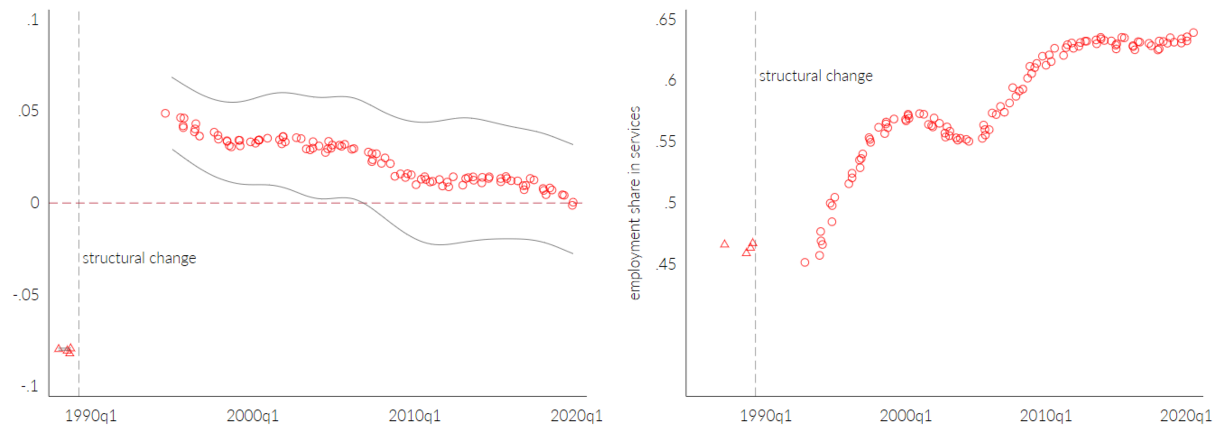
1 Introduction

We study the effects of structural change on inequality and preference for redistribution. The existing theoretical models of structural change without frictions yield no effects of structural change on inequality. In contrast, the models with frictions generate a gradual change in both employment and wage ratio between wages in the declining and the rising sectors. This is at odds with the empirical evidence: observational data suggest a gradual change in employment but a rapid, hump-shaped change in wage ratio instead (Lee and Wolpin 2006, Ngai and Pissarides 2007). We illustrate this point using the example of Central and Eastern Europe. In Figure 1, we document a hump-shaped rapid increase and gradual decline in wage ratios between the rising sector of services and the declining sector of manufacturing, with a massive rise in employment in the service sector (from under 40 percent 1988 to 65.6 percent in 2015, see also Growiec et al. 2015).[1]

Figure 1: Wage premium in service sector relative to manufacturing adjusted for individual characteristics (left) and employment in services sector as % of salaried workers (right)



Notes: data for 1988 come from Polish Household Budget Survey, distributed by LIS Data Center. Data for 1995-2019 come from the Polish Labor Force Survey, quarterly data collected by Statistics Poland on a representative population of households. The wage premium γ is obtained from estimating a model $ln(wage) = \alpha + \beta X + \gamma services + \epsilon$, where X set of controls includes age, gender, household characteristics, residence, tenure and education for salaried workers. Services are defined based on NACE sections for market and non-market services. Wages are expressed in hourly terms.

We provide an overlapping generations setup which replicates these stylized facts. The existing evidence from longitudinal studies shows that new technology is associated with early labor market exits of the older workers (Bárány and Siegel 2018, Yashiro et al. 2020), as well as intensive entry and churning of young workers (Dauth et al. 2021). Likewise, the majority of the employment change in the process of economic transition across all former Soviet Block countries as well as Central and Eastern Europe occurred through

[1]The case of Central and Eastern Europe is interesting to study because rapid growth was experienced in the decades ensuing the collapse of central planning. While our model is, to some extent, stylized after CEE countries, its implications are not limited to this region. Intuitively, skill-biased technological change, as well as automation across industrialized countries, constitute similar processes. The main difference was that these structural changes did not have a clearly defined starting date in Western Europe, whereas in CEE countries, the transition started in 1989 with the fall of the Berlin Wall and the collapse of the Soviet Union.

older workers exiting the declining sectors and young workers entering predominantly the rising sectors (Tyrowicz and van der Velde 2018). We offer a model consistent with these observed patterns of worker flows: the probability of changing the sector is decreasing in age.

Our analysis incorporates the role of labor mobility frictions. The existing literature on structural transformation (for the exhaustive review see Herrendorf et al. 2014) typically utilizes setups with frictionless reallocation (see for example Hansen and Prescott 2002, Ngai and Pissarides 2007, Duarte and Restuccia 2010, Buera and Kaboski 2012). In the 1990s, introducing labor mobility frictions delivered novel insights on the effects of new technology on employment and thus inequality (see Mortensen and Pissarides 1998, Pissarides and Vallanti 2007, Miyamoto and Takahashi 2011, among others). Data-driven studies reinforce the point that labor market rigidity is of paramount relevance in studying structural transformation (see for example Buera and Kaboski 2009). In this strand of research, Alonso-Carrera and Raurich (2018) develop a two-sector growth model where the sectoral composition of employment and GDP is derived from non-homothetic preferences. Labor mobility is costly in this model, born by the workers who move between sectors. This cost creates a wage gap which reduces the speed of structural change. Alonso-Carrera and Raurich (2018) argue that wage gaps are essential for the model to be able to jointly explain a structural change in the sectoral composition of both GDP and employment (see also Sim and Oh 2017, for the case of Japan). In a similar spirit, there is a large body of literature examining the "optimal speed of transition" for Central and Eastern European countries during the structural change ushered in by the abandonment of central planning and the adoption of market-based systems (Aghion and Blanchard 1994, Castanheira and Roland 2000, Tichit 2006).[2]

