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Inequality and Structural Change under Non-Linear Engels' Curve

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Abstract: We analyze the relationship between income inequality and structural change in the sectoral composition of the tradable and the non-tradable sectors. We construct a small open economy two sector model where preferences imply non-linear Engel curves and we show that the relationship between income inequality and structural change crucially depends on the non-linearity of the Engel curves. We calibrate this model to the US economy in the period 1960-2010 and we show that it explains the observed patterns of structural change in terms of the sectoral composition of consumption and employment, it also explains the increase in inequality measured by the Gini index and, finally, it is consistent with the large reduction in the trade balance. From the analysis of several counterfactual exercises, we obtain the following insights: (i) income inequality contributes to explain structural change and reduces GDP when Engel curves are non-linear; (ii) asset accumulation and the time path of GNP do not depend on the level of inequality, but on the evolution of income inequality; and (iii) a rising inequality implies a faster accumulation of assets, a larger growth of GNP and a faster deterioration of the trade balance.

JEL Codes: O41, O47.

Keywords: Income inequality, Structural change, Engel curves.

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1 Introduction

Income inequality has increased in most countries, in particular in advanced economies, in the last decades.[1] The macroeconomic effects of a rising inequality is then an obvious relevant issue. The macroeconomic literature has already studied empirically and theoretically the effect that income inequality has on the growth rate of gross domestic product (GDP).[2] Our aim in this paper is to contribute to this literature by analyzing the effect that inequality can have on the sectoral composition. More precisely, we want to explore if the rising income inequality has contributed to the reduction in the size of the tradable sector, which basically corresponds to the agriculture and manufacturing sectors. Figure 1 shows the time path of the share of employment in the tradable sector in several economies. It clearly shows that the reduction in the tradable sector is a general phenomenon during the last decades.

Recently, there has been a renewed interest in the growth literature on the determinants of the sectoral composition of employment and GDP. A stream of contributions has highlighted the role of income effects associated with economic development as the main driver of structural change in sectoral shares (Matsuyama, 1992; Laitner, 2000; Kongsamut et al., 2001; Foellmi and Zweimuller, 2008; Dennis and Iscan, 2009; Herrendorf et al. 2013, 2014; Alonso-Carrera, J. and Raurich, X., 2015, 2016). These income effects arise when preferences are non-homothetic. Some others have focused on the supply side pointing out the role of substitution effects in demand associated to relative price changes (Ngai and Pissarides, 2007; Acemoglu and Guerrieri, 2008; Moro, 2012; Alvarez-Cuadrado, et al. 2017, Herrendorf et al., 2015; Felice, 2016). Finally, Matsuyama (2009), Teignier (2014), Sposi (2012) and Uy et al. (2013) also propose that international trade has affected this process of structural change.[3]

None of the aforementioned papers consider the increase in income inequality that most advance economies exhibited in this period as another driver of this process of structural change. But if income effects are at work on the demand side, also income inequality might matter, since rich and poor people choose different consumption bundles. Only a few papers in the literature have considered the effect of inequality on the sectoral composition. Falkinger and Zweimuller (1997) and Foellmi and Zweimuller (2006) show a positive relationship between income inequality and product diversity. However, they do not analyze the structural change between the tradable and non-tradable sectors. Boppart (2014) in order to quantify the relative weight of supply side and demand side determinants of structural change, introduces PIGL preferences,

[1] Banerjee and Duflo (2000), Easterly (2007), Bertola et al. (2005), Quadrini and Rios-Rull (2014) among many others provide evidence on these patterns of inequality.

[2] See Banerjee and Duflo (2000), Bertola, Foellmi and Zweimüller (2005), Easterly (2007), Foellmi and Zweimüller (2006), among many others.

[3] Recently, some contributions have made an attempt to jointly consider income effects and relative productivity dynamics in order to quantify the relative contribution of the above mentioned mechanisms (Boppart, 2014; Comin et al., 2015). In general both channels emerge as relevant drivers, but a wide consensus has been reached in particular on the role of income effects in driving substantially the process of structural change.

showing that income inequality affects the sectoral composition of employment when Engel curves are non-linear.[4] In this case, the aggregate demand of each sector depends on both the level of total income of the economy and it also depends on the degree of income inequality. Hence, cross-country differences in income inequality may contribute to explain differences in the sectoral composition. However, in his framework, income inequality is constant and, hence, he cannot study the effects of a rising income inequality on structural change, which is our purpose in this paper.

We provide evidence showing the effect of inequality on the sectoral composition. Figure 2 shows the partial regression plot between sectoral composition and income inequality emerging from a cross-country analysis using an unbalanced panel of 29 countries for the period 1962-2011. In particular, it plots the relationship between the residual (log) employment in the tradable sector, i.e. manufacturing and agriculture, as a share of total employment and the residual (log) Gini index, after partialling out the GDP per capita, the relative price, a proxy of a country's openness, and country and year fixed effects.[5] The slope of the log-linear fit, representing the elasticity of the employment share of the tradable sector to inequality (0.21), shows a negative relationship between the two variables. The inclusion of GDP per capita, relative prices and openness as control variables is aimed to capture the classical drivers of structural change that the literature has already considered. Therefore, the coefficient of the Gini index represented in Figure 2 should capture the income inequality effect. This descriptive evidence suggests that an increase in inequality contributes to explain the reduction in the employment share in the tradable sector.

We study the structural change between the tradable and the non-tradable sectors in a small open economy. By analyzing a small open economy we have a framework suitable to investigate not only the dynamics of the sectoral composition and the GDP per capita, but also those of the Gross National Product (GNP) and the external position of a country. The preferences considered belong to the class of non-Gorman preferences, which are a particular class of non-homothetic preferences that imply non-linear Engel curves. Hence, two different mechanisms drive the process of structural change between the tradable and the non-tradable sector. The first mechanism is the classical income effect, highlighted by the literature as one of the main determinants of structural change, explaining a large part of the increase in the non-tradable sector. This mechanism is based on an income elasticity of the demand of non-tradable goods larger than one. As a consequence, as the economy develops, resources are shifted towards the non-tradable sector. Income elasticities different from one arise when preferences are non-homothetic, which is the case in our paper.

The second mechanism considered in this paper is the rising income inequality. We assume that income inequality is caused by both labor earnings inequality and initial wealth inequality. Therefore, the interaction between sav-

[4] Foellmi and Zweimüller (2008) introduce non-linear Engel curves in models of structural change with a representative agent.

[5] See Appendix C for a description of the data, details on the methodology and further analysis on a larger sample of countries.

ings decisions and the initial inequality drives the evolution of income inequality during the transition. The evolution of income inequality drives structural change when Engel curves are non-linear.

Under our preference structure the consumption share for the tradable good is decreasing with both income and income inequality, in line with the evidence provided by previous literature (Herrendorf et al. 2014; Boppart, 2014) and our elaborations shown above. We assume that the technology in both sectors, tradable and non-tradable, is Cobb-Douglas with constant returns to scale. Consistent with the empirical findings of Valentinyi and Herrendorf (2008), we assume that the capital output elasticity is larger in the tradable sector. As a consequence, the process of structural change that reduces the tradable sector shifts employment towards the labor intensive sector, which negatively affects the level of GDP in this economy.

As we assume a small open economy, GDP and GNP may follow a different time path. On the one hand, as before mentioned, the process of structural change deters GDP. On the other hand, assets' accumulation implies that GNP is growing faster in the numerical simulation that fits the evolution of inequality and structural change of the US economy in the period 1960-2010. The differential evolution of GDP and GNP obviously implies that trade deficit worsens, which is a pattern observed in the US economy during the period analyzed. Therefore, the numerical simulation of the model calibrated to the US economy explains the observed patterns of structural change in the US in terms of the sectoral composition of consumption and employment, it also explains the increase in inequality measured by the Gini index and, finally, it is consistent with the large reduction of the trade balance.

In order to obtain insights on the effects that income inequality has in this economy, we perform several counterfactual exercises. In a first exercise, we compare the calibrated economy with two counterfactual economies: one with linear Engel curves, where only the income effect drives structural change, and another one with homothetic preferences, where there is no structural change in the sectoral composition of consumption. From the comparison among these three economies, we show that the increase in income inequality contributes to explain structural change and the effects on GDP only when Engel curves are non-linear.

In a second exercise, we compare the calibrated economy, where inequality is rising, with two counterfactual economies that have constant inequality levels. We obtain two main insights from this exercise. First, we show that the level of inequality does not affect assets' accumulation and, hence, it does not affect the time path of GNP. Second, we show that the differences in the dynamics of income inequality affect both the process of assets' accumulation and also the time path of GNP. As a consequence, the differences in the dynamics of income inequality may have an important effect on the trade balance. In the numerical exercise, we show that a rising inequality implies a faster accumulation of assets, a larger growth of GNP and, hence, a faster deterioration of the trade balance.

