different from one if the joint distributions of initial wealth and efficiency in each country are different.

The transactions technology considered has a nice property. The heterogeneity of the effective price of consumption is a function of the share of cash payments done by households, which is now different across households. Everything else constant, the higher the fraction of payments with cash, the

higher is the effective price of consumption, since

$$\frac{\partial \mathcal{P}_i}{\partial \frac{m_i}{C_i}} = R - 2wk \left(1 - \frac{m_i}{C_i} \right) = \frac{w\bar{N}}{C_i} > 0. \quad (24)$$

It follows that credit technologies with economies of scale imply a non degenerate distribution of $\frac{m_i}{C_i}$ across households. Poor agents consume less, hold a higher share of money and face a higher effective price of consumption. This result is quite important to understand the relation between inflation and inequality. It says that, when the monetary model economy is able to replicate the payments facts, households react to inflation differently, some decide not to participate in the credit market, and those that participate choose to participate with different intensities. For an invariant tax rate on consumption and real wage, the existence of increasing returns to scale in the use of credit implies, an effective price of consumption that decreases with the volume of transactions done. The richer the household is, the lower is his effective price of consumption.

The effective price of consumption for the poorer households is higher than the one for the richer ones, i.e. $\frac{\mathcal{P}_i}{\mathcal{P}_j} > 1$ for $i > j$ (because $A_i < A_j$). When inflation increases all households face a higher price but because the richer households can substitute cash for credit more cheaply, the price faced by the richer households increases by less than that faced by the poorer households. The relative price of consumption across agents, i.e. the relative price $\frac{\mathcal{P}_i}{\mathcal{P}_j}$ for all $i > j$, increases with the inflation level. Thus, the effect on equity of an inflation regime change is amplified since inflation amplifies the exogenous inequality.

This can be shown formally. Using equation (23) the sign of the direct effect of a marginal change in inflation on the ratio $\frac{\mathcal{P}_i}{\mathcal{P}_j}$, i.e. $\partial \frac{\mathcal{P}_i}{\mathcal{P}_j} / \partial R$, is given by

$$\mathcal{P}_j \frac{m_i}{C_i} - \mathcal{P}_i \frac{m_j}{C_j} = \left[(1 + \tau_c) + wk \left(1 - \frac{m_j}{C_j} \frac{m_i}{C_i} \right) \right] \left(\frac{m_i}{C_i} - \frac{m_j}{C_j} \right) > 0 \quad (25)$$

as $1 \geq \frac{m_i}{C_i} > \frac{m_j}{C_j}$, for all $i > j$. Thus, $\partial \frac{\mathcal{P}_i}{\mathcal{P}_j} / \partial R > 0$, inflation has a direct effect on the relative effective price of consumption that is positive. The direct effect of inflation is regressive. Higher inflation increases more the effective tax rate on the consumption of the poorer households than on the consumption of the richer ones.

In the previous section we reached the conclusion that when the credit technology is a constant returns to scale then inflation is an additional source of inequality. An increase in inflation, compensated by a decrease in the tax on consumption, so that the tax revenues are maintained, will increase the relative difference in utility between "rich" and "poorer" households. However, when the credit constraint exhibits increasing returns to scale, besides being a source of inequality, inflation is regressive also. In this context we should expect that a decline of inflation would have effects similar to the ones caused with the implementation of a more progressive fiscal policy. Thus, we should expect that with this additional channel, the decline in inflation would reduce inequality further.

The effective price of consumption is specific to the household and the real wage is specific to the country if the credit technology is not constant returns to scale. This invalidates the possibility of obtaining aggregation in the economy, as a necessary condition for aggregation is that the prices faced by the different households be identical. Below, we calibrate and compute numerically the stationary equilibria associated with different levels of inflation in this non-aggregable heterogeneous household model. As always, when this type of methodology is used, the results are conditional on the specific calibration. The particular calibration includes both values for the parameters that determine the aggregate behavior and a joint distribution of characteristics across households.

2.3 Equilibrium

In this section we describe the various equilibrium equations and solve them. One of these equilibrium conditions is the budget constraint (22). This equation can be rewritten as

$$g(C_i)C_i + w(1 - f(C_i))\bar{N} = wE_iN_i + (1 - \beta)A_i, \text{ for all } i \in S_H \quad (26)$$

where $g(C_i) \equiv \mathcal{P}_i$, which is given by (23), and $f(C_i) \equiv \frac{m_i}{C_i}$, which is given by (21). There are similar budget constraints for the households of country F

$$g(C_j^*)C_j^* + w^*(1 - f(C_j^*))\bar{N} = w^*E_j^*N_j^* + (1 - \beta)A_j^*, \text{ for all } j \in S_F. \quad (27)$$

The intratemporal decisions of the households of country H and of the households of country F are such that:

$$N_i = \left\{ \frac{wE_i}{\epsilon} \frac{1}{g(C_i) + g'(C_i)C_i - w\bar{N}f'(C_i)} \right\}^{\frac{1}{\alpha}}, \text{ for all } i \in S_H, \quad (28)$$

and

$$N_j^* = \left\{ \frac{w^* E_j^*}{\epsilon} \frac{1}{g(C_j^*) + g'(C_j^*) C_j^* - w \bar{N} f'(C_j^*)} \right\}^{\frac{1}{\alpha}}, \text{ for all } j \in S_F. \quad (29)$$

Since markets are competitive and firms have a linear technology in labor, the nominal wage, W is equal to the nominal constant productivity,

$$W = zP_h. \quad (30)$$

The real wage, w , can be expressed, using (30) and (1), as a function of the terms of trade, $p \equiv \frac{P_f}{P_h}$,

$$w = \frac{W}{P} = \frac{zP_h}{P} = \frac{z}{\Phi} \left(\frac{1}{p} \right)^{1-\alpha}, \quad (31)$$

where $\Phi \equiv \left(\frac{1}{\alpha} \right)^\alpha \left(\frac{1}{1-\alpha} \right)^{1-\alpha}$. There is a similar condition for the nominal wage paid by foreign firms, W^* ,

$$W^* = zP_f,$$

and for the real wage

$$w^* = \frac{zP_f}{P} = \frac{z}{\Phi} p^\alpha. \quad (32)$$

Define the variable $C_{i,h}$ and $C_{i,f}$ for $i \in S_H$, as the quantities of the home good and the foreign good, respectively, that the firm that produces the composite home good uses to produce the quantity of composite good C_i . Define similarly $\{C_{i,h}^*, C_{i,f}^*\}$ for $i \in S_F$ and $\{G_h, G_f, G_h^*, G_f^*\}$. These variables satisfy the following conditions:

$$C_i = C_{i,h}^\alpha C_{i,f}^{1-\alpha}, \text{ for } i \in S_H, \text{ with } 0 < \alpha < 1, \quad (33)$$

$$C_i^* = C_{i,h}^{*\alpha} C_{i,f}^{*1-\alpha}, \text{ for } i \in S_F, \text{ with } 0 < \alpha < 1, \quad (34)$$

$$G = G_h^\alpha G_f^{1-\alpha}, \quad (35)$$

and

$$G^* = G_h^{*\alpha} G_f^{*1-\alpha}. \quad (36)$$

We assume, as is standard in this literature, that aggregate public expenditures are exogenous, and that the consumption tax rates adjust to satisfy the government budget constraints of country H and F ,

$$\tau_c \int_{i \in S_H} (C_{i,h} + pC_{i,f}) di + R\Phi p^{1-\alpha} \int_{i \in S_H} m_i di = G_h + pG_f + (1 - \beta) B, \quad (37)$$

and

$$\tau_c^* \int_{j \in S_F} (C_{j,h}^* + pC_{j,f}^*) dj + R\Phi p^{1-\alpha} \int_{j \in S_F} m_j^* dj = G_h^* + pG_f^* + (1 - \beta) B^*, \quad (38)$$

where B and B^* are the initial public debts of country H and F , respectively. Since we want to emphasize the case of similar countries we assume that foreign debt levels are zero, i.e. $B + \int_{i \in S_H} A_i di = B^* + \int_{j \in S_F} A_j^* dj = 0$.