We augment our model of structural change with political economy. We make the extent of redistribution through the tax system endogenous, determined by pure majority voting, in the spirit of the seminal paper by Meltzer and Richard (1981).[3] We use this setup to study the preference for redistribution in an economy undergoing a structural change. We provide a **novel result**: structural change raises inequality and thus the societal preference for redistribution. The main intuition behind this finding relates to the observation that with labor mobility frictions, the reallocation of labor across sectors is slower. In our set up, the shares of expenditure on both types of goods are determined by parameters of CES utility and the relative price of those goods. With higher productivity growth in manufacturing, there is less labor demand in that sector sector, which encourages labor reallocation. With frictions in labor reallocation, wages across sectors diverge: the price of services is pushed up, which raises the wages in the service sector, despite lower productivity growth in services because demand for services rises. This raises inequality and thus

[2]With human capital specificity, models of this variety can generate interesting insights into the character of unemployment during structural change (Caballero and Hammour 1996a,b, 2005).

[3]Alternative setups such as Alesina and Rodrik (1994) or Persson and Tabellini (1994) deliver similar results, but the mechanism is less tractable.

redistribution because, in pure majority voting, the scale of redistribution is determined by the median voter, whose position in the society is worsened relative to the average.

Our contribution to the literature is thus twofold. First, we study the structural change in an overlapping generations economy with labor mobility frictions. This way, we study the role of the empirically relevant demographic exchange in employment change. Using this setup, we show that labor mobility frictions lead to higher inequality. Second, we explain how this affects societal preferences for redistribution.

Our paper is structured as follows. In section 2, we specify the model, and we show numerical simulations to build some intuition. Section 3 contains the main results of the paper. Section 4 concludes.

2 The model

In this section, we set up the model of structural change. Individuals face uncertainty about survival until the next period. Newcomers select between two sectors of the economy: an old declining sector or a rising sector. For the sake of brevity, we name the former manufacturing and the latter services. However, the setup is general enough to account for structural change stemming from skill-biased technological change, routine-biased technological change, etc. We show that in such a setup, with labor mobility frictions, inequality rises during structural change. Further, we show that even without direct preferences for redistribution, a political equilibrium emerges with higher taxes and transfers.[4]

2.1 Model set up

Consider a standard OLG Blanchard-Yaari model (Blanchard 1985, Yaari 1965). In this model, each individual faces probability of death ρ, constant across age groups. Population N_t is constant, hence in each period an equal measure of workers enters the labor market. The size of the population is normalized to one.

Our economy consists of two production sectors in which two types of goods are produced: $\kappa \in \{m, s\}$, where m and s denote, respectively, manufacturing and services. Newborn workers are randomly assigned to each sector. The probability of assignment is equal to the share of the population working in that sector in the previous period. For each random assignment, the newborn workers can change the sector at switching cost ϱ. This cost is expressed in real units: it involves utility loss. Hence it is absent from the budget constraint or the resource constraint. It is idiosyncratic across workers and is drawn from the uniform distribution $\varrho_t \sim U[0, A_{m,t}\chi]$, where $A_{m,t}$ denotes the technology in the manufacturing sector, and $\chi \geq 0$ describing the dispersion of the switching costs. In particular, if we set $\chi = 0$ we

[4] See Alesina and Giuliano (2011) for an extensive overview of the factors affecting preferences for redistribution, like historical experience, culture, structure and organization of family, perception of fairness, etc.

get a frictionless environment. Each newborn worker in sector κ decides whether to switch sectors before learning her individual idiosyncratic productivity. This decision is based on comparison of the average wage in services $\bar{w}_{s,t}$ and the average wage in manufacturing $\bar{w}_{m,t}$ plus her sector switching cost ϱ_t.[5] In the case that $\bar{w}_{s,t} > \bar{w}_{m,t}$, there will be cutoff level $\bar{\varrho}_t$, such that individuals with $\varrho_t < \bar{\varrho}_t$ will switch sector and individuals with $\varrho_t > \bar{\varrho}_t$ will not. This cutoff level will be given by

$$\bar{w}_{s,t} = \bar{w}_{m,t} + \bar{\varrho}_t \tag{1}$$

where$\bar{\varrho}_t$ denotes the switching cost of a newborn who is indifferent between two sectors. Note that $Pr(\varrho_t < \bar{\varrho}_t) = \bar{\varrho}_t \frac{\chi}{A_{m,t}}$.

Once all young agents choose the sector κ, their idiosyncratic productivity e is drawn from a distribution continuous and common across sectors with density function $\mu(e)$, where $e \in \subseteq R_0^+$ which is bounded from below. The worker does not change the sector until she leaves the labor market. Hence workers are effectively described by the productivity draw e and the sector κ. We denote the share of workers in sector κ as $N_{\kappa,t}$.

The density function $\mu(e)$ has the mean $\bar{e} = 1$, median $e^{med} < 1$ and single mode $e^{mod} < e^{med}$ as well as $\mu'(e) < 0$ for all $e > e^{mod}$. These properties imply that the distribution function $F_e(e) = \int d\mu(e)$ is strictly increasing and concave on $\hat{E} = \{e : e \in E \text{ and } e > e^{mod}) \subseteq E$.