In a third numerical exercise, we compare economies with permanently different levels of income inequality when Engel curves are linear and when they are not. We show that the linearity of the Engel curve determines the effect of inequality on structural change and on GDP, whereas it does not determine the effect of inequality on assets' accumulation and GNP. Finally, in the last numerical exercise, we compare two economies with transitory differences in the levels of income inequality. As a consequence, these economies are differentiated in the level of inequality and also in the dynamics of this inequality. The interaction between these two differences implies that the employment share in the tradable sector is initially smaller in the more equal economy, but eventually becomes larger. This result outlines that not only the level of income inequality but also its evolution determine the sectoral composition of GDP. The main contribution of this paper is to show that cross-country differences in the dynamics of income inequality also contribute to explain cross-country differences in both structural change and on GNP.

The rest of the paper is organized as follows. Section 2 introduces the model and Section 3 characterizes the equilibrium. Section 4 solves the model numerically and obtains the main results. Finally, Section 5 includes some concluding remarks.

2 Model

We consider a small open economy populated by a constant number I of infinitely lived individuals. Individuals differ in their endowments of efficiency units of labor and of initial assets. We also assume that there is a wide-world capital market, where individuals of our economy can borrow or lend by selling or buying equities from residents of others economies. Finally, we consider a tradable and a non-tradable sector.

2.1 Technology

We distinguish two sectors in a small open economy. One sector, denoted by Sector 1, produces a good that is tradable, whereas the other sector, Sector 2, produces a non-tradable good.

The two sectors produce with the following constant returns to scale production functions:

$$Y_j = (s_j K)^{\alpha_j} (u_j L A_j)^{1-\alpha_j},$$

where Y_j is the good produced in each sector, s_j is the fraction of capital K employed in sector j, u_j is the fraction of efficiency units of labor L employed in sector j, A_j measures the total factor productivity (TFP) in sector j, and α_j is the capital output elasticity in the sector. Consistently with the empirical evidence, we assume that Sector 1 is the capital intensive sector and Sector 2 is the labor intensive sector, we assume that $\alpha_1 > \alpha_2$. $L = \Sigma_{i=1}^{I} l_i$, where l_i are the efficiency units of labor of individual i.

Given that the economy is open and small, the interest rate r is exogenously set in the world capital markets. From the first order conditions of the profit maximization problem in a perfect competition model, we obtain the wage per efficiency unit, w, and the relative price p of goods produced in sector 2 in units of goods produced in sector 1 as the following functions of the interest rate:

$$w = A_1 (1 - \alpha_1) \left(\frac{r}{\alpha_1} \right)^{\frac{\alpha_1}{\alpha_1 - 1}},$$

and

$$p = \left(\frac{r}{\alpha_2} \right)^{\alpha_2} \left(\frac{1 - \alpha_1}{1 - \alpha_2} \right)^{1-\alpha_2} \left(\frac{r}{\alpha_1} \right)^{\frac{\alpha_1(1-\alpha_2)}{\alpha_1 - 1}} \left(\frac{A_1}{A_2} \right)^{1-\alpha_2}.$$

From using the first order conditions with respect to employment, we obtain production in each sector as a function of the wage

$$Y_1 = \frac{u_1}{1 - \alpha_1} w \qquad \text{and} \qquad Y_2 = \frac{u_2}{1 - \alpha_2} \frac{w}{p} \tag{1}$$

Finally, gross domestic product (GDP) is equal to

$$Q = Y_1 + pY_2 = \left(\frac{u_1}{1 - \alpha_1} + \frac{u_2}{1 - \alpha_2} \right) w.$$

Two important remarks follow from the previous expressions. First, the relative price is constant in a small open economy unless we assume a process of biased technological change. For the sake of simplicity, we assume that TFP remains constant in both sectors and, hence, the relative price is constant in this model. This also implies that sustained growth is assumed away. Second, the expression of GDP implies that structural change, by placing more workers in the labor intensive sector, reduces GDP.

2.2 Households

Households have identical preferences that are assumed to be defined by the following non-homothetic utility function:

$$u_i = \frac{\theta}{\sigma_1} \log \left(c_{1,i}^{\sigma_1} - \eta_1 \right) + \frac{1 - \theta}{\sigma_2} \log \left(c_{2,i}^{\sigma 2} - \eta_2 \right), \tag{2}$$

where $c_{j,i}$, $j = 1, 2$, is consumption by household i of the commodity produced in sector j, η_j is interpreted as the minimum consumption requirement when it takes positive values and as home production when it takes negative values, $\theta \in (0, 1)$ measures the weight of each consumption good in the utility function, and σ_j is a preference parameter that can be either positive or negative. This utility function is well defined, monotonically increasing, jointly concave in its two arguments and exhibits a positive intertemporal elasticity of substitution (IES) if the following assumption is satisfied:

Assumption A. For all i and $j = 1, 2$, (i) $c_{j,i}^{\sigma_j} > \eta_j$ and (ii) $c_{j,i}^{\sigma_j} > (1 - \sigma_j) \eta_j$.

Households obtain in every period capital income, ra^i, and labor income, wl^i. With this income, they consume and invest. Therefore, the budget constraint of a household is

$$\dot{a}_i = wl_i + ra_i - p\kappa\left(a_i\right) - c_i, \tag{3}$$

where $c_i = c_{1,i} + pc_{2,i}$ is individual consumption expenditures and $\kappa\left(a_i\right)$ is a convex asset holding cost that satisfies

$$\kappa = a_i \phi e^{\psi \frac{wl_i}{a_i}}, \text{ where } \phi > 0 \text{ and } \psi > 0.$$

As in Neumeyer and Perri (2005) and Schmitt-Grohe and Uribe (2003), this cost is introduced to obtain a unique steady state. Note that $\phi e^{\psi \frac{wl_i}{a_i}}$, the unitary cost, is increasing in the labor income of the individuals and decreasing in the assets of the individuals. On the one hand, as individuals labor earnings increase, their opportunity cost of managing their assets increases and, hence, they demand more financial services. These services are produced in the non-tradable sector and, as a consequence, they enter in the individual budget constraint multiplied by the relative price. On the other hand, the unitary cost is decreasing in the level of assets. It follows that the asset holding cost κ is a parabola with respect to a, as in Neumeyer and Perri (2005). The value of a_i that minimizes the cost κ is a proportion ψ of the labor income. Finally, the parameter ϕ measures the intensity of the asset holding cost.

Households maximize the discounted sum of flow utilities subject to the budget constraint (3), where the flow utility is defined in (2) and we define by $\rho > 0$ the constant subjective discount rate. The solution to this maximization problem consists of both an intra-temporal and an inter-emporal decision. The former is obtained from the equality between the marginal rate of substitution between the two consumption goods and the relative price, which implies

$$\left(\frac{c_{2,i}^{\sigma_2 - 1}}{c_{1,i}^{\sigma_1 - 1}}\right)\left(\frac{c_{1,i}^{\sigma_1} - \eta_1}{c_{2,i}^{\sigma_2} - \eta_2}\right)\left(\frac{1-\theta}{\theta}\right) = p. \tag{4}$$

The intertemporal decision is obtained from the Euler condition, which implies

$$\frac{\dot{c}_{1,i}}{c_{1,i}} = \Omega_{1,i}\left(r - p\kappa'\left(a_i\right) - \rho\right),$$

$$\frac{\dot{c}_{2,i}}{c_{2,i}} = \Omega_{2,i}\left(r - p\kappa'\left(a_i\right) - \frac{\dot{p}}{p} - \rho\right),$$

where

$$\Omega_{j,i} = \frac{c_{j,i}^{\sigma j} - \eta_j}{c_{j,i}^{\sigma j} + \eta_j\left(\sigma_j - 1\right)},$$

and $\kappa'\left(a_i\right)$ is the marginal asset holding cost.

At this point, we define $\mu_i = c_{1,i}/\, c_i$ as the individual expenditure share in tradable goods on total expenditure. By using the Euler conditions, the growth rate of the individual total consumption expenditure is given by

$$\frac{\dot{c}_i}{c_i} = \Omega_i \left(r - p\kappa'\left(a_i\right) - \rho\right) + \left(1 - \Omega_{2,i}\right)\left(1 - \mu_i\right)\frac{\dot{p}}{p}, \tag{5}$$

where

$$\Omega_i = \mu_i \Omega_{1,i} + \left(1 - \mu_i\right)\Omega_{2,i}. \tag{6}$$

The variable Ω_i is the intertemporal elasticity of substitution (IES), which is individual specific. As a consequence, the effect of interest rate changes on consumption growth generally depends on income inequality.[6]

2.3 Engel curve

In this model, structural change in the sectoral composition of consumption expenditures depends on both total income and income distribution. The first mechanism depends on the non-homotheticity of preferences, whereas the second mechanism is based on the non-linearity of the Engel curve. In this section, we identify these two channels by characterizing the parameter conditions for which the Engel curve is non-linear. This curve describes the relationship between the amount consumed of the commodity produced in Sector 1, $c_{1,i}$, and total consumption expenditures, c_i. From using the definition of the individual expenditure share, μ_i, the Engel curve is defined as $c_{1,i} = \mu_i\left(c_i\right)c_i$, where μ_i is obtained implicitly, by using (4), as a function of total consumption expenditures from the following equation:

$$\left(\frac{\left(1-\mu_i\right)^{\sigma_2 - 1}}{\mu_i^{\sigma_1 - 1}} c_i^{\sigma_2 - \sigma_1}\right)\left(\frac{\mu_i^{\sigma_1} c_i^{\sigma_1} - \eta_1}{\left(1-\mu_i\right)^{\sigma_2} c_i^{\sigma_2} - p^{\sigma_2}\eta_2}\right) = \frac{\theta}{1-\theta}. \tag{7}$$

The Engel curve is linear in two different cases: (i) if $\eta_j = 0$ for $j = 1, 2$; and (ii) if $\sigma_j = 1$ for $j = 1, 2$. In the first case, the Engel curve is a linear ray that emanates from the origin as preferences are homothetic. In the second case, preferences are Stone-Geary, and the Engel curve is linear although it does not emanate from the origin. In this second case, structural change is only driven by total income growth. As it is well-known, in both cases, preferences are Gorman, meaning that the aggregate consumption of one good depends on the aggregate income, but it does not depend on the distribution of income. Thus, the sectoral composition does not depend on the income distribution in these two cases.[7]

[6] The effect of the interest rate on aggregate savings, measured by the aggregate IES, depends on the income distribution when the preferences are characterized by the utility function (2), $\sigma_j \neq 1$ and $\eta_j \neq 0$. If $\sigma_j = 1$ then $\Omega_i = \frac{c_i - \bar{c}}{c_i}$ where $\bar{c} = \eta_1 + p\eta_2$ and if $\eta_j = 0$ then $\Omega_i = 1$. In these two particular cases, aggregation is possible meaning that the aggregate IES does not depend on the income distribution.