The market clearing conditions in the home good market and in the foreign good market are

$$\int_{i \in S_H} C_{i,h} di + \int_{j \in S_F} C_{j,h}^* dj + G_h + G_h^* + z \int_{i \in S_H} l_i di = z \left(\int_{i \in S_H} E_i N_i di \right), \quad (39)$$

and

$$\int_{i \in S_H} C_{i,f} di + \int_{j \in S_F} C_{j,f}^* dj + G_f + G_f^* + z \int_{j \in S_F} l_j^* dj = z \left(\int_{j \in S_F} E_j^* N_j^* dj \right). \quad (40)$$

Optimality in the production of the composite good of country H requires that the terms of trade, or relative price, $p \equiv \frac{P_f}{P_h}$, be equal to the relative consumption, $\frac{C_{i,h}}{C_{i,f}}$ (or $\frac{G_h}{G_f}$), times a relative preference factor, $\Theta = \frac{1-\alpha}{\alpha}$. A similar condition holds for the producers of the composite good of country F .

$$p_t = \Theta \frac{G_h}{G_f} = \Theta \frac{G_h^*}{G_f^*} \quad (41)$$

$$= \Theta \frac{C_{i,h}}{C_{i,f}} = \Theta \frac{C_{j,h}^*}{C_{j,f}^*}, \text{ for all } i \in S_H \text{ and } j \in S_F. \quad (42)$$

Using (41), (42), (39) and (40) we get

$$\frac{\alpha}{1-\alpha} p = \frac{\int_{i \in S_H} (E_i N_i - l_i) di}{\int_{j \in S_F} (E_j^* N_j^* - l_j^*) dj}. \quad (43)$$

This equation expresses the terms of trade as a function of the ratio between the amount of efficiency units of labor used in the production of the home good (net of the efficiency units used in credit services in country H) and the amount of efficiency units of labor used in the production of the foreign good (net of the efficiency units used in credit services in country F).

In general different households will choose different money consumption ratios as they have different initial wealth levels and efficiency levels. As such they will face different effective prices of consumption, which will result in different choices of hours. A redistribution of the initial wealth levels, or a change in the inflation rates will affect the choice of hours and in that way the terms of trade according to (43).

3 Numerical exercise

We take the interest rate, R , the initial wealth levels $\{A_i, A_j^*, E_i, E_j^*, B, B^*\}$ and the aggregate government expenditures vector, $\{G, G^*\}$, as exogenous variables. As we show below, the endogenous variables $\{C_i, C_{i,h}, C_{i,f}, l_i, N_i, m_i, w, G_h, G_h^*, \tau_c, C_i^*, C_{i,h}^*, C_{i,f}^*, l_i^*, N_i^*, m_i^*, w^*, G_f, G_f^*, \tau_c^*, p\}$, which are 21 in number, can be expressed as a function of the exogenous variables using 21 static equilibrium equations that we describe below.

The algorithm used to compute the equilibrium variables is simple. It has two stages. In the first stage we compute all the equilibrium variables for a set of tax rates $\{\tau_c, \tau_c^*\}$. In the second stage we check if the set of tax rates considered can be part of an equilibrium. Thus, we write l_i and $\frac{m_i}{C_i}$ from (20) and (21) as functions of C_i . Similarly we determine l_i^* and $\frac{m_i^*}{C_i^*}$ as functions of C_i^* . For a given vector $\{\tau_c, \tau_c^*, R\}$ the vector $\{C_i, N_i, w\}$ is determined from (26), (28) and (31) as a function of p , and similarly the vector $\{C_i^*, N_i^*, w^*\}$ is determined from (27), (29) and (32) as a function of p . Once we introduce the variables $\{N_i, l_i, N_i^*, l_i^*\}$, which we just determined as a function of p , in equation (43) we obtain the equilibrium value for p . Given the terms of trade, p , and the aggregates $\{C_i, C_i^*, G, G^*\}$ from (33)-(36), and (41)-(42) we obtain $\{C_{i,h}, C_{i,f}, C_{i,h}^*, C_{i,f}^*, G_h, G_h^*, G_f, G_f^*\}$. Finally, we check if the vector of tax rates $\{\tau_c, \tau_c^*\}$ satisfies the government budget constraints, (37) and (38). If not, we go back to stage one, in which we compute all the equilibrium variables for a new set of candidate tax rates. Each new candidate tax rate will be slightly lower if the public revenue exceeds the public consumption and it will be slightly higher otherwise. We keep iterating until (37) and (38) are satisfied.

We consider a simple open heterogeneous economy with no government and only two types of households in each economy, a rich household and a poor household. The households have the same efficiency levels, $E_i = 1$ for all i , but different wealth levels, the rich household has a larger initial wealth

than the poor household. The parameter values assumed are reasonable: we took $\beta = 0.97$, $\epsilon = 1$, $\chi = 2$, $\alpha = 0.5$, and $z = 1$.

We compare the values of the equilibrium variables of country H in the 10 percent nominal interest rate regime with the ones in the 2 percent nominal interest rate regime. Figures 1A and 1B show, for a given inequality of country F and a nominal interest of 10 percent, the country H equilibrium values for various degrees of inequality in this country. Figures 2A and 2B display the same information for the case when the nominal interest rate is 2 percent. In country F the initial wealth of the rich household is equal to six outputs of the country (in units of the composite good) and the initial wealth of the poor household is equal to one output of the country. This implies that the average household has an initial wealth of about 3.5 outputs. In country H we consider that the average household has an initial wealth of about 3.5 outputs too, but allow for many different distributions of the initial wealth. In Figures 1A-2B the inequality in country H is represented in the horizontal axis and it is measured in units of output. More precisely, the variable in the horizontal axis is the difference in the initial wealth between the rich and poor household. The extreme inequality considered is an initial wealth level equal to about 9 outputs for the rich household and -2 outputs for the poor household.

Heterogeneity plays an important role in the equilibrium. Figure 1A shows the effective price of consumption, levels, money to consumption ratios and the consumption tax rate for various levels of inequality. The poor household effective price decreases monotonically as inequality decreases, while the rich household price decreases initially, but after a certain level of inequality starts increasing as inequality decreases. As expected the consumption of the rich household decreases as his wealth decreases and the consumption of the poor household increases as his wealth increases. The money to consumption ratio of the rich family increases as inequality decreases while the money consumption ratio of the poor family only decreases when households become close to being equal. The behaviors of the money consumption ratios imply that the consumption tax rate decreases monotonically as inequality decreases. For the extreme value of inequality considered the tax rate was about just above 39 percent, while for the case of no inequality the tax rate was just above 32 percent. The large decrease in the tax rate, almost 7 percent points, associated with the reduction of inequality, is due to the fact that for the extreme inequality considered the rich household is using money in less than 10 percent of his transactions, while when households are equal

they are both using money in 95 percent of their transactions. The tax base of the inflation tax is larger when the households are more equal, and that allows for a decrease in the consumption tax rate.