Given the properties of the productivity distribution, the median wage in sector κ is given by $w_{\kappa,t}^{med} = e^{med} \cdot \bar{w}_{\kappa,t}$, and similarly, the mode of the wage distribution in sector κ is given by $w_{\kappa,t}^{mod} = e^{mod} \cdot \bar{w}_{\kappa,t}$. This assumption is consistent with the observational data about the distribution of wages: they are typically skewed, with the mean larger than the median (see Atkinson 2007). Wages in the economy are given by the distribution $F_t(w_t)$ where w_t is a mixed random variable, $w_t = N_{m,t} w_{m,t} + N_{s,t} w_{s,t}$, with wages in each sector given by the distribution $F_{\kappa,t}(w_t)$. To guarantee concavity of the distribution $F_t(w_t)$ in both sectors past the median wage in any sector, we assume that in each period the median wage in each sector is higher than any mode of the $w_{\kappa,t}$.

Assumption 1. Wages in each sector κ are given by $w_{\kappa,t} = e\bar{w}_{\kappa,t}$, where density of e, $\mu(e)$, has the mean $\bar{e} = 1$, median $e^{med} < 1$ and single mode $e^{mod} < e^{med}$ as well as $\mu'(e) < 0$. Furthermore, $\max\{w_{s,t}^{mod}, w_{m,t}^{mod}\} < \min\{w_{s,t}^{med}, w_{m,t}^{med}\}$.

Our modeling of the sectoral choice and productivity distributions is similar to Kennan and Walker (2011) and Sim and Oh (2017).[6] Given this setup, each worker is assigned to one of the production

[5]The assumption that workers take decisions based on current average wages not expected lifetime income simplifies the analysis and eases the exposition. Assuming that agents look at expected lifetime income, we would get the same result, but it would be harder to follow the arguments. For our result, it is crucial that wages in both sectors are not equal. With labor mobility frictions it would be true independently of what workers take into account, current or expected lifetime income.

[6]See also Ishimaru et al. (2017), McFadden (1974), Artuc et al. (2008).

sectors. Once they select a sector, they cannot change it. The productivity distributions align with the empirical regularities, which lends policy relevance to our framework.

Firms Firms in each sector $\kappa \in \{m, s\}$ operate in a perfectly competitive environment. Firms hire labor services$L_{\kappa,t}$, and produce output $Y_{\kappa,t}$, with constant returns to scale technology

$$Y_{\kappa,t} = A_{\kappa,t} L_{\kappa,t}. \tag{2}$$

They sell output at price $p_{\kappa,t}$. Therefore, in each sector, the average wage is given by:

$$p_{\kappa,t} A_{\kappa,t} = \bar{w}_{\kappa,t} \tag{3}$$

We set $p_{m,t} = 1$, that is manufacturing goods are priced as a numeraire. Structural change is operationalized as a differentiated rate of technological growth across sectors κ: $\gamma_{\kappa,t} = \frac{A_{\kappa,t}}{A_{\kappa,t-1}}$ denotes technological growth in sector κ. For the sake of specificity, in the remainder of this paper we assume $\gamma_{m,t} > \gamma_{s,t}$.

Consumers Individuals do not have access to saving technology, so they consume all their disposable income in each period. Each individual as indexed by e and κ) consumes services $c^{\kappa}_{s,t}(e)$ and manufacturing goods $c^{\kappa}_{m,t}(e)$. The following function describes the preferences of agents in period t

$$\{\vartheta(c^{\kappa}_{s,t}(e))^{\frac{\varepsilon-1}{\varepsilon}} + (1-\vartheta)(c^{\kappa}_{m,t}(e))^{\frac{\varepsilon-1}{\varepsilon}}\}^{\frac{\varepsilon}{\varepsilon-1}} \tag{4}$$

with $\varepsilon \in (0, 1)$. Households only source of income is labor income. Given equation (3), wages vary across sectors. Each agent supplies inelastically one unit of labor. To account for distortionary taxation, we follow Alesina and Giuliano (2011), who propose to introduce a nonlinear cost of taxation $\tau^2\Gamma$ in the consumer choice, with $\Gamma > 0$. This assumption has the same welfare and efficiency implications as distortionary taxation in a model with endogenous labor: it introduces dead weight loss to the budget constraint of the consumer.

The budget constraint of an individual with productivity draw e working in sector κ in period t is given by

$$p_{s,t} c^{\kappa}_{s,t}(e) + c^{\kappa}_{m,t}(e) = (1-\tau) e\bar{w}_{\kappa,t} - \tau_t^2 \mathit{\Gamma} e\bar{w}_{\kappa,t} + m_t \tag{5}$$

where m_t denotes lump-sum transfers from the government.

With manufacturing goods priced as a numeraire, $p_{s,t}$ is the relative price of services in terms of manufacturing goods. First-order conditions of the consumer problem give us the following equation determining consumption of both goods

$$\frac{c^{\kappa}_{m,t}(e)}{c^{\kappa}_{s,t}(e)} = (p_{s,t})^{\varepsilon}(\frac{1-\vartheta}{\vartheta})^{\varepsilon} \tag{6}$$

Aggregating the equation (6) over all individuals, yields the following formula for the aggregate consumption for both types of goods

$$\frac{c_{m,t}}{c_{s,t}} = (p_{s,t})^{\varepsilon}(\frac{1-\vartheta}{\vartheta})^{\varepsilon} \iff \frac{c_{m,t}}{p_{s,t}c_{s,t}} = (p_{s,t})^{\varepsilon-1}(\frac{1-\vartheta}{\vartheta})^{\varepsilon} \tag{7}$$

This formula determines the demand for each type of good. Together with the supply side, it determines the evolution of the employment in each sector, which we describe in detail in the next subsection. Note that for $\gamma_{m,t} > \gamma_{s,t}$ and $\varepsilon \in (0,1)$, the share of services in consumption expenditure increases over time, which reflects the empirical regularities. In a frictionless environment, with $\gamma_{m,t} > \gamma_{s,t}$, to keep wages equal across the sectors, price of services has to be increasing, as follows from equation (3). From equation (7), the ratio of expenditure on manufacturing to services is decreasing.