[7] Gorman preferences, i.e. preferences implying linear Engel curves, are characterized by an aggregation property such that the consumption emerging from aggregating the individuals' consumption choices coincides with the consumption choice of a representative agent (Pollak, 1974).

In contrast, the Engel curve is non-linear if $\eta_j \neq 0$ and $\sigma_j \neq 1$ for at least $j = 1$ or $j = 2$. In this case, the sectoral composition of the economy depends on income distribution. If the Engel curve relating $c_{1,i}$ with c_i is concave then an increase in inequality shifts the sectoral composition towards Sector 2, whereas the opposite occurs when the Engel curve is convex. This result is shown in Figure 3 that compares two economies with the same level of total consumption expenditures but different inequality. Panel (a) displays a concave Engel curve and shows that c_1 is smaller in the more unequal economy. Panel (b) displays a convex Engel curve and shows the opposite result.

Therefore, the relation between sectoral composition and inequality depends on the concavity of the Engel curve. As the empirical evidence suggests the sectoral composition shifts towards sector 2 when inequality rises, we will assume that the Engel curve relating $c_{1,i}$ with c_i is concave. We proceed to obtain parameter conditions for which the Engel curve is concave. To this end, we introduce the following simplifying assumption:

Assumption B. $\sigma_2 = 1$ and $\eta_2 = 0$.

Proposition 1 *If Assumptions A and B hold, then the Engel curves relating* $c_{1,i}$ *with* c_i *and* $c_{2,i}$ *with* c_i *satisfy:*

1. *Both are linear if either* $\sigma_1 = 1$ *or* $\eta_1 = 0$ *and they are non-linear otherwise.*
2. *Both are increasing.*
3. *If* $(1 - \sigma_1)\,\eta_1\sigma_1 > (<)\,0$ *the Engel curve relating* $c_{1,i}$ *with* c_i *is concave (convex) and the Engel Curve relating* $c_{2,i}$ *with* c_i *is convex (concave).*

The following proposition provides conditions for which the expenditure share in tradable goods either increases or decreases with consumption expenditures.

Proposition 2 *If assumptions A and B hold, then the expenditure share in tradable goods decreases with aggregate consumption expenditure if and only if* $\sigma_1\eta_1 > 0$.

As mentioned in the introduction, the empirical evidence shows that (i) consumption expenditure in tradable goods decreases with inequality and (ii) consumption expenditure in tradable goods decreases with total consumption expenditure. From this evidence, we conclude that the relevant parametric cases that satisfy this evidence are (i) $\eta_1 > 0$ and $\sigma_1 \in (0, 1)$ or (ii) $\eta_1 < 0$ and $\sigma_1 < 0$. In the first case, the Engel curves are almost linear when consumption expenditure is sufficiently large. Thus, as the economy grows, the Engel curves becomes linear implying that the mechanism relating inequality with consumption expenditure vanishes. Therefore, this case is not interesting for our purposes in the numerical analysis. In contrast, in the second case, the Engel curves are clearly non-linear even for large values of consumption expenditures. We will then consider this parametric case in the numerical exercises.

Assumption C. $\eta_1 < 0$ and $\sigma_1 < 0$.

As a final remark, we should mention that the IES belongs to the interval $(0, 1)$ and is increasing in total consumption expenditure when Assumption C holds.[8] The economic intuition of a IES increasing with income is that poor individuals have a larger share of necessity goods in total expenditure, which are less substitutable across time.[9]

3 Equilibrium

In this section we characterize the equilibrium. To this end, we use the market clearing condition in the non-tradable sector that implies that

$$Y_2 = c_2 + \frac{\Gamma}{p},$$

where $c_2 = \Sigma_{i=1}^{I} (1 - \mu_i) c_i/p$ is total consumption expenditure in non-tradable goods and $\Gamma = p\Sigma_{i=1}^{I}\kappa_i$ is the total asset financial cost in units of tradable goods. Using (1), the market clearing condition can be rewritten as

$$u_2 = \frac{(pc_2 + \Gamma)(1 - \alpha_2)}{w}. \tag{8}$$

We can now define an equilibrium as a path of $\{a_i, c_i, \mu_i, u_1\}_{t=0}^{\infty}$ for all individuals that, given the initial assets, $a_i(0)$, and the efficiency units of labor, l_i, of each individual satisfies the system of equations formed by (3), (5), (7), and (8).

Note that the state variables of the dynamic equilibrium are the initial wealth of each individuals and, hence, the number of initial conditions equals the number of individuals. This large state space can be summarized in only two initial conditions: the initial stock of aggregate wealth and the joint distribution of efficiency units and of initial wealth.

In order to obtain the steady state of this economy, we define by m_i the ratio between labor income and individual assets, i.e. $m_i = wl_i/a_i$. We use (5) at the steady state to obtain the m_i^* solving the following equation

$$\frac{r - \rho}{p\phi} = e^{\psi m_i^*} (1 - \psi m_i^*).$$

[8] This patterns of the IES are in line with the empirical evidence (Atkeson and Ogaki, 1996; Attanasio et al., 2002; Guvenen, 2005; Crossley and Low, 2011).

[9] See Crossley and Low (2011), for an exhaustive theoretical and empirical analysis of the relationship between intratemporal and intertemporal allocation of expenditure.

From the previous equation it is obvious that there is a unique steady state value of m_i if and only if $r - \rho < p\phi$.[10] Moreover, the steady state value of m_i is identical across individuals so that $m_i^* = m^*$. We therefore introduce the following assumption:

Assumption D. $\frac{r-\rho}{p\phi} < 1$.

The steady state value of individual assets, a_i^*, satisfies $a_i^* = wl_i / m^*$. Note that in the absence of labor income differences, individuals in the long run would converge to the same level of assets and income. Thus, long run income inequality is driven only by labor earnings inequality. The steady state level of individual consumption expenditures, c_i^*, is obtained from (3) as follows

$$c_i^* = wl_i + ra_i^* - p\kappa\left(a_i^*\right).$$

We obtain the steady state individual expenditure share in tradable goods, μ_i^*, from (7) as follows

$$\mu_i^* c_i^* - \left(\mu_i^* c_i^*\right)^{1-\sigma_1} \eta_1 = \frac{\theta}{1-\theta}\left(1-\mu_i^*\right) c_i^*.$$

Finally, from using (8), we obtain the long run sectoral composition of the employment, u_1^*.

We next characterize the dynamics of this economy around the steady state. For each individual, we use (7) to rewrite (5) and (3), obtaining the following system of two differential equations:

$$\dot{c}_i = c_i \Omega\left(\mu_i\left(c_i\right), c_i\right)\left(r - p\kappa'\left(a_i\right) - \rho\right),$$
$$\dot{a}_i = wl_i + ra_i - p\kappa\left(a_i\right) - c_i.$$

Note that this system of differential equations is independent on the distribution of income. Hence, it is enough to focus on the dynamics of each individual. The Jacobian matrix at the steady state satisfies

$$J = \begin{pmatrix} \frac{\partial \dot{c}_i}{\partial c_i} & \frac{\partial \dot{c}_i}{\partial a_i} \\ \frac{\partial \dot{a}_i}{\partial c_i} & \frac{\partial \dot{a}_i}{\partial a_i} \end{pmatrix} = \begin{pmatrix} 0 & -c_i^* \Omega^* p\kappa''\left(a_i\right) \\ -1 & \rho \end{pmatrix}.$$

The determinant of the Jacobian matrix is $-c_i^* \Omega^* p\kappa''\left(a_i\right) < 0$ as $\kappa''\left(a_i\right) > 0$, and, hence, the steady state is locally saddle path stable. This implies that there is a unique dynamic path of c_i, μ_i and a_i for each individual that monotonically converges to the steady state.