Unsurprisingly, as Figure 1B shows, the ratio between the utility of the poor household and the utility of the rich household, and the sum of the two households utilities, both increase as inequality decreases. Production in country H , evaluated in units of the composite good, decreases as inequality decreases, while the terms of trade increase as inequality decreases. In country H the prices of the imported good are larger than of the exported good if inequality is larger in country H than in country F , and the opposite if inequality is larger in country F than in country H . The percentage increase in the terms of trade is 3.5 percent when inequality in country H decreases from 11 to 0.

Independently of the initial inequality in wealth, the change to a lower inflation regime benefits both rich and poor households. But the gains of changing to a lower inflation regime in efficiency and equity are larger the higher is the inequality in the country. This can be seen in Figures 2A-2B, which display the values of the relevant equilibrium variables in the two inflation regimes. The effective price of consumption is smaller for the poor household in the low inflation regime, and about the same for the rich household. The consumptions of rich and poor households are higher in the low inflation regime for all levels of inequality. The consumption tax rate is about the same in the two regimes for large degrees of inequality, but for more equitable distributions of wealth, as expected, it is much higher in the low inflation regime, to compensate the drop in seigniorage.

In the low inflation regime the terms of trade and production are independent of the wealth inequality. On the other hand, lower inflation promotes efficiency and equity as both are higher in the low inflation regime for all levels of inequality. Also, the gains on efficiency and on equity of the decline of inflation in the home country are larger the higher the degree of inequality in the home country.

The equilibrium variables in country H depend on the inequality in country F . This is shown in Figures 3A-3B, where we keep invariant the distribution of wealth in the home country and compute the equilibrium in country H for different distributions of wealth in the foreign country, when the nominal interest rate is 10 percent. We assume that in the home country the rich household has a wealth equal to six outputs of the country (in units of the composite good) and the initial wealth of the poor household is equal to

one output of the country. Thus, the average household in country H has an initial wealth of about 3.5 outputs. In country F we consider that the average household has an initial wealth of about 3.5 outputs too, but allow for many different distributions of the initial wealth, which is represented in the horizontal axis of the Figures 3A-3B. As before, the variable in the horizontal axis is the difference in the initial wealth between the rich and poor household, and the extreme inequality considered is an initial wealth level equal to about 9 outputs for the rich household and -2 outputs for the poor household.

Figure 3A shows that as the distribution of wealth in the foreign country becomes more equal, the consumptions in the home country increase for both types of households, which allows for a decrease in the consumption tax rate and the effective consumption prices. The money to consumption ratio decreases for the rich household as inequality in country F decreases because the rich household consumes more as inequality in country F decreases. Figure 3B shows that the the good produced in country H becomes more expensive as inequality decreases in country F , i.e. the terms of trade ($p \equiv \frac{p_f}{p_h}$) decrease as equality increases in country F . Moreover, Figure 3B shows that production in country H , efficiency in country H , and equity in country H increase. Thus, we conclude that in open economies, for a given distribution of characteristics in the home economy, the higher the inequality in the foreign country the lower are the efficiency and equity in the home country for a given interest rate. Also, the terms of trade decrease with the equality in the foreign country.

Additionally, we compare the effect on the efficiency and equity in country H , for various levels of inequality in country H of a redistribution in country F . Figure 4 shows the results for 3 distributions of inequality in country H : one in which the wealth levels are equal across households, one in which the rich household has an initial wealth level equal to 6 outputs and the poor household an initial wealth level equal to 1 output, and another in which the rich household has an initial wealth level equal to 9 outputs and the poor household has an initial wealth level equal to -2 outputs. We determine that the gains on efficiency and on equity in the home country of the decline in inequality in the foreign country are larger the higher the degree of inequality in the home country.

Finally, we look at how the interaction between the nominal interest rate and inequality in the foreign country affects efficiency and equality in the home country. Figure 5 shows for various levels of inequality in country F ,

the equity and efficiency levels for country H , for the nominal interest rates of 10 percent and 2 percent when the rich household in country H has an initial wealth of six outputs and the poor household one unit of output. We conclude that the gains on efficiency and on equity of the decline of inflation in the home country are larger the higher the degree of inequality in the foreign country.

We conclude that the effects on equity and efficiency of a change to a lower inflation regime are positive and larger, the higher is the inequality in the home country or in the foreign country. Moreover, the effects of a redistribution either in country H or in country F are larger, the higher is the inflation regime. Thus, for a high inflation and inequality the effects on equity and efficiency of a redistribution are similar to the effects of a change to a low inflation regime.

4 Conclusion

The aggregate equilibrium in a multi-country model is affected significantly by the heterogeneity in each country. Two groups of countries that are identical in everything, except on the exogenous households' wealth distribution, will have different aggregate equilibria. We obtain that a redistribution of wealth in a given country increases equity and efficiency in that country, but it also increases equity and efficiency in the other countries. Another important result is that common policy changes have idiosyncratic effects in the countries that are part of the monetary union. We investigate the effects of an inflation regime switch. A decrease in the target (steady state) inflation brings about an increase in efficiency and equity in all countries, but the magnitude of the effects depends on the level of the initial heterogeneity. The gains with the reduction in inflation are higher in the countries that have a larger exogenous initial heterogeneity. While in the literature it is already established a connection between inflation and inequality, there is to our knowledge no strong results on how the relation between changes in inflation and the aggregate outcome is influenced by the underlying heterogeneity.

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Figure 1A
 Variables of country H for a nominal interest rate of 10%,
 the distribution of the initial wealth in country F is fixed, while it varies in country H,
 (the difference in the initial wealth between the two groups is in the horizontal axis)