Government We assume that the government levies a flat tax rate with a universal lump sum transfer. This assumption simplifies the formalization of our argument but is not necessary for the results to hold. The government budget is balanced (Razin et al. 2002). Thus, the tax rate τ_t and the lump sum transfer m_t are linked.

$$m_t = \tau_t \sum_{\kappa\in\{m,s\}} N_{\kappa,t}\bar{w}_{\kappa,t} \tag{8}$$

Thus, the government policy can be sufficiently described by one variable.

Market clearing We close the model with market clearing conditions. The labor market in sector κ clears when

$$L_{\kappa,t} = N_{\kappa,t}\int_E e d\mu(e) \tag{9}$$

which, given that the average e in sector κ equals one, implies that $L_{\kappa,t} = N_{\kappa,t}$. The goods market in sector κ clears when

$$c_{\kappa,t} + \tau_t^2 \Gamma_t Y_{\kappa,t} = Y_{\kappa,t}, \tag{10}$$

where

$$c_{\kappa,t} = N_{m,t}\int_E c^{m}_{\kappa,t}(e)d\mu(e) + N_{s,t}\int_E c^{s}_{\kappa,t}(e)d\mu(e). \tag{11}$$

Equilibrium A competitive equilibrium is an allocation $\{(c^{\kappa}_{s,t}(e), c^{\kappa}_{m,t}(e))_{e\in E,\kappa\in\{m,s\}}, Y_{m,t}, Y_{s,t}, N_{m,t}, N_{s,t}, L_{m,t}, L_{s,t}\}_{t=0}^{\infty}$, prices $\{p_{s,t}, \bar{w}_{m,t}, \bar{w}_{s,t}\}_{t=0}^{\infty}$, government policy $\{\tau_t, m_t\}_{t=0}^{\infty}$, the distribution of agents over productivity given by density in each sector $\mu(e)$ and the distribution of sector switching costs for newborn agents $\varrho_t \sim U[0, A_{m,t}\chi]$ such that in each period t

- $(c^{\kappa}_{s,t}(e), c^{\kappa}_{m,t}(e))$ maximizes (4) subject to the budget constraint (5);
- each newborn agent with reallocation cost ϱ_t assigned to sector κ switches sector if $\bar{w}_{-\kappa,t} \geq \bar{w}_{\kappa,t} + \varrho_t$ where $\bar{w}_{-\kappa,t}$ denotes the average wage in sector other than κ;
- in each sector wages are given by (3) and output by (2);
- the government budget (8) is balanced;
- markets clear, i.e. (10) and (9) are satisfied.

2.2 Structural change

We describe the evolution of the share of employment in manufacturing $N_{m,t}$. First, notice that the fraction $(1-\rho)$ of workers from the previous period survives and still works in manufacturing in period t. Second, there are newborn, which amount to ρ, given that the total population is normalized to one. Originally, the newborns are distributed across sectors according to the employment shares from period $t-1$, therefore $\rho N_{m,t-1}$ is assigned to manufacturing. The newborns, can decide to change the sector, incurring the cost ϱ. Denote the share of the newborn workers switching from manufacturing to services as $\Delta_{m,s,t}$. The following formula describes the dynamics of employment in manufacturing

$$N_{m,t} = (1-\rho)N_{m,t-1} + \rho N_{m,t-1}(1-\Delta_{m,s,t}). \tag{12}$$

Since $\varrho_t \sim U[0, A_{m,t}\chi]$, $\Delta_{m,s,t}$ is given by

$$\Delta_{m,s,t} = Pr(\varrho_t \leq \bar{\varrho}_t) = \bar{\varrho}_t \frac{1}{\chi A_{m,t}}. \tag{13}$$

Substituting for wages from equation (3) and for $\bar{\varrho}_t$ from equation (13) into equation (1) and dividing by $A_{m,t}$ we obtain

$$p_{s,t}\frac{A_{s,t}}{A_{m,t}} = 1 + \Delta_{m,s,t}\chi.$$

Substituting for $\Delta_{m,s,t}$ into equation (12) we obtain:

$$\chi N_{m,t} = \chi N_{m,t-1} + \rho(1 - p_{s,t}\frac{A_{s,t}}{A_{m,t}})N_{m,t-1} \tag{14}$$

Assuming away corner solutions, equation (14) implies that with no labor mobility frictions ($\chi = 0$) price of services is given by $\tilde{p}_{s,t} = A_{m,t}/A_{s,t}$, where we use tilde to denote frictionless outcomes. Note that average wages are the equal in both sectors, see equation (1). However, with labor mobility frictions ($\chi > 0$), a decline of employment in manufacturing $N_{m,t} < N_{m,t-1}$ implies that $p_{s,t} > A_{m,t}/A_{s,t}$ and $\bar{w}_{s,t} > \bar{w}_{m,t}$. Intuitively, frictions slow down the reallocation of workers from manufacturing to services. With insufficient supply of services, given demand, the relative price of services rises. This increase boosts wages in services relative to manufacturing.