Once the time path of the variables characterizing the individuals decisions, c_i, μ_i and a_i, are obtained, we can compute the time path of the variables

[10] Let $F\left(m_i\right) \equiv e^{\psi m_i^*}\left(1 - \psi m_i^*\right)$. Note that $F'\left(m_i\right) < 0$, $F(0) = 1$ and $F(\infty) = -\infty$. Hence, there exists a unique steady state if $r - \rho < p\phi$.

characterizing the sectoral composition, u_1, and we can also obtain the time path of GDP. However, these time paths will depend on the initial distribution of assets and of efficiency units of labor. This implies that the time path of the sectoral composition can only be obtained numerically.

At this point, it is important to clarify that the dynamic equilibrium exhibits structural change in the sectoral composition and changes in income inequality, while the aggregate variables, capital and GDP, follow an almost BGP. In order to see this, we can use the equality between the marginal product of capital and the interest rate to obtain that $rK = \alpha_1 Y_1 + \alpha_2 p Y_2$. Using this relation, (1) and the definition of GDP, we obtain that

$$\frac{rK}{Q} = \frac{u_1\left(\alpha_1 - \alpha_2\right) + \alpha_2\left(1 - \alpha_1\right)}{u_1\left(\alpha_1 - \alpha_2\right) + 1 - \alpha_1}.$$

This expression shows that the changes in the employment share will almost not affect the ratio rK/Q. This ratio will be almost constant during the transition, which shows that the equilibrium follows an almost BGP.

4 Sectoral composition and income inequality

4.1 Calibration

We proceed to obtain numerically the time path of the sectoral composition. To this end, we set the value of the parameters describing technology, preferences and the financial cost. Regarding the technological parameters, we normalize $A_1 = 1$ and we set $A_2 = 0.7857$ to set the relative price of tradable goods relative to non-tradable goods equal to 1.3, which is the value measured by Mano and Castillo (2015). The capital output elasticities, α_1 and α_2, are taken from Valentinyi and Herrendorf (2008). The interest rate, r, is set at 10%, which is a standard value in the literature of small open economies. The preference parameters are set as follows: θ is such that the model replicates the expenditure share in tradables in 2010, the parameter ρ is set so that the ratio between wealth and GDP is slightly above 4, which is the value provided by Davies et al. (2010), σ_1 and η_1 are set to match the employment share in tradable goods in the years 1960 and 2010. The parameters characterizing the financial cost function, ϕ and ψ, are set to match the fraction of total value added generated in the financial sector and to obtain a long run speed of convergence close to 2%.

To close the calibration, we need to characterize the distribution of efficiency units and the initial distribution of assets. The distribution of efficiency units is totally exogenous, constant and for the sake of simplicity we assume that it is a uniform distribution in the interval $\left[\underline{l}, \overline{l}\right]$. Given that we normalize the total amount of efficiency units to 1, the distribution of efficiency units is completely characterized by using an index of inequality such as the Gini. We then set the Gini of efficiency units to match the Gini index of income in 2010. Regarding the distribution of assets, it is an endogenous distribution that changes in every period. Therefore, we only set the initial distribution of assets. To this end, we assume that it is a uniform distribution and to characterize it we need to set the initial aggregate level of assets and provide a measure of initial inequality. We set the initial value of assets to be 64% of the steady state level and we set the initial inequality, measured by the Gini index on assets, to match the Gini index on income inequality in the year 1960. All the parameters are provided in Table 1 and the details of the calibration of the distribution are provided in an online appendix.

At this point, it is important to clarify that the distribution of assets is uniform only in the initial period. During the transition, this distribution evolves endogenously and, hence, it is no longer uniform. This also implies that the distribution of income is not uniform except in the initial period.

Figure 4 displays the time paths of the main macroeconomic variables in their transition to the steady state from the following initial conditions: the initial aggregate stock of assets is 64% of its long run value, which implies that the growth of the ratio of assets to GDP equals the growth of this ratio in the US economy in the period 1960-2010, and the initial distribution of assets is such that the initial Gini index of income equals the Gini index in 1960. Therefore, Figure 4 displays the transitional dynamics of the US economy in the period 1960-2010. The first three panels show the decreasing path of both the consumption expenditure share in tradable goods and the employment share in the sector of tradable goods and the increasing path of income inequality measured by the Gini Index. The results from the simulation match the US data.

Panel (iv) shows the increase of assets that explains the increase of GNP in panel (viii). Both the increase in income (GNP) and the increase in income inequality cause the reduction of the tradable sector displayed in panels (i) and (ii). As employment moves to the non-tradable sector which is labor intensive, GDP declines (see panel vii). The different evolution of GDP and GNP explains the time path of trade deficit, which is consistent with the observed patterns of trade deficit in the US economy. Finally, panel (vi) shows that the financial cost is slightly above 8% of GDP. This is a figure consistent with the fraction of the value added that is generated in the financial intermediation sector in the US economy. In the EUKlems, the financial sector amounts 8% of total value added.

4.2 Numerical exercises

We proceed to study how the increase in income inequality affects sectoral composition and some of the main macroeconomic indicators. In so doing, we outline the role of the preferences introduced in this paper. This section is organized in four different exercises. In the first one, we illustrate the mechanism linking income inequality with sectoral composition based on non-linear Engel curves. In the second exercise, we compare economies with constant income inequality with economies with a rising inequality. In the third one, we compare the performance of economies that exhibit permanent differences in income inequality and, in the last exercise, we compare the performance of economies that exhibit transitory differences in income inequality.

4.2.1 Non-linear Engel curves

The purpose of this exercise is to illustrate numerically the role played by the preferences introduced in this paper in explaining the relationship between income inequality and structural change. As mentioned before, the preferences in this paper belong to the class of non-homothetic preferences for which Engel curves are non-linear. Therefore, to outline that the crucial property driving the relationship between inequality and structural change is the non-linearity of the Engel curves, we propose two different numerical exercises. In the first one, we compare the benchmark economy with an otherwise identical economy where $\sigma_1 = 1$ and $\eta_1 = 0.05$. These values of the preferences parameters imply that the utility function is non-homothetic, but the Engel curves are still linear, as follows from (1). In the second exercise, we also compare the benchmark calibrated economy with an otherwise identical economy where there is not a minimum-consumption requirement, i.e. $\eta_1 = 0$. In this case, preferences are homothetic and, obviously, Engel curves are linear.

Figure 5 displays the comparison between the benchmark economy and an economy where Engel curves are linear although preferences are non-homothetic. Both economies exhibit the same level of inequality and GNP. However, because of the differences in preferences, there are differences in the sectoral composition of both economies (see Panels i and ii). In the economy with non-linear Engel curves, both the increase in income and the rise of income inequality explain structural change, whereas only income growth cause structural change in the economy with linear Engel curves. This explains that structural change is faster in the economy with non-linear Engel curves. Structural change is measured in Table 2 by the growth rate of the variables during the period analyzed. From the comparison between the growth rates, it can be shown that the sectoral composition of consumption does almost not change in the economy with linear Engel curves, whereas the change in this variable is large when Engel curves are non-linear. This mechanism explains the differences in the patterns of structural change between the benchmark and the counterfactual economy. The differences in the patterns of structural change in the sectoral composition cause important differences in the evolution of GDP. The different patterns of structural change exhibited by GNP and GDP imply relevant differences in the evolution of trade deficits, as shown in the growth rates.

Figure 6 shows the comparison between the benchmark economy with an economy where preferences are homothetic. In this economy, the consumption shares remain constant as no factor explains structural change in consumption. From the comparison among the growth rates and between Figures 4 and 5, we can conclude that there is not a significative difference between the two counterexamples. This points out that the crucial mechanism linking the effect of income inequality on sectoral composition and, hence, on aggregate variables is the non-linearity of the Engel curve.

4.2.2 Constant versus increasing income inequality

We proceed to study the effects of a rising inequality on sectoral composition. To this end, we compare three economies that are different in the level and the dynamics of income inequality. The first economy is the benchmark economy where the Gini index is initially at 40% and it increases till 48%. The second economy is an economy where income inequality is constant during the period and it is equal to 40%. The last economy is a completely different economy without income inequality, i.e. the Gini index equals zero. Obviously, it corresponds to a representative agent economy.

The comparison among these three economies is displayed in Figure 7 and the results from the growth rates are displayed in Table 3. Two clear results follow from this comparison. First, economies with a larger income inequality have a smaller tradable sector and, because of the differences in the capital intensity, the GDP is also smaller. Obviously, this first result follows from the non-linearity in the Engel curve. Note that this negative effect of inequality on the tradable sector is consistent with the evidence shown in Figure 2.

Second, the differences between the economy with a constant inequality and the economy with a zero inequality in terms of the growth rate are negligible, whereas the differences with respect to the benchmark economy with a rising inequality are substantial. In fact, the levels of aggregate consumption, aggregate assets and GNP between the two counterfactual economies are identical. As the inequality in these two economies remains constant and they share the same initial condition on aggregate wealth, both economies exhibit the same time path of assets' accumulation and, therefore, they exhibit the same time path of GNP. In contrast, the benchmark economy exhibits an increasing path of income inequality, which introduces another source of transition that drives the differences in the path of assets' accumulation. We conclude that the differences in the levels of income inequality cause differences in the sectoral composition (measured by either expenditure share or employment shares) and, as a consequence, they cause differences in the GDP level. However, these differences in the levels of income inequality do not cause differences in the patterns of structural change, as shown in Table 3. In contrast, the rising inequality of the benchmark economy causes a larger accumulation of assets and, hence, GNP grows faster. The faster income growth and the rising income inequality explain the faster process of structural change in the sectoral composition. In turn, this explains the faster reduction of GDP and the faster deterioration of the trade deficit. We conclude that while sectoral composition is explained by the levels of income inequality, the patterns of structural change are explained by the evolution of income inequality.