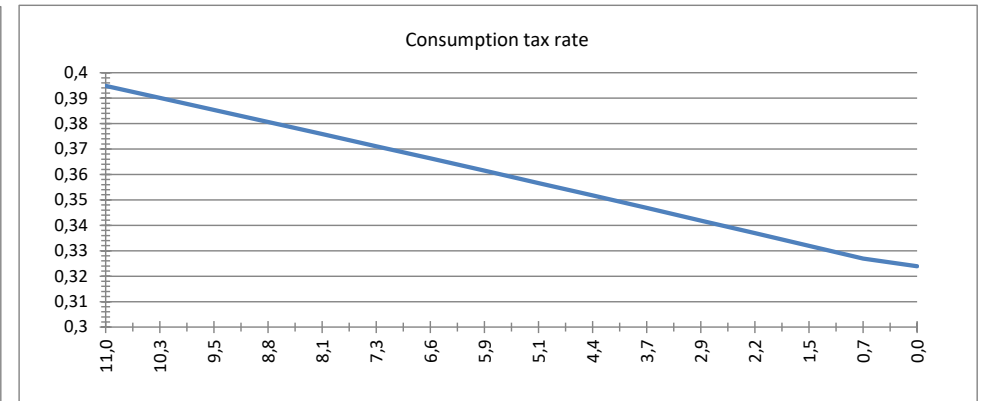
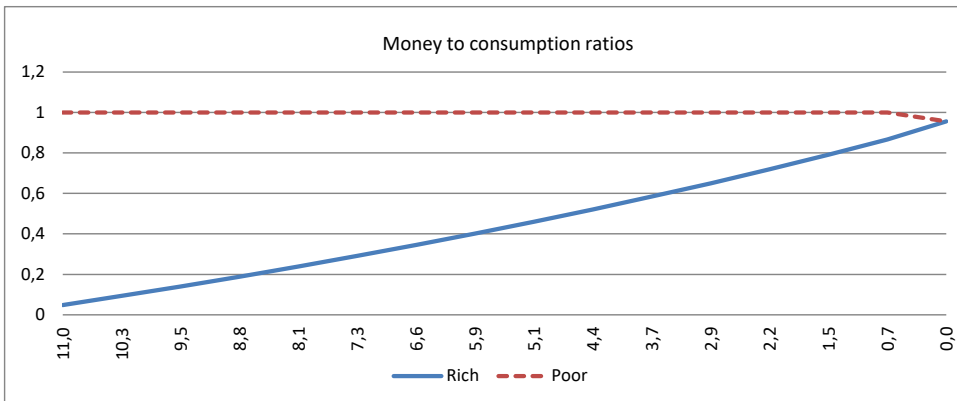
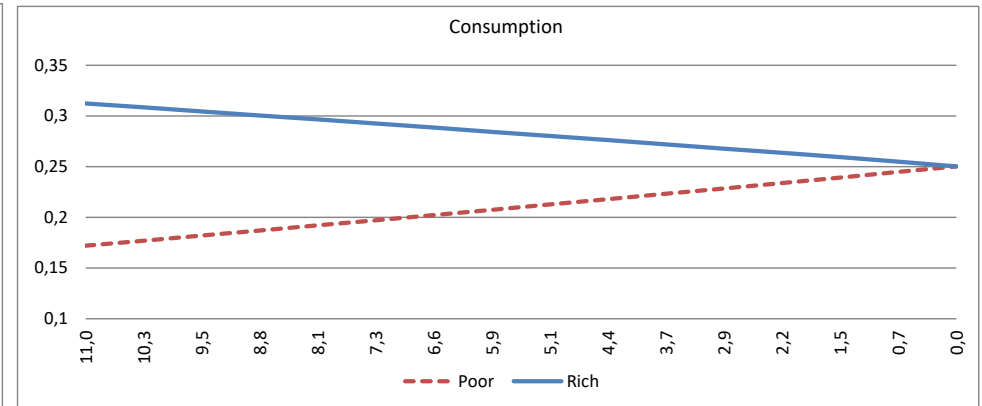
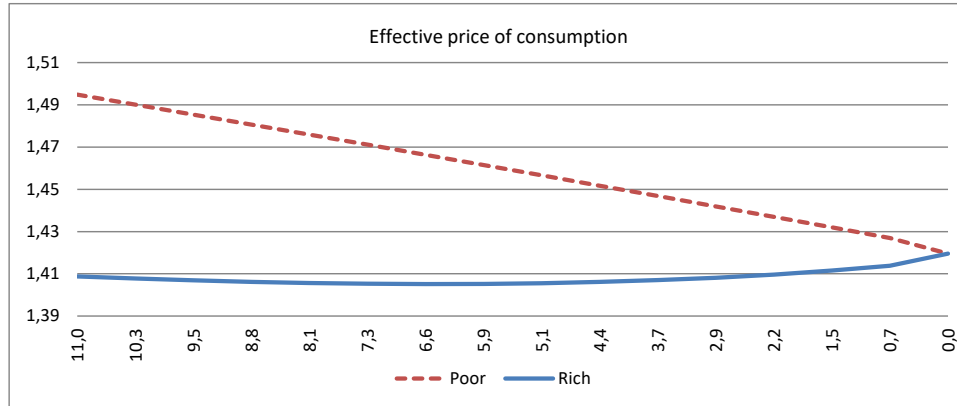


Figure 1B
 Variables of country H for a nominal interest rate of 10%,
 the distribution of the initial wealth in country F is fixed, while it varies in country H,
 (the difference in the initial wealth between the two groups is in the horizontal axis)

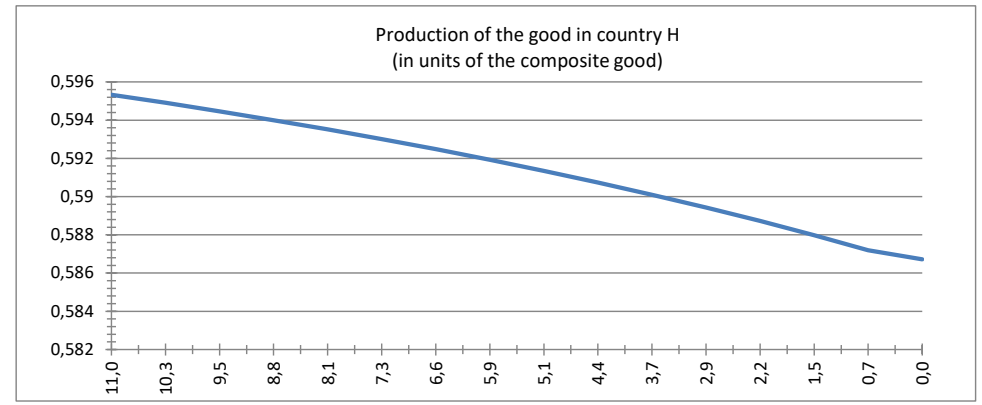
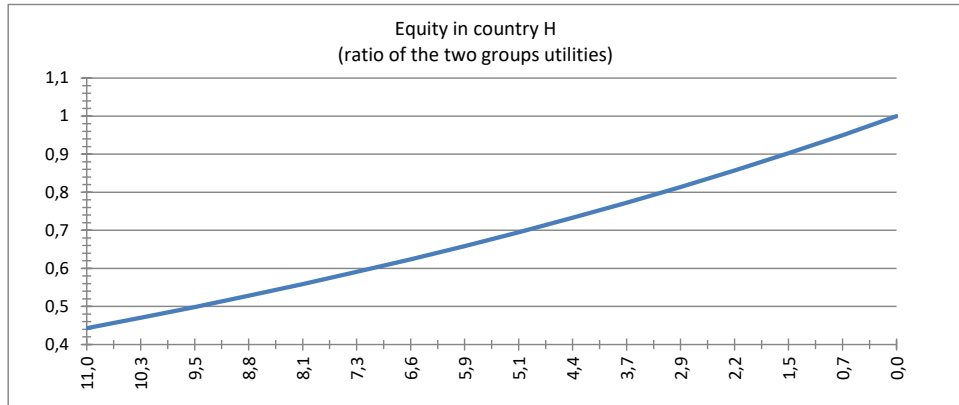
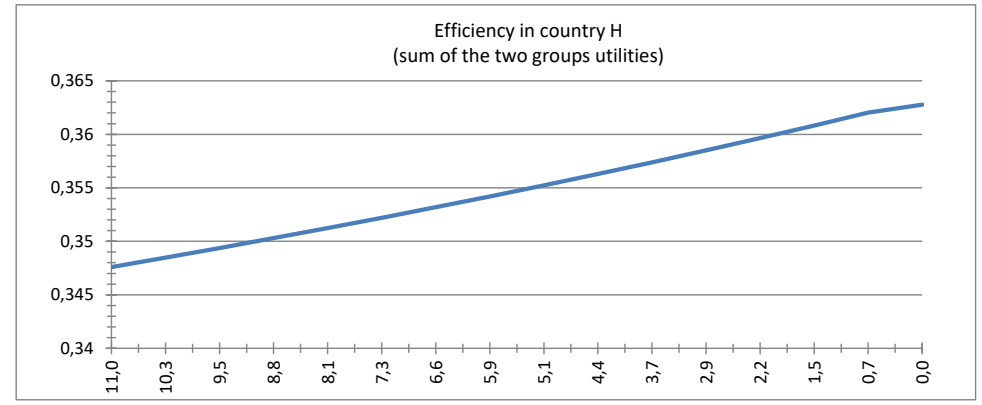
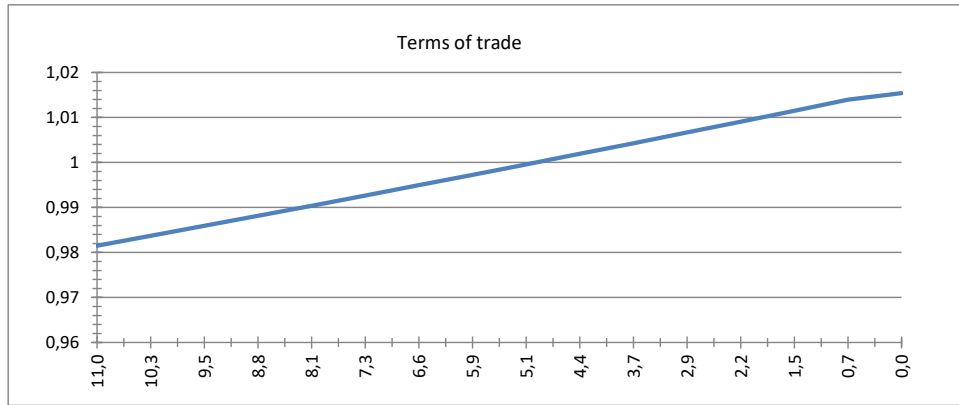