Next, we are going to substitute away prices of services from equation (14) in order to derive the formula that uniquely determines employment. First, we substitute from feasibility $c_{\kappa,t} = (1 - \tau_t^2 \Gamma) A_{\kappa,t} N_{\kappa,t}$ into (7) to get

$$\frac{A_{m,t} N_{m,t}}{A_{s,t}(1 - N_{m,t})} = (p_{s,t})^{\varepsilon} (\frac{1-\vartheta}{\vartheta})^{\varepsilon} \tag{15}$$

Next, we substitute for $p_{s,t}$ from equation (14) to equation (15) to get the formula that allows to track employment in manufacturing sector:

$$\frac{N_{m,t}}{(1 - N_{m,t})} = (1 + \frac{\chi}{\rho}(1 - \frac{N_{m,t}}{N_{m,t-1}}))^{\varepsilon} (\frac{A_{s,t}}{A_{m,t}})^{1-\varepsilon} (\frac{1-\vartheta}{\vartheta})^{\varepsilon}. \tag{16}$$

This formula demonstrates the response of labor to technology growth across sectors and the implications of labor mobility frictions to labor reallocation. We use this formula in the proofs in the subsequent propositions.

2.3 Properties of structural change

This section conveys the features of structural change. First, we show that the technology growth differentials across sectors induce reallocation of labor between those sectors. The reallocation is slower in the presence of labor mobility frictions. Second, we present the implications of reallocation for wages across sectors of the economy. Intuitively, wages are equal across sectors in a frictionless economy regardless of technology growth differentials. In an economy with labor mobility frictions, slower labor reallocation prevents immediate equalization of wages. Indeed, with labor augmenting technology, wages are higher in the sector which grows slower.

It is convenient to denote equilibrium outcomes in a frictionless economy ($\chi = 0$) with tilde; for example $\tilde{N}_{\kappa,t}$, denotes employment shares if sector κ in a frictionless economy, uniquely determined by equation (16). Proposition 1 conveys the behavior of employment in manufacturing in an economy with frictions.[7]

Proposition 1. *Assume* $\varepsilon \in (0,1)$*, an economy undergoing structural change,* $N_{m,t-1} \geq \tilde{N}_{m,t-1}$ *and*

[7] This result is consistent with for example Kennan and Walker (2011) and Sim and Oh (2017).

$\gamma_{m,t} > \gamma_{s,t}$, then in period t:

1. *labor reallocates from manufacturing to services ($N_{m,t} < N_{m,t-1}$). The reallocation is slower with labor mobility frictions ($N_{m,t} - N_{m,t-1} > \tilde{N}_{m,t} - N_{m,t-1}$).*

2. *with labor mobility frictions, average wages in services are higher than in manufacturing $\bar{w}_{s,t} > \bar{w}_{m,t}$ and the relative price of services is larger than in the case of a frictionless labor market $p_{s,t} > A_{m,t}/A_{s,t}$.*

Proposition 1 portrays the nature of structural change. Consider an economy with two sectors differing by the rate of technological progress. In a frictionless world, the ratio between the technological levels $(\frac{A_{s,t}}{A_{m,t}})$ determines the shares in employment across sectors. A change in this ratio (implied by the the growth rates $\gamma_{m,t}$ and $\gamma_{s,t}$) determines an instantaneous change in employment shares. Suppose that initially employment in services is too low relative to the frictionless setup and technological change occurs ($N_{s,t} < \tilde{N}_{s,t}$ and $\gamma_{m,t} > \gamma_{s,t}$). Labor should reallocate away from manufacturing to services. With labor mobility frictions, even if the economy starts at the same employment shares as in a frictionless setup $N_{m,t-1} = \tilde{N}_{m,t-1}$, the reallocation is slower $N_{m,t-1} - N_{m,t} < N_{m,t-1} - \tilde{N}_{m,t}$.

Formally, we prove Proposition 1 by contradiction (the proof is relegated to Appendix). Here we present the key intuition. With faster productivity growth in the manufacturing sector and the shares of consumption expenditure given by the preferences, demand for labor in manufacturing decreases. However, the newborn workers are assigned too frequently to manufacturing. The opposite holds for services. With labor mobility frictions ($\chi > 0$), although higher wages encourage newborn workers to change the sector, only those workers whose cost of reallocation is sufficiently low change sector. This slower reallocation increases the relative price of services which discourages consumers from services and, given that labor markets in each sector are perfectly competitive, raises wages in services. In summary, reallocation occurs when growth rates differ between sectors, and this reallocation is slower with labor mobility frictions, raising prices and wages in services. Next, we show how the reallocation in the presence of labor mobility frictions affects inequality. It is convenient in political economy considerations to measure inequality as the ratio of mean to median.

Proposition 2. *[Mean and median wage with structural change] Suppose Assumption 1 is satisfied and individual wages age given by $w_{\kappa,t} = e\bar{w}_{\kappa,t}$. Then $\bar{w}_{s,t} \neq \bar{w}_{m,t}$ implies*

$$w_t = N_{m,t}w_{m,t}^{med} + N_{s,t}w_{s,t}^{med} \text{ and } w_t^{med} < N_{m,t}w_{m,t}^{med} + N_{s,t}w_{s,t}^{med}$$

where $N_{s,t} = 1 - N_{m,t}$.

This proposition is instrumental to the political economy theorem. The proof of this proposition is technical and relegated to the Appendix. It is based on the property that the average of the mixed random variable is equal to the average of the means. In contrast, the median of that variable is not equal to the average of the medians. When the average wage in services is higher than in manufacturing, the average wage in the economy is equal to weighted averages in each sector. However, the median wage is lower than the weighted average of sectoral medians. Consider the following example: the economy consists of two equal-sized sectors ($N_{m,t} = N_{s,t} = 0.5$): manufacturing and services. In each sector, wages have a uniform distribution with $F_{s,t}(w_{s,t}) = 0.5w_{s,t}$ on $[0, 2]$ interval and $F_{m,t}(w_{m,t}) = w_{m,t}$ on $[0, 1]$. Then $w_{s,t}^{med} = 1$ and $w_{m,t}^{med} = 0.5$. The average median equals 0.75. However, the value of distribution function of mixed random variable $F_t(w_t)$ at $w_t = 0.75$ is above half $F_t(0.75) = 0.5F_{s,t}(0.75)+0.5F_{m,t}(0.75) = 9/16 > 0.5$, which implies that the median of the w_t wage distribution is lower. This holds for any distributions of wages generated by the distribution of productivity $\mu(e)$ satisfying Assumption 1.