4.2.3 Permanent differences in income inequality

In Figure 8, we compare the performance of two economies that exhibit permanent differences in income inequality: one economy has a 10% lower Gini index than the benchmark economy displayed in Figure 4, whereas the other one has a 10% larger value of the Gini index.[11] The economy with a larger inequality exhibits a faster accumulation of assets, which implies a larger growth of the GNP. As a consequence, this economy exhibits a much faster process of structural change, which explains a faster reduction in the level of GDP. The different paths followed by GDP and GNP in these two economies explain that trade balance worsens substantially more in the more unequal economy.

Figure 9 displays the same two economies when preferences are homothetic, i.e. we assume that $\eta_1 = 0$. The comparison between the time paths of the variables displayed in the Figures 8 and 9 is summarized in Table 4 that shows the growth rates of several variables. The main insight that we obtain from this comparison is that preferences determine the effect of inequality on structural change in the sectoral composition and in GDP, whereas they do not determine the effect of inequality on assets' accumulation and GNP.

4.2.4 Transitory differences in income inequality

In the last numerical exercise we analyze the effects of transitory differences in income inequality. In Figure 10 we display two economies: the benchmark economy of Figure 4 and a counterfactual economy with an initial income inequality that is 10% larger than the benchmark economy. However, the differences in income inequality are only transitory and they eventually vanish in the long run.[12] On the one hand, the larger income inequality of the counterfactual economy explains that the expenditure share in tradable goods is smaller, which also explains that the initial employment share in the tradable sector is smaller in the counterfactual economy. On the other hand, the differences in the dynamics of income inequality imply a differential accumulation of assets. Asset accumulation is substantially faster in the more equal economy, which implies a faster growth of GNP. This faster growth of GNP fosters structural change in the sectoral composition of employment. The interaction between these two mechanisms of structural change explains that the employment share in the tradable sector and GDP level are initially larger in the benchmark economy, but eventually they become smaller. Note that this example clearly shows that the effects of income inequality on the sectoral composition of the employment depend on both the level and the evolution of income inequality.

Finally, Figure 11 shows the same two economies when preferences are homothetic and, hence, Engel curves are linear. Table 5 shows the growth rates associated to the changes in the variables displayed in Figures 10 and 11. From the comparison of these two figures, we also conclude that preferences determine the effect of inequality on structural change, whereas they do not determine the effect of inequality on assets' accumulation.

[11] In one economy, the initial Gini index on income equals 0.3 and it converges to 0.39. In the other economy, the initial Gini index on income equals 0.5 and converges to 0.68. The differences during the time period considered between the Gini indexes of these two economies remains almost constant and equal to 20%.

[12] Both economies converge to the same long run Gini index of income which is 0.5408. However, initially the Gini index of the benchmark economy equals 0.4, whereas the Gini index of the counterfacutal economy equals 0.5.

5 Concluding remarks

This paper contributes to the structural change literature by highlighting the role of increasing income inequality, beyond that of income growth, in affecting structural change, through consumption composition and saving behavior. We investigate the joint dynamics of structural change and income inequality in order to single out the channel through which inequality affects the structural change and the GDP growth, together with other macroeconomic variables as GNP and a country's external position. This analysis is based on a small open economy model where two different mechanisms drive the process of structural change between the tradable and the non-tradable sectors. One mechanism is an income effect and the other one is based on income inequality. While the first mechanism arises when preferences are non-homothetic, the second one only arises for the class of non-homothetic preferences implying non-linear Engel curves.

We calibrate this model to the US economy in the period 1960-2010 and we show that it explains the observed patterns of structural change in terms of the sectoral composition of consumption and employment, it also explains the increase in inequality measured by the Gini index and, finally, it is consistent with the large reduction of the trade balance. From the analysis of several counterfactual exercises, we obtain the following insights: (i) the increase in income inequality contributes to explain structural change and the effects on GDP only when Engel curves are non-linear; (ii) assets' accumulation and the time path of GNP do not depend on the level of inequality, but on the dynamics of income inequality; (iii) a rising inequality implies a faster accumulation of assets, a larger growth of GNP, a faster reduction of GDP and a faster deterioration of the trade balance.

References

[1] Acemoglu, D. and Guerrieri, V. (2008). Capital deepening and non-balanced economic growth. *Journal of Political Economy* 116, 467-498.

[2] Alonso-Carrera, J. and Raurich, X. (2015). Demand-based structural change and balanced economic growth. *Journal of Macroeconomics*, 46, 359-374.

[3] Alonso-Carrera, J. and Raurich, X. (2016). Labor mobility, structural change and economic growth. *UB Economics Working Papers* E15/325.

[4] Alvarez-Cuadrado, F., Van Long, N. and Poschke, M. (2017). Capital Labor Substitution, Structural Change and Growth. *Theoretical Economics, forthcoming.*

[5] Attanasio, O., Banks, J. and S. Tanner. (2002) Asset Holding and Consumption Volatility. *Journal of Political Economy* 110, 771-93.

[6] Banerjee, A. and Duflo, E. (2000). Inequality and growth: what can the data say?. NBER Working Paper 7793.

[7] Bertola, . Foellmi, R. and Zweimüller, J. (2005). Income Distribution in Macroeconomic Models. Princeton University Press.

[8] Boppart, T. (2014). Structural Change and the Kaldor Facts in a Growth Model With Relative Price Effects and Non-Gorman Preferences. *Econometrica* 82, 2167–2196.

[9] Comin, D., Lashkari, D. and M. Mestieri (2015). Structural Change with Long-run Income and Price Effects. *Unpublished manuscript.*

[10] Crossley, T. F. and Low, H.W. (2011). Is the Intertemporal Elasticity of Substitution Constant? *Journal of the European Economic Association* 9(1), 87-105.

[11] Dennis, B.N., Iscan, T.B. (2009). Engel versus Baumol: Accounting for structural change using two centuries of U.S. data. *Explorations in Economic History* 46, 186-202.

[12] Davies, J.B., Sandström, S., Shorrocks, A. And Wolff, E.N., (2010): "The level and distribution of global household wealth," The Economic Journal 121, 223-254.

[13] Easterly, W. (2007). Inequality does cause underdevelopment: Insights from a new instrument. *Journal of Development Economics* 84, 755–776.

[14] Falkinger, J. and Zweimüller, J. (1997). The Impact of Income Inequality on Product Diversity and Economic Growth. *Metroeconomica* 48, 211-237.

[15] Felice, G. (2016). Size and composition of public investment, sectoral composition and growth. *European Journal of Political Economy* 44, 136-158.

[16] Foellmi, R., Zweimüller, J. (2006). Income Distribution and Demand-Induced Innovation. *Review of Economic Studies* 73, 941–960.

[17] Foellmi, R., Zweimüller, J. (2008). Structural change, Engel's consumption cycles and Kaldor's facts of economic growth. *Journal of Monetary Economics* 55, 1317-1328.

[18] Guvenen, F., (2006). Reconciling Conflicting Evidence on the Elasticity of Intertemporal Substitution: A Macroeconomic Perspective. *Journal of Monetary Economics* 53(7), 1451-1472.

[19] Herrendorf, B., Rogerson, R. and Valentinyi, Á. (2013). Two Perspectives on Preferences and Structural Transformation, *American Economic Review* 103, 2752-2789.

[20] Herrendorf, B., Rogerson, R. and Valentinyi, Á. (2014). Growth and structural transformation. *Handbook of Economic Growth,* P. Aghion and S.N. Durlauf (eds.). Amsterdam: North-Holland Publishing Company.

[21] Herrendorf, B., Herrington, C. and Valentinyi, Á. (2015). Sectoral technology and structural transformation. *American Economic Journal: Macroeconomics*, 7, 104-133.

[22] Kongsamunt, P., Rebelo, S., Xie, D. (2001). Beyond balanced growth. *Review of Economic Studies* 68, 869-882.

[23] Laitner, J. (2000). Structural change and economic growth. *Review of Economic Studies* 67, 545-561.

[24] Mano, R. and Castillo, M. (2015). The Level of Productivity in Traded and Non-Traded Sectors for a Large Panel of Countries. IMF Working Paper, WP/15/48.

[25] Matsuyama, D. (1992). A simple model of sectoral adjustment. *Review of Economic Studies* 59, 375-388.

[26] Matsuyama, K. (2009). Structural Change in an Interdependent World: A Global View of Manufacturing Decline. *Journal of the European Economic Association* 7, 478-486.

[27] Moro, A. (2012). The Structural Transformation between Manufacturing and Services and the Decline in the US GDP Volatility. *Review of Economic Dynamics* 12-3, 402-415.

[28] Ngai, R., Pissarides, C. (2007). Structural change in a multisector model of growth. *American Economic Review* 97, 429-443.