Figure 2A
 Variables of country H
 the distribution of the initial wealth in country F is fixed, while it varies in country H,
 (the difference in the initial wealth between the two groups is in the horizontal axis)

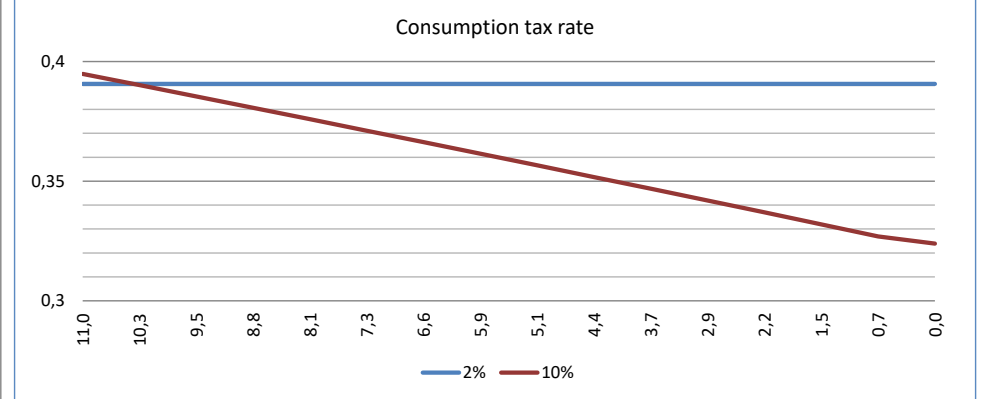
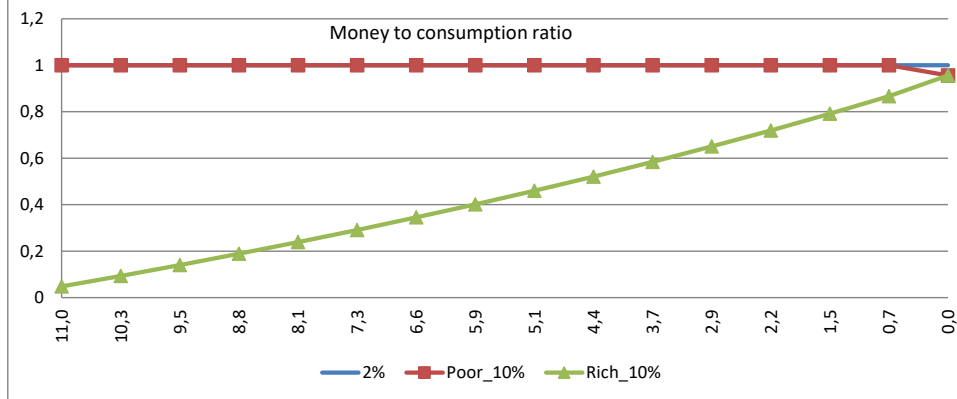
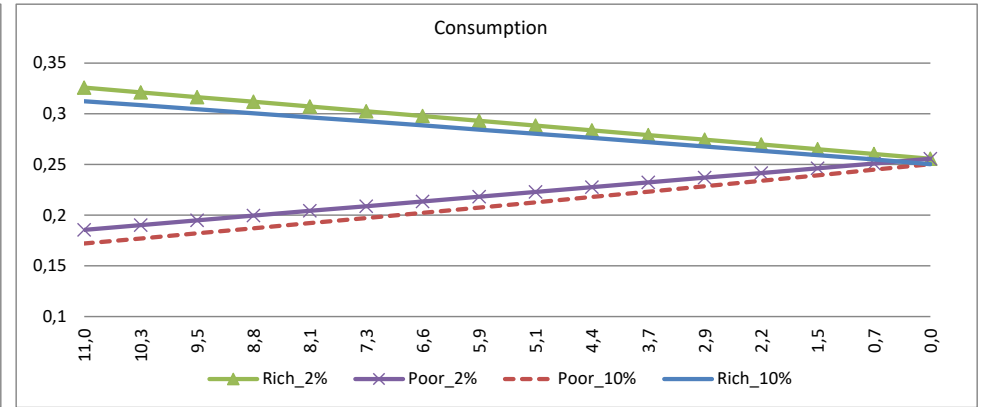
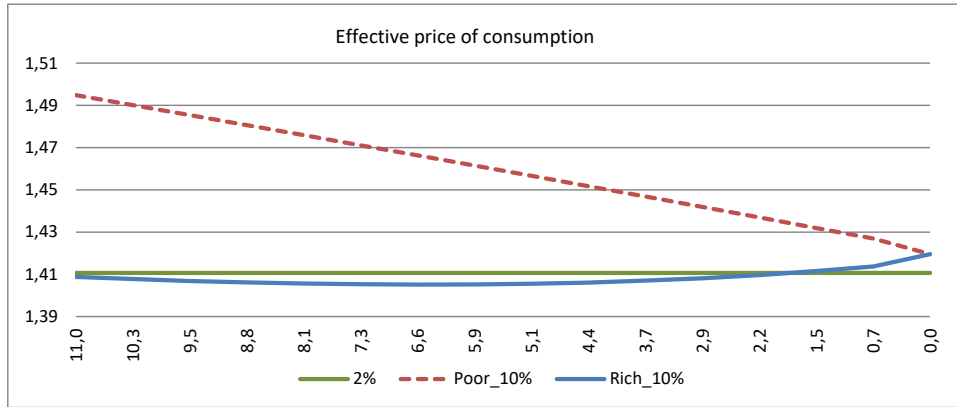