3 Political economy of redistribution with structural change

In this section, we present results on political economy for which Proposition 2 is instrumental. We use the concept of pure majority voting for collective decision-making. In pure majority voting, the outcome is well defined if preferences over one-dimensional policy variable are single-peaked. In such a case, the median voter theorem applies, and the policy preferred by the median voter wins in majority voting. Therefore, we first derive the indirect utility function over policy for each agent, then show that it is single-peaked. We express voter preferences over policy as an indirect utility that is a function of one policy parameter: tax rate τ. Then, we introduce our key theoretical result in Proposition 4.

Notice that income taxes do not affect $p_{s,t}$. Therefore, an individual working in sector κ with idiosyncratic productivity e prefers the policy $\tau_t \in [0, 1]$ such that it maximizes her current income $(1 - \tau_t)e\bar{w}_{\kappa,t} - \tau_t^2 \mathit{\Gamma} e_k \bar{w}_{\kappa,t} + m_t$. Substituting for the lump-sum transfers m_t from the government budget we get:

$$(1 - \tau_t)e\bar{w}_{\kappa,t} - \tau_t^2 \mathit{\Gamma} e\bar{w}_{\kappa,t} + \tau_t \sum_{\kappa} N_{\kappa,t}\bar{w}_{\kappa,t}.$$

Therefore, a worker's preferences for policy τ_t are given by

$$W(\tau_t, e, \kappa) = e\bar{w}_{\kappa,t} - \tau_t^2 \mathit{\Gamma} e\bar{w}_{\kappa,t} + \tau_t(\sum_{\kappa} N_{\kappa,t}\bar{w}_{\kappa,t} - e\bar{w}_{\kappa,t}). \tag{17}$$

In consequence, redistribution leads to two effects: the efficiency effect due to distortionary taxation ($-\tau_t^2 \mathit{\Gamma} e\bar{w}_{\kappa,t}$) and the redistribution effect ($\tau_t(\sum_{\kappa} N_{\kappa,t}\bar{w}_{\kappa,t} - e\bar{w}_{\kappa,t})$). The higher the individual wage (which depends on both individual productivity and the sector), the higher the efficiency loss and the lower the gains from higher redistribution (higher tax rate τ). Analogously to the efficiency effect, the redistribution effect also depends on both individual productivity and the allocation of workers across sectors. Intuitively, the differences in wages between sectors affect the preferred tax rate τ.

The proof that the preferences towards policy (tax rate τ), described by the indirect utility given in equation (17), are single-peaked is relegated to the Appendix (Proposition 5 and its proof). It is based on the derivative of the indirect utility. Next, we move on to our main results. We study how structural change and labor mobility frictions affect the selected policy relative to no structural change or labor mobility frictions.

Proposition 3. *[Preferred taxes without structural change] With no structural change or in the absence of labor mobility frictions, the policy (tax rate) selected in majority voting is given by*

$$\tilde{\tau}_t = \frac{\bar{w}_t - w_t^{med}}{2\Gamma w_t^{med}} = \frac{1 - e^{med}}{2\Gamma e^{med}} > 0.$$

Since, preferences are single-peaked we need to find median voter preferred policy. In a frictionless economy (or a frictional, but without structural change), the average wages in the two sectors are equal, $\bar{w}_{m,t} = \bar{w}_{s,t}$, which follows from equation (1). Thus, the median income corresponds to the median value of e from the distribution $\mu(e)$, e^{med}. In order to find the median voter preferred policy we differentiate equation (17) with respect to τ_t and subsequently solve it for $\tau_{t.}$. With $\bar{w}_{m,t} = \bar{w}_{s,t} = \bar{w}_t$, and given that the median is smaller than the mean ($e^{med} < \bar{e} = 1$), the preferred tax rate in a frictionless environment $\tilde{\tau}_t$ is given by

$$\tilde{\tau}_t = \frac{\bar{w}_t - w_t^{med}}{2\Gamma w_t^{med}} = \frac{\bar{w}_t - e^{med}\bar{w}_t}{2\Gamma e^{med}\bar{w}_t} = \frac{1 - e^{med}}{2\Gamma e^{med}} > 0.$$

We use this tax rate as a reference point for the case with labor mobility frictions, which we state in the next Proposition.

To find the tax preferred by the majority, the properties of the median wage are key for the case when mean wages across sectors are not equal ($\bar{w}_{s,t} \neq \bar{w}_{m,t}$), because the ratio between the mean and median changes. We show this in Proposition 2, which establishes that the median of the wage distribution is smaller than the weighted average of the medians in both industries. We obtain this result using Assumption 1 because the median of the joint distribution is lower than the weighted average of the medians from two distributions (with shares of workers in each sector providing the weights). By contrast, the mean of the joint distribution is equal to the averages of the two means (with the same weights). Given this implication, we formulate our key result: with structural change, the preferred tax rate τ is higher in an economy with labor mobility frictions than without them.