[29] Neumeyer, P. and Perri, F. (2005). Business cycles in emerging economies: the role of interest rates. *Journal of Monetary Economics 52,* 345-380.

[30] Ogaki, M. and Atkeson, A. (1996). Rate of Time Preference, Intertemporal Elasticity of Substitution and the Level of Wealth. *The Review of Economic and Statistics*, 564-572.

[31] Pollak, R. A. (1974). Additive Utility Function and Linear Engel Curves. *The Review of Economic Studies*, 38 (4), 401-414.

[32] Quadrini, V. and Rios Rull, J.V. (2014). Inequality in Macroeconomics. *Handbook of Income Distribution*, V. 2B, Ch. 15.

[33] Schmitt-Grohe, S. and Uribe, M. (2003). Closing small open economy models. *Journal of International Economics* 61, 163–185.

[34] Solt, F. 2016. The Standardized World Income Inequality Database. *Social Science Quarterly* 97(5),1267-1281.

[35] Sposi, M. (2016). Evolving Comparative Advantage, Sectoral Linkages and Structural Change. *Unpublished manuscript*.

[36] Teignier, M. (2014). The Role of Trade in Structural Transformation. Manuscript.

[37] Uy, T., Yi, K., Zhang, J. (2013). Structural change in an open economy. *Journal of Monetary Economics* 60, 667-682.

[38] Valentinyi, Á. and Herrendorf, B. (2008). Measuring factor income shares at the sectoral level. *Review of Economic Dynamics* 11, 820-835.

A Descriptive evidence. Data description and additional tables

In this section we report our strategy to explore the relationship between income distribution and sectoral composition in order to provide some descriptive evidence working as a starting point for our theoretical contribution. To the best or our knowledge there are no previous contributions analyzing the relationship between employment sectoral composition and indexes of income inequality.

A.1 Data description.

For the information on income distribution we use the SWIID database (Standardized World Income Inequality Database, Solt, 2016). The dataset is built by standardizing information on inequality across countries starting, as main sources, from the World Income Inequality Database (WIID, UNU-WIDER, 2008) and the Luxembourg Income Study (LIS). This database provides comparable Gini indices of gross and net income inequality for 192 countries for as many years as possible from 1960. It is suitable to cross-countries analysis since it maximizes comparability across countries and years with respect to other data sets. It has been recently used in other works studying income inequality across countries and years (Acemoglu et al., 2013). We employ the most traditional measure of inequality, the Gini index (gini-market: household income pre-tax, pre-transfer).

For the sectoral employment and the relative price, we rely on the Groningen 10 sector database and the EUKLEMS database (2009). In particular, depending on whether controlling for the relative price or not, we rely on a database built by combining GGDC-10 sector and EUKLEMS database: 50 countries (excluding less developed), 1960-2011 (not controlling for relative price); or the Groningen 10 sector database only: 29 countries (excluding less developed, Eastern and Baltic countries), 1962-2011 (controlling for relative price). We build two main macro-sectors, Tradable and Non-tradable goods, according to the taxonomy used in Herrendorf and Valentinyi (2008), where Tradable includes Manufacturing and Agriculture, while the rest of the economy is classified as Non-Tradable. For the additional controls, we rely on Penn tables (GDP per capita) and World Development indicators (Openness).

List of countries: Argentina, Austria, Australia, Belgium, Brazil, Botswana, China, Costa Rica, Cyprus, Czech Rep., Germany, Denmark, Spain, Estonia, Ethiopia, Finland, France, United Kingdom, Ghana, Greece, Hong Kong, Hungary, Indonesia, India, Ireland, Italy, Japan, Kenia, Korea, Lithuania, Luxemburg, Latvia, Mexico, Malta, Mauritius, Malawi, Malaysia, Nigeria, Netherlands, Philippines, Poland, Portugal, Senegal, Slovenia, Slovakia, Sweden, Thailand, Taiwan, United States, South Africa.

A.2 Descriptive evidence. Tables and Figures.

Figures 2 and 12 show the relationship between residual tradable (log) share in total employment and residual Gini (log). Residual tradable (log) share in total employment and residual Gini are constructed by taking the residuals of the following fixed effects (FE) regressions:

$$EMPTsh_{it} = a_0 + a_1 X_{it} + \gamma_i + \gamma_t + u_{it}$$

where the dependent variable is country i's Employment share in Tradable sectors on Total Employment at time t, and X_{it} is a vector of explanatory variables (gdp per capita, relative price, openness), and, similarly,

$$GINI_{it} = b_0 + b_1 X_{it} + \eta_i + \eta_t + \epsilon_{it}$$

where the dependent variable is country i's the Gini index (market) at time t, and X_{it} is a vector of explanatory variables (gdp per capita, relative price, openness).

In a first model (Model 1), represented in Figure 3, all the controls are included, this reducing the sample to EUKLEMS data (29 countries). In a second model (Model 2), represented in Figure 12, we show the relationship by including gdp per capita only as a control variable, this allowing to use the combined EUKLEMS-10 sector database (50 countries). The advantage of using the combined data is that we add countries and years. We then estimate

$$\widehat{u}_{it} = c_0 + c_1 \widehat{e}_{it} + z_{it}$$

The table below reports the results of the correlation between the residuals (represented in Figures 3 and 12).

Partial correlation of inequality and employment composition

	Model 1 (Fig. 3) Dep. var: Residual (log) T. Share in Employment	Model 2 (Fig. 12) Dep. var: Residual (log) T. Share in Employment
Residual (log) Gini index	-0.215^{**}	-0.218^{***}
	(0.086)	(0.080)
R-Squared	0.067	0.036
N	1080	1635

Note: Standard errors clustered by country.

B Proof of Propositions

Proof of Proposition 1

From using (4), we obtain

$$c = \left(\frac{1}{\theta}\right) c_1 - \eta_1 \left(\frac{1-\theta}{\theta}\right) c_1^{1-\sigma_1}.$$

Note that this equation is the inverse Engel curve. The properties are

$$\begin{aligned}
\frac{\partial c}{\partial c_1} &= \frac{1}{\theta} - (1-\sigma_1)\,\eta_1 \left(\frac{1-\theta}{\theta}\right) c_1^{-\sigma_1} = \frac{\left[c_1^{\sigma_1} - (1-\sigma_1)\,\eta_1\,(1-\theta)\right] c_1^{-\sigma_1}}{\theta} > 0, \\
\frac{\partial^2 c}{\partial c_1^2} &= \sigma_1\,(1-\sigma_1)\,\eta_1 \left(\frac{1-\theta}{\theta}\right) c_1^{-\sigma_1-1} > (<)\, 0 \text{ if } \sigma_1\,(1-\sigma_1)\,\eta_1 > (<)\, 0.
\end{aligned}$$

The sign of the first inequality follows from Assumption A. The previous results characterize the inverse Engel curve. It follows that the Engel curve is increasing and it is concave if and only if $\sigma_1\,(1-\sigma_1)\,\eta_1 > 0$.

In order to characterize the Engel curve relating c_2 with c, we take into account that $pc_2 = c - c_1$. We then obtain that

$$\begin{aligned}
\frac{\partial pc_2}{\partial c} &= \frac{\partial\,(c-c_1)}{\partial c} = 1 - \frac{1}{\frac{\partial c}{\partial c_1}} = \frac{\left[c_1^{\sigma_1} - (1-\sigma_1)\,\eta_1\right](1-\theta)}{c_1^{\sigma_1} - (1-\sigma_1)\,\eta_1\,(1-\theta)} > 0, \\
\frac{\partial^2 pc_2}{\partial c^2} &= \frac{(1-\theta)\,\theta c_1^{\sigma_1-1}\sigma_1\,(1-\sigma_1)\,\eta_1}{\left[c_1^{\sigma_1} - (1-\sigma_1)\,\eta_1\,(1-\theta)\right]^2} > (<)\, 0 \text{ if } \sigma_1\,(1-\sigma_1)\,\eta_1 > (<)\, 0.
\end{aligned}$$

The first inequality follows from Assumption A.

Proof of Proposition 2

From the definition of, μ, we obtain that $\mu = c_1/c$ and, hence,

$$\frac{\partial \mu}{\partial c} = \frac{\frac{\partial c_1}{\partial c} - \mu}{c} = \frac{1 - \frac{\partial c}{\partial c_1}\mu}{c\frac{\partial c}{\partial c_1}} < 0$$

if $1 < \frac{\partial c}{\partial c_1}\mu$, which requires

$$\frac{\left[c_1^{\sigma_1} - (1-\sigma_1)\,\eta_1\,(1-\theta)\right] c_1^{-\sigma_1}}{\theta}\mu > 1.$$

From using (4), we obtain that

$$\mu = \frac{c_1^{\sigma_1}}{c_1^{\sigma_1}\left(\frac{1}{\theta}\right) - \left(\frac{1-\theta}{\theta}\right)\eta_1}.$$

We use the expression of μ to proof that the previous inequality holds when $\sigma_1\eta_1 > 0$.

C Tables and Figures

Table 1. Parameter values.