Figure 2B
 Variables of country H,
 the distribution of the initial wealth in country F is fixed, while it varies in country H,
 (the difference in the initial wealth between the two groups is in the horizontal axis)

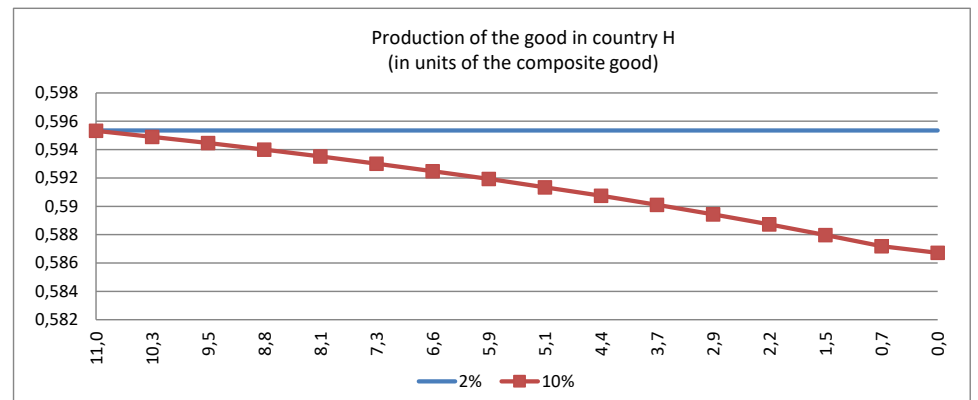
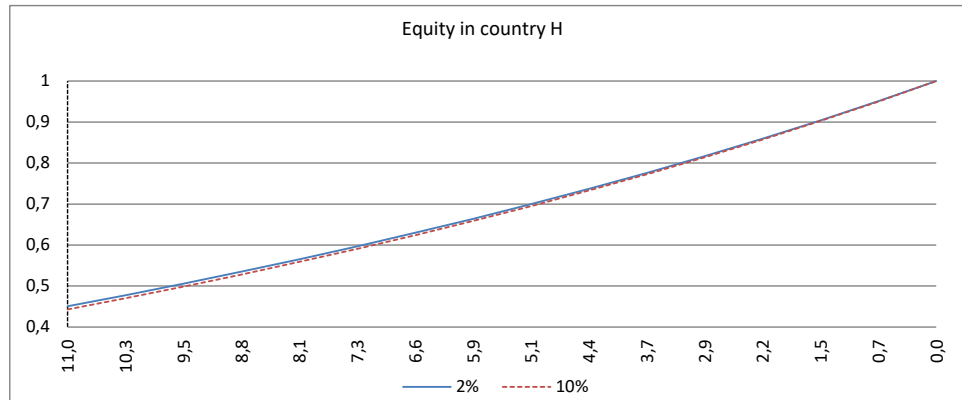
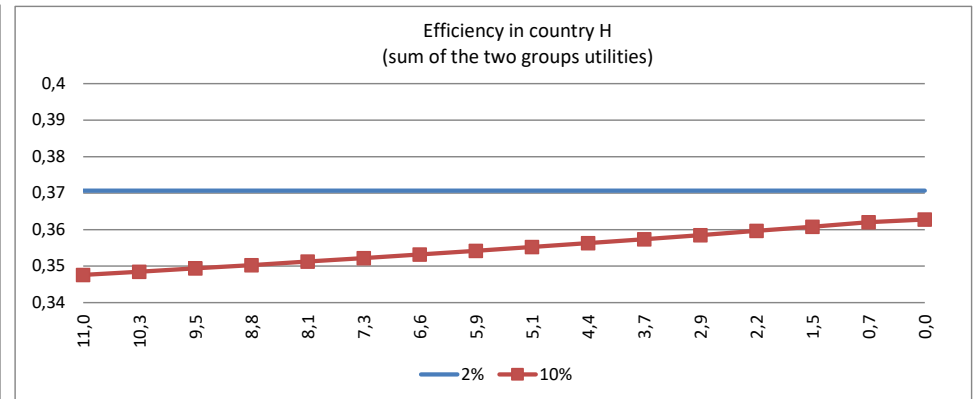
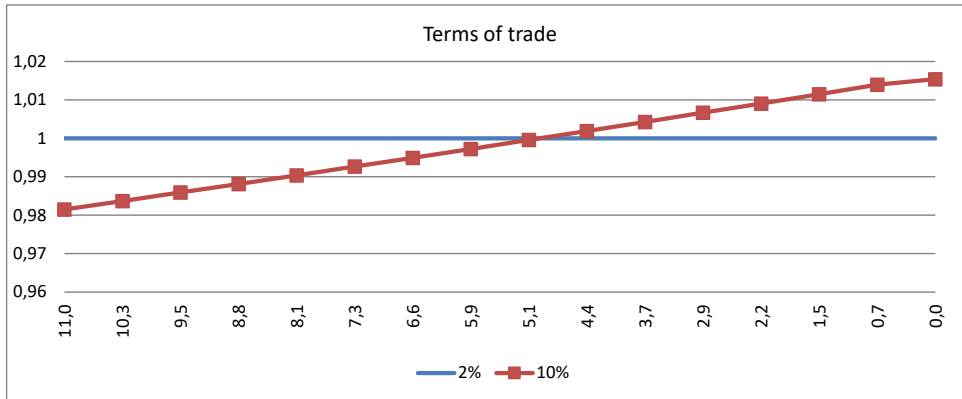


Figure 3A
 Variables of country H for a nominal interest rate of 10%,
 the distribution of the initial wealth in country F changes, while it is constant in country H,
 (the difference in the initial wealth between the two groups is in the horizontal axis)