Proposition 4. *[Preferred taxes with structural change] Suppose Assumption 1 is satisfied. In an economy undergoing the structural change, in the presence of labor mobility frictions - the policy (tax rate) selected in majority voting is higher than* $\tilde{\tau}$.

$$\tau_t = \frac{(\bar{w}_t - w_t^{med})}{2\Gamma w_t^{med}} > \tilde{\tau}_t > 0$$

Proof. As in the case of Proposition 3, to prove this result it is enough to find the median voter preferred policy. We get it in three steps. First, Proposition 2 establishes that

$$\tau_t = \frac{\bar{w}_t - w_t^{med}}{2\Gamma w_t^{med}} > \frac{\bar{w}_t - (N_{m,t} w_{m,t}^{med} + N_{s,t} w_{s,t}^{med})}{2\Gamma (N_{m,t} w_{m,t}^{med} + N_{s,t} w_{s,t}^{med})}.$$

Second, we use $w_{\kappa,t}^{med} = e^{med} \bar{w}_{\kappa,t}$ to substitute

$$\tau_t > \frac{\bar{w}_t - (N_{m,t} e^{med} \bar{w}_{m,t} + N_{s,t} e^{med} \bar{w}_{s,t})}{2\Gamma (N_{m,t} e^{med} \bar{w}_{m,t} + N_{s,t} e^{med} \bar{w}_{s,t})} = \frac{\bar{w}_t - e^{med}(N_{m,t} \bar{w}_{m,t} + N_{s,t} \bar{w}_{s,t})}{2\Gamma e^{med}(N_{m,t} \bar{w}_{m,t} + N_{s,t} \bar{w}_{s,t})}.$$

Finally, since $\bar{w}_t = (N_{m,t} \bar{w}_{m,t} + N_{s,t} \bar{w}_{s,t})$, we obtain that:

$$\tau_t > \frac{1 - e^{med}}{2\Gamma e^{med}} = \tilde{\tau}_t > 0.$$

□

Summarizing our results, we obtain that productivity growth rate differentials across sectors trigger the reallocation of labor. Next, we obtain that labor mobility frictions slow down this process. Since adjustment on the supply side of the goods market is slower, given the demand, prices of products of the sector that receives an insufficient influx of workers increase. Since labor markets are perfectly competitive, this increase boosts relative wages in this sector. The divergence in wages raises inequality, which we operationalize as the ratio between mean and median wage in an economy. This rise encourages higher redistribution. Thus, our derivations demonstrate that reallocation contributes to the rise in inequality, in a setup with such frictions.

In addition to the size of the welfare state during reallocation, the spans of support for redistribution are longer as the frictions decelerate reallocation. Given the existing literature, this result is not obvious: a rising share of individuals earns higher wages during reallocation. Hence there could be less support for redistribution rather than more. The reason behind our result is that wage dispersion in an economy increases, which raises the median wage less than it boosts the mean wage.

3.1 Discussion and empirical illustration

Ultimately, our model is consistent with the following stylized facts.[8] First, total factor productivity grows faster in manufacturing than in services. This fact is confirmed for both industrialized countries (e.g., Herrendorf et al. 2015, for the case of US) and for CEE countries (e.g., Growiec et al. 2015, for the case of Poland). Second, the wage is higher in services than in manufacturing. This is a general pattern worldwide (Ngai and Pissarides 2007). These patterns are fairly universal and non-controversial.

Further, for our model to be consistent with the data, it would have to hold that in the periods of structural change, the relative price of services increases, and so does the services sector wage premium. We document that the hump-shaped pattern of the service sector premium is consistent with the data, at least in some countries (recall Figure 1). Admittedly, for most countries establishing the "start" of the structural change is impossible, which makes dating the pattern of service sector premium in wages challenging. Finally, the patterns of relative prices are subject to numerous forces, particular international trade in goods and services and changes in the global value chains. As in the case of service sector premium, the same dating challenge exists: timing the trends of the relative prices is thus beyond the scope of this paper.

One way to empirically test the implications of our theoretical setup is taking the model to the data. We test if the model is consistent with the data in the following manner. We use World Input Output Database (WIOD) to obtain economic structure across countries and years. WIOD provides data on economic structure for employment, which is convenient given our model setup. The 2014 edition is available for 1995-2011 and covers forty countries. We capture structural change using a Lilien index (1982), as adjusted by Stamer (1998). This index captures which share of workers in the economy changed sectors within a defined period of time. We use annual measures of structural change.

This data is combined with the indicators of the degree of redistribution from the World Development Indicators database provided by The World Bank. Note that in this data source, the inequality indicators are based on disposable income (after taxes and transfers). Hence they cannot be used in our study. Coverage of redistribution indicators varies substantially by country and indicator. We selected the few indicators with the greatest availability for the countries and years represented in structural change data. These indicators include subsidies and other transfers (expressed as % of GDP and as % of total government expenditure) and tax revenue (as % of GDP).

This empirical illustration has no ambitions to provide a causal analysis. We simply test if the model predictions are consistent with the data. We estimate a panel model with country fixed effects and standard errors clustered at the country level. We estimate two specifications: with and without adjustment for the

[8]We are grateful to an anonymous referee for offering the framework for this synthesis.