Parameters	Values	Targets
A_1	1	Normalization
A_2	0.7857	Relative price equals 1.3[(1)]
α_1	0.37	Labor-income share in tradables[(2)]
α_2	0.32	Labor-income share in non-tradables[(2)]
r	0.1	Return on capital equals 10%
θ	0.5394	Expenditure share in tradables in 2010 is 17.77%[(3)]
ρ	0.091	The ratio of wealth to GDP is 4.5[(4)]
σ_1	-3	Employment share in tradables in 2010 is 10%[(5)]
η_1	-2000	Employment share in tradables in 1960 is 29%[(5)]
ϕ	0.01	Value added in financial sector is 8%[(5)]
ψ	4.2	Speed of convergence approximately 2% (1.8%)[(6)]
$G_a(0)$	0.07	Gini index of income in 1960 equals 0.4[(7)]
G_w	0.5408	Gini index of income in 2010 equals 0.47[(7)]

Notes: (1) Mano and Castillo (2015); (2) Valentinyi and Herrendorf (2008); (3) Herrendorf (2013); (4) Davies et al. (2010); (5) EuKlems database; (6) Barro and Sala-i-Martin (1992); (7) SWIID from Solt (2016).

Table 2. Growth rates. Different preferences

Variables	Benchmark	Linear Engel curves	Homothetic Preferences
μ	-16.34%	-1.57%	0%
u	-65.44%	-15.80%	-16.88%
G_I	17.41%	17.45%	18.87%
GNP	13.65%	13.54%	13.77%
GDP	-1.47%	-0.7%	-0.7%
XN	-183%	-147%	-149%

Table 3. Growth rates. Different dynamics of income inequality

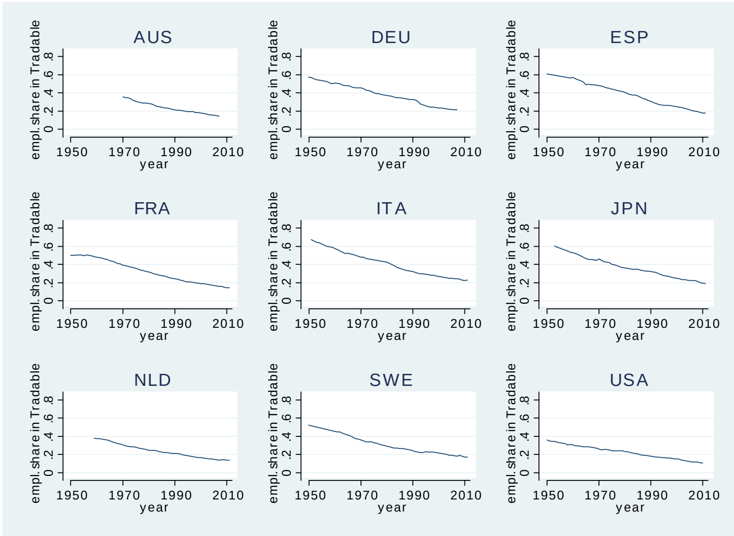
Variables	Benchmark	Constant inequality	No inequality
μ	-16.34%	-8.81%	-8.97%
u	-65.44%	-48.07%	-46.29%
G_I	17.41%	0.00%	-0.00%
GNP	13.65%	10.70%	10.66%
GDP	-1.47%	-0.97%	-0.96%
XN	-183%	-167%	-165%

Table 4. Growth rates. Permanent differences in income inequality

	Non-linear Engel Curves		Homothetic Preferences	
Variables	Equal Eco.	Unequal Eco.	Equal Eco.	Unequal Eco.
μ	-12.74%	-20.31%	0.00%	0.00%
u	-55.25%	-78.45%	-14.41%	-20.53%
G_I	20.03%	11.96%	21.91%	12.75%
GNP	11.74%	16.58%	12.05%	16.83%
GDP	-1.20%	-1.83%	-0.6%	-0.87%
XN	-171%	-196%	-138%	-163%

Table 5. Growth rates. Transitory differences in income inequality

Variables	Non-linear Engel Curves		Homothetic Preferences	
	Equal Eco.	Unequal Eco.	Equal Eco.	Unequal Eco.
μ	-16.34%	-11.3%	0.00%	0.00%
u	-65.44%	-53.46%	-16.88%	-13.24%
G_I	17.41%	5.22%	-18.87%	5.47%
GNP	13.65%	11.13%	13.77%	11.52%
GDP	-1.47%	-1.07%	-0.7%	-0.55%
XN	-183%	-171%	-149%	-135%


AUS
DEU
ESP
FRA
ITA
JPN
NLD
SWE
USA
empl.share in Tradable
0
.2
.4
.6
.8
1950
1970
1990
2010
year
Figure 1.

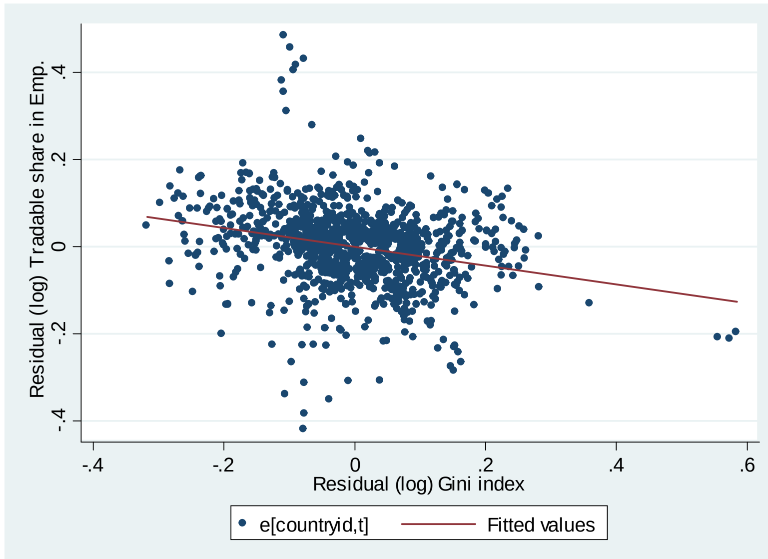
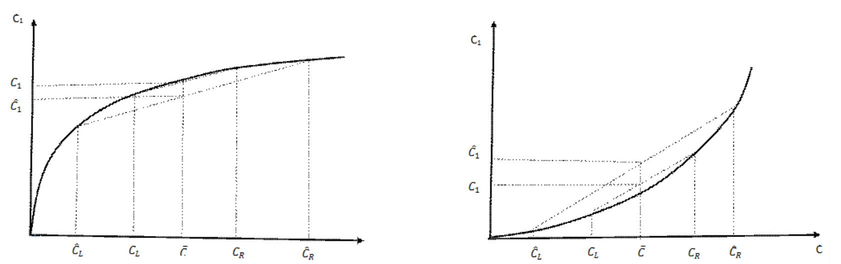