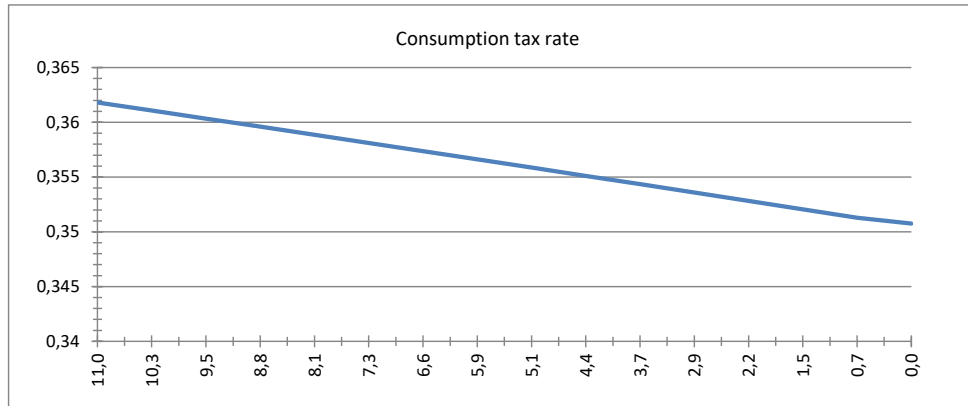
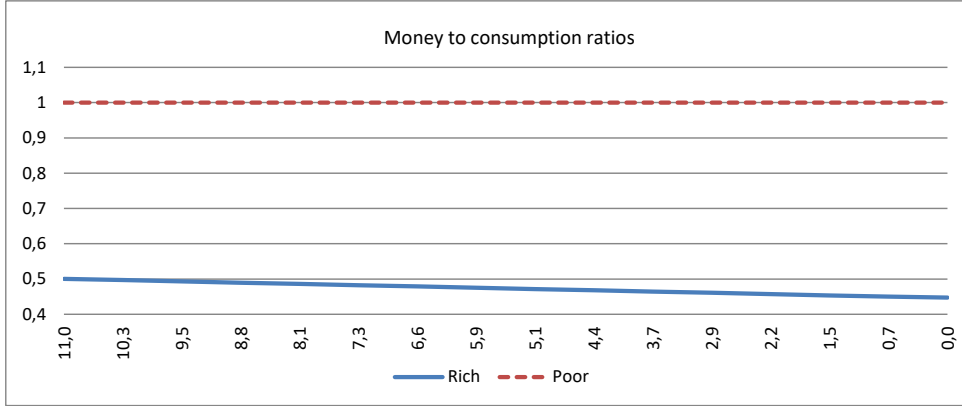
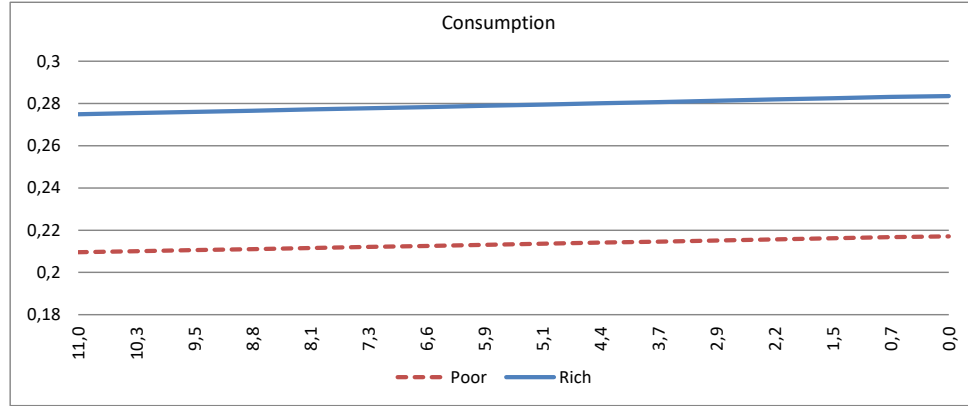
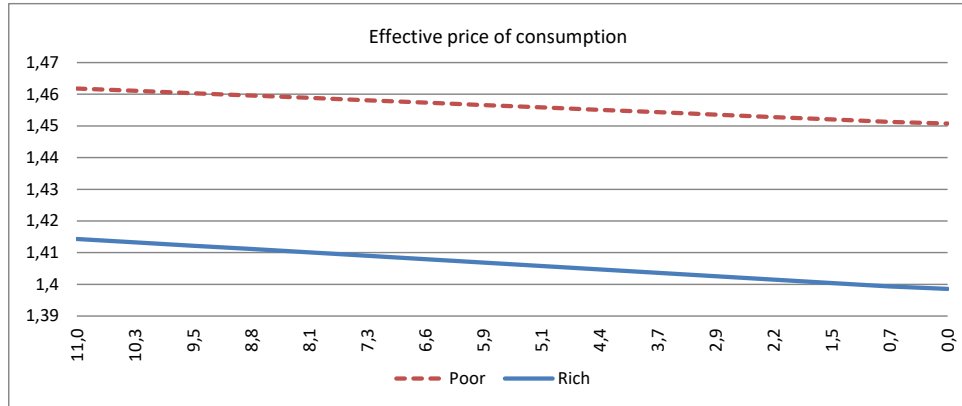


Figure 3B
 Variables of country H for a nominal interest rate of 10%,
 the distribution of the initial wealth in country F changes, while it is constant in country H,
 (the difference in the initial wealth between the two groups is in the horizontal axis)

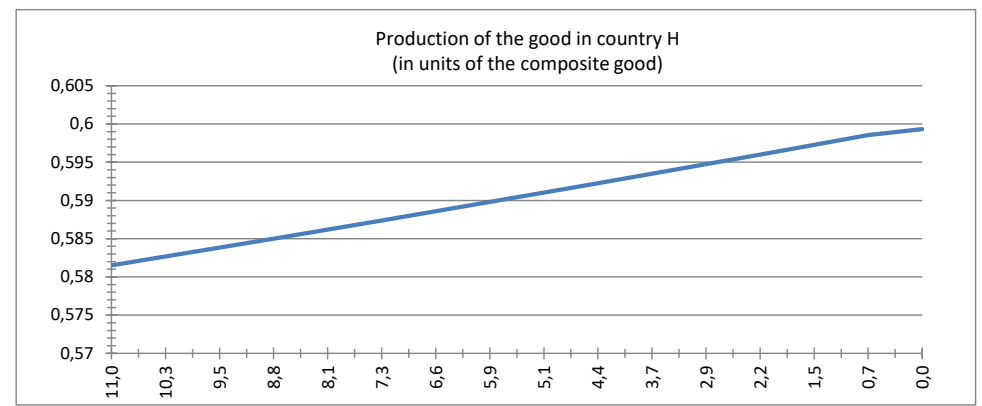
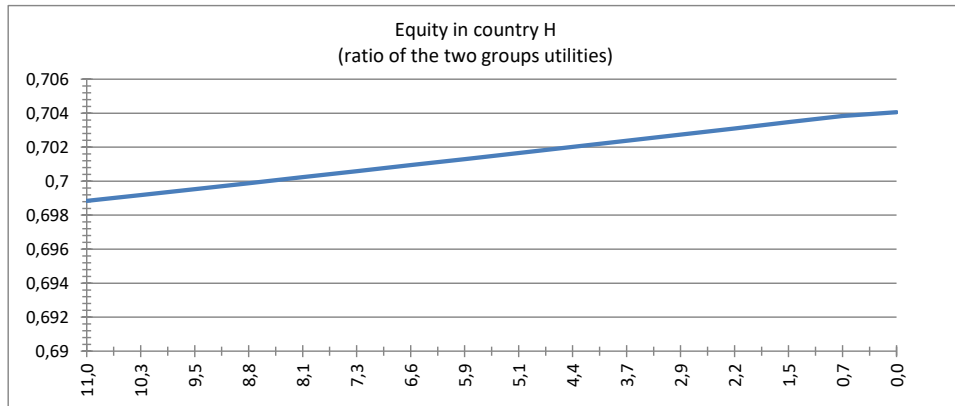
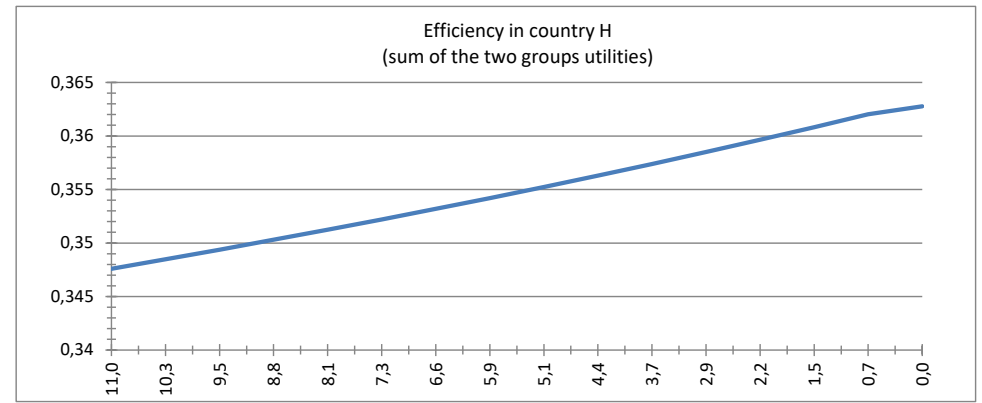
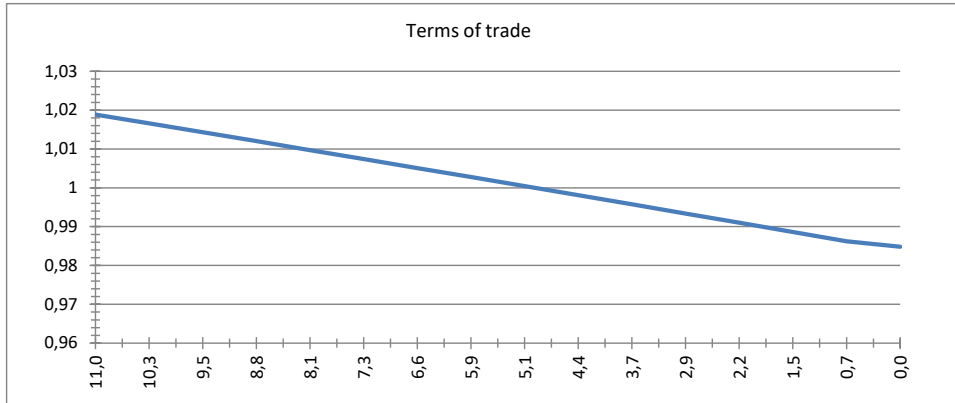