Table 1: Empirical illustration

	Subsidies / GDP			Subsidies / Expenses			Taxes /GDP		
	(1)	(1a)	(1b)	(2)	(2a)	(2b)	(3)	(3a)	(3b)
Lilien index	1.66***	1.64***	1.50**	2.16*	2.26*	1.87	-0.68	-0.68	-0.86
	(0.57)	(0.57)	(0.60)	(1.25)	(1.24)	(1.36)	(0.71)	(0.72)	(0.78)
GDP per capita		0.70*	0.59		-2.26***	-0.37		-0.02	1.99**
		(0.39)	(0.79)		(0.84)	(1.77)		(0.48)	(0.96)
Tertiary enrollment			-0.01			-0.07*			-0.06**
			(0.02)			(0.04)			(0.02)
Observations	441	440	378	452	451	387	467	466	402
R^2	0.93	0.93	0.92	0.90	0.91	0.90	0.90	0.90	0.90

Notes: panel model with country fixed effects. Constant included in estimation, ommited from reporting (available upon request). Data for structural change come from World Input Output Database, the Lilien index for changes in employment shares. Data on the extent of transfers and redistribution comes from The World Bank. Columns (1), (1a) and (1b) have subsidies and other social transfers as % of GDP as the dependent variable. Columns (2), (2a) and (2b) have subsidies and other social transfers as % of total government expenditure as a the dependent variable. Columns (3), (3a) and (3b) have tax revenue as % of GDP as the dependent variable. Note that the availability of data on tertiary enrollment is lower than for the fiscal indicators, hence lower number of observations in columns denoted by the letter b. The asteriks *, **, and *** denote significance at 10%, 5% and 1%, respectively.

GDP per capita (also taken from the WDI database, it is adjusted for PPP and expressed in per capita terms). The results are reported in Table 1.

We find statistically significant and positive contemporaneous correlations between the extent of labor reallocation and the indicators of structural change. This is in line with the implications of our model: economies undergoing structural change experience higher income inequality and intensified demand for redistribution. We do not find adjustments in tax revenues. The relationship is not statistically significant. There may be several reasons for this result. The governments may adjust public debt rather than immediately adjust taxes. Also, tax revenues may be the same in a country, but the tax composition may be such that redistribution is raised. Overall, this stylized empirical illustration does not reject the implications of the theoretical model in this paper.

4 Conclusion

This paper contributes to the literature on structural change, inequality, and redistribution. We show that an economy experiencing a structural change has higher income inequality if it features labor mobility frictions. We study a setup where differentiated productivity growth translates to unequal wages across sectors. Frictions prevent wage equalization and slow down the reallocation process. The increase in inequality raises the median voter's appetite for redistribution.

Note that, for our result, both reallocation and labor mobility frictions are essential. The theoretical setup is parsimonious. We assume exogenous labor supply; taxes generate a cost of distortion rather than discourage labor. However, it is intuitive that, with an elastic labor supply, the appetite for redistribution would further slow down the reallocation (by attenuating the wage differentials between sectors). Further, we assume that workers rely on comparing instantaneous wage levels rather than lifetime incomes, but for all intents and purposes, these two are equivalent in our setup. Thus, a less parsimonious setup would be less tractable, but would yield qualitatively the same implications. Finally, we assume that transfers do not discourage labor supply. This channel of links between redistribution and inequality has been extensively studied in the existing literature. Our paper supplements these existing theories.

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Appendix: Proofs

Proof of Proposition 1 (by contradiction).

First, we check how employment would change in an environment without and with mobility frictions. We prove it by contradiction, suppose there is no reallocation, i.e. $N_{m,t} \geq N_{m,t-1}$. Notice that $\gamma_{m,t} > \gamma_{s,t}$ implies $\frac{A_{m,t}}{A_{s,t}} > \frac{A_{m,t-1}}{A_{s,t-1}}$ and for $\varepsilon \in (0,1)$ from (16) we get

$$\tilde{N}_{m,t} = \frac{1}{(\frac{A_{m,t}}{A_{s,t}})^{1-\varepsilon}(\frac{\vartheta}{1-\vartheta})^{\varepsilon} + 1},$$

which yields a derivative with respect to the productivity ratio $\frac{A_{m,t}}{A_{s,t}}$. This derivative is negative, therefore, $\tilde{N}_{m,t-1} > \tilde{N}_{m,t}$. By implication $N_{m,t} \geq N_{m,t-1} \geq \tilde{N}_{m,t-1} > \tilde{N}_{m,t}$ Next, from (16) using $N_{m,t} \geq N_{m,t-1}$ we get

$$\frac{N_{m,t}}{(1-N_{m,t})} = (1 + \frac{\chi}{\rho}(1 - \frac{N_{m,t}}{N_{m,t-1}}))^{\varepsilon}(\frac{A_{s,t}}{A_{m,t}})^{1-\varepsilon}(\frac{1-\vartheta}{\vartheta})^{\varepsilon} \leq (\frac{A_{s,t}}{A_{m,t}})^{1-\varepsilon}(\frac{1-\vartheta}{\vartheta})^{\varepsilon} = \frac{\tilde{N}_{m,t}}{(1-\tilde{N}_{m,t})} \tag{18}$$

which, in turn, implies $N_{m,t} \leq \tilde{N}_{m,t}$ that is a contradiction. Thus, in period t there is reallocation of labor from manufacturing to services: $N_{m,t} < N_{m,t-1}$.

The relationship between $N_{m,t}$ and $\tilde{N}_{m,t}$ can be obtained from equation (16). It implies that the opposite of equation (18) is true:

$$\frac{N_{m,t}}{(1-N_{m,t})} = (1 + \frac{\chi}{\rho}(1 - \frac{N_{m,t}}{N_{m,t-1}}))^{\varepsilon}(\frac{A_{s,t}}{A_{m,t}})^{1-\varepsilon}(\frac{1-\vartheta}{\vartheta})^{\varepsilon} > (\frac{A_{s,t}}{A_{m,t}})^{1-\varepsilon}(\frac{1-\vartheta}{\vartheta})^{\varepsilon} = \frac{\tilde{N}_{m,t}}{(1-\tilde{N}_{m,t})}.$$

Consequently, $N_{m,t} > \tilde{N}_{m,t}$, which completes the proof that $N_{m,t-1} - N_{m,t} < N_{m,t-1} - \tilde