Figure 2



Panel a. Concave Engel curve

Panel b. Convex Engel curve

Figure 3. Non-linear Engel curves

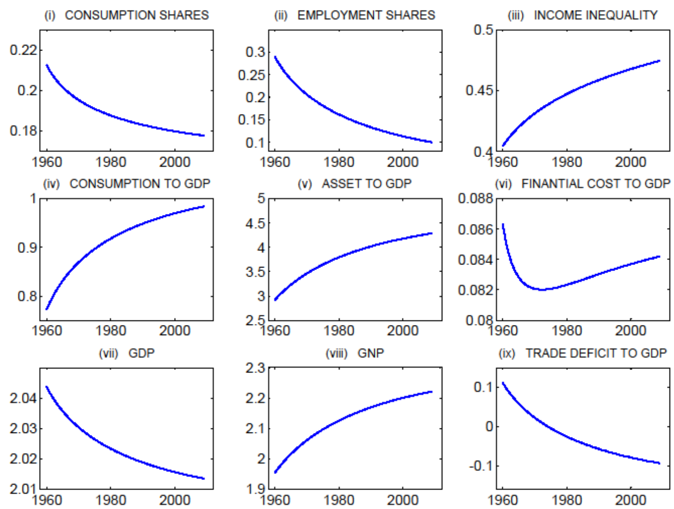


Figure 4. Calibration of the US economy

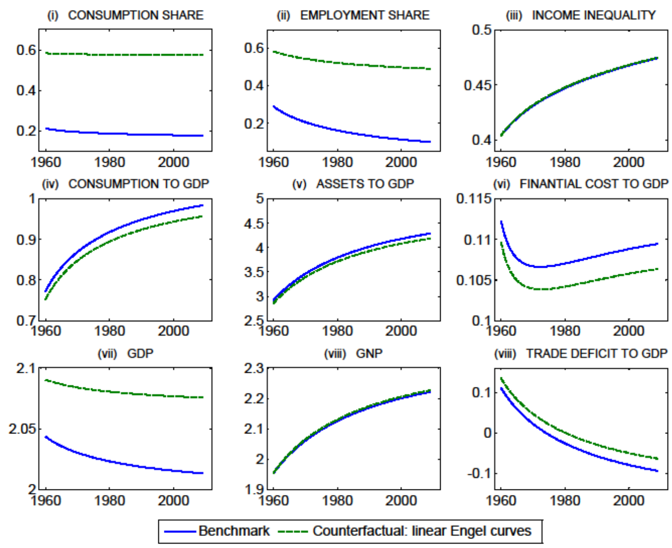


Figure 5. Linear Engel curves

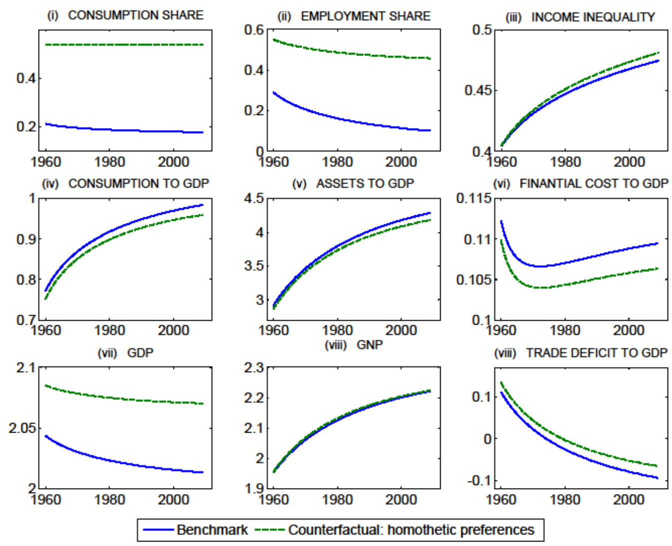


Figure 6. Homothetic preferences

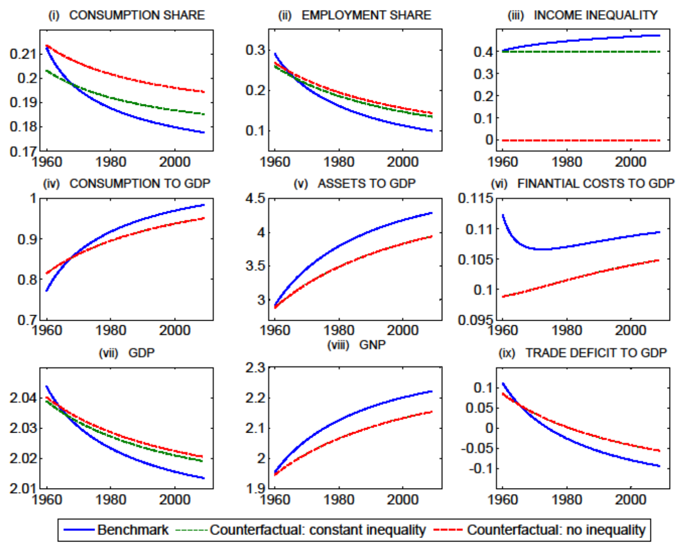


Figure 7. Different dynamics of income inequality

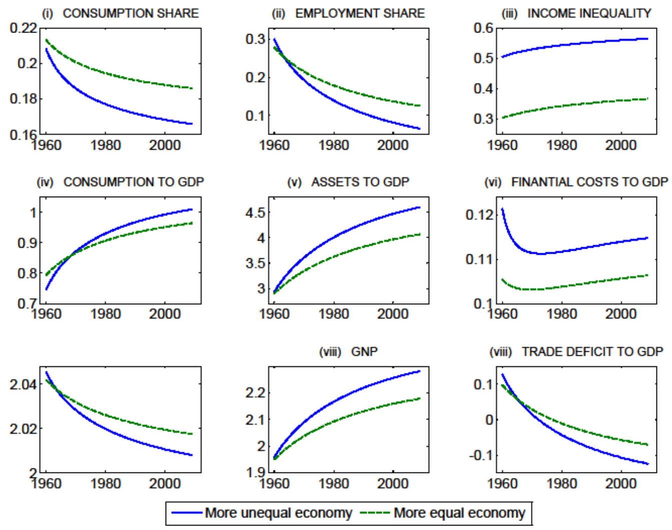


Figure 8. Permanent differences in income inequality

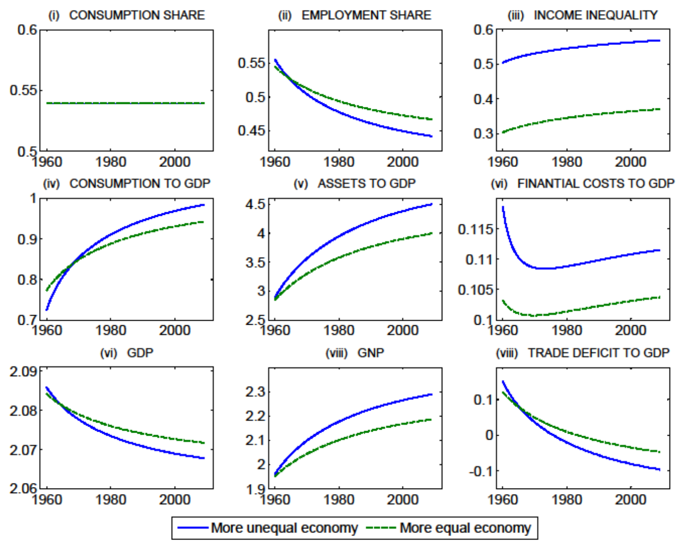


Figure 9. Permanent diff. income inequality. Homothetic preferences

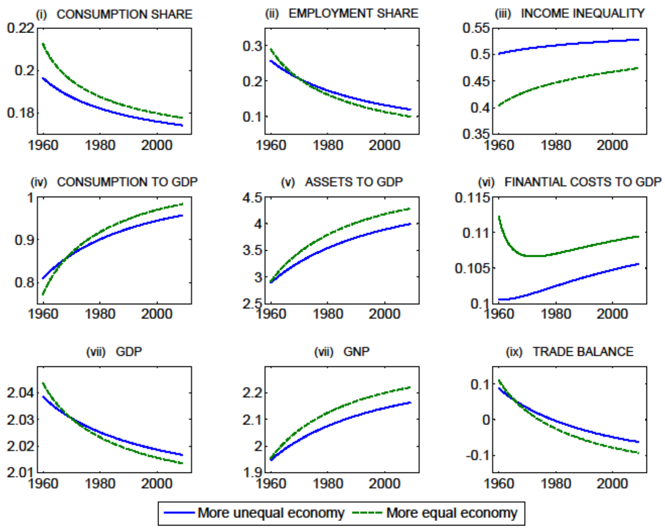


Figure 10. Transitory differences in income inequality

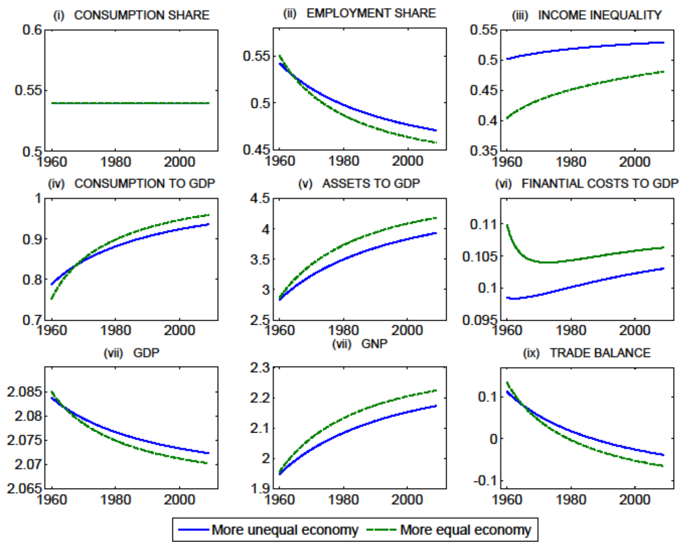


Figure 11. Transitory diff. in inequality. Homothetic preferences

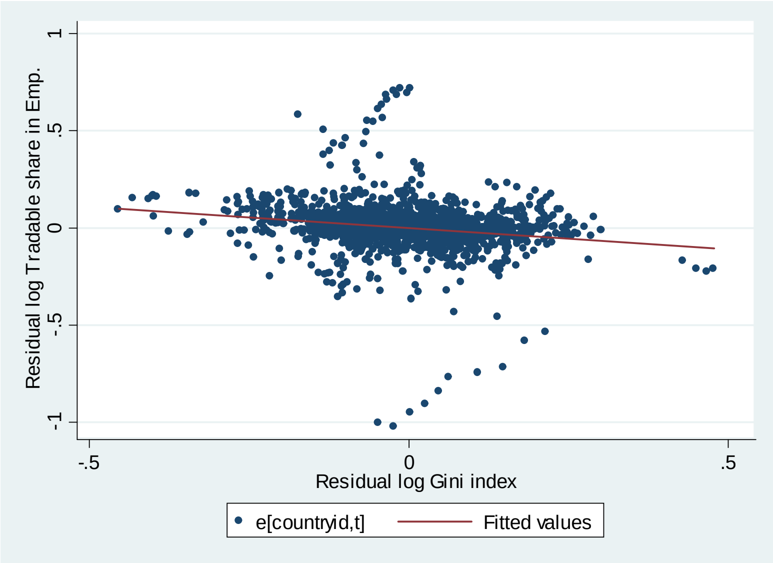

Residual log Tradable share in Emp.
1
.5
0
-.5
-1
-.5
0
.5
Residual log Gini index
e[countryid,t]
Fitted values

Figure 12