Figure 4
 Variables of country H for a nominal interest rate of 10%,
 the distribution of the initial wealth in country F changes, while it is constant in country H,
 (the difference in the initial wealth between the two groups is in the horizontal axis)

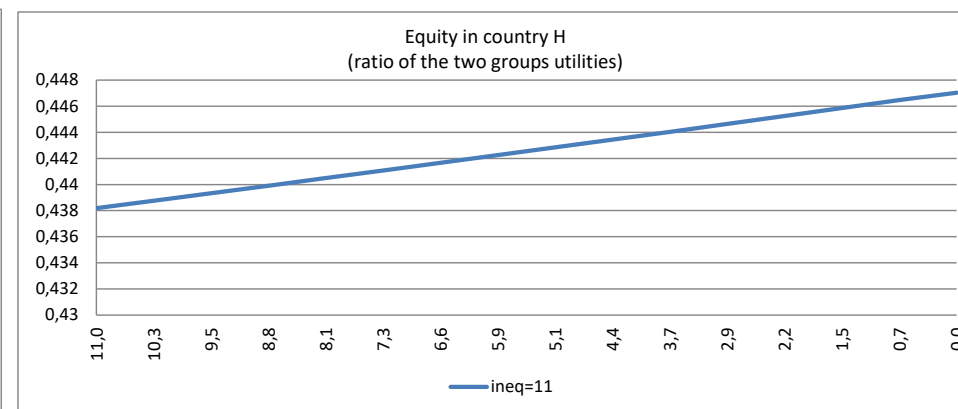
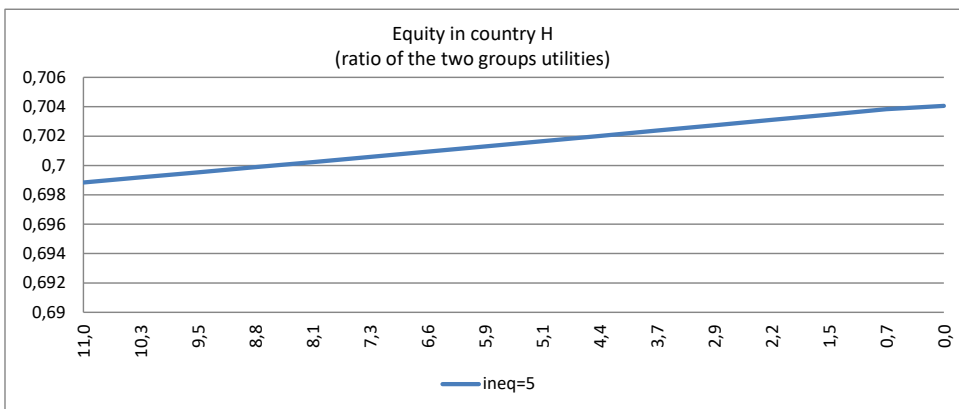
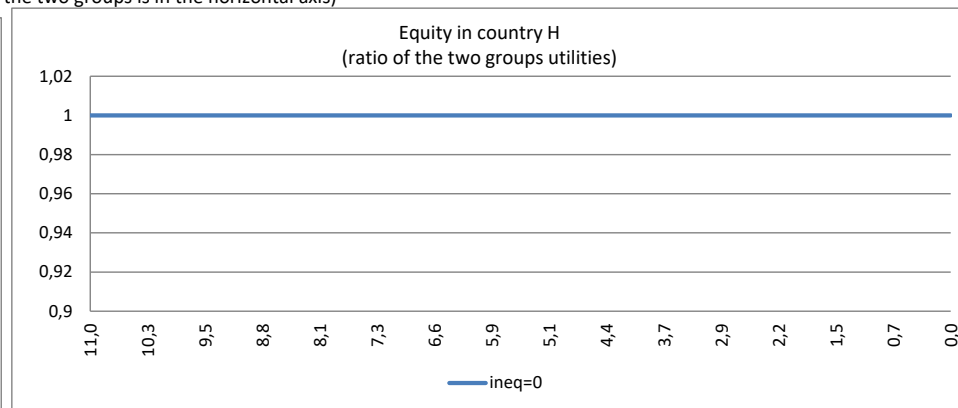
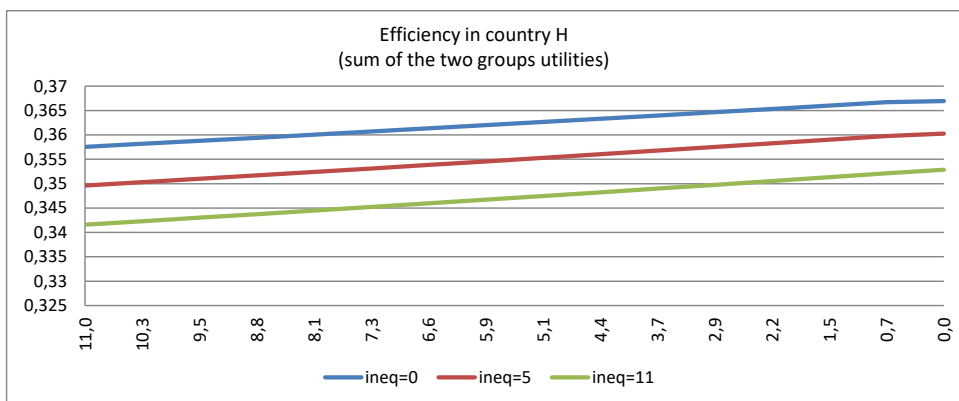


Figure 5
Variables of country H,
the distribution of the initial wealth in country F changes, while it is constant in country H,
(the difference in the initial wealth between the two groups is in the horizontal axis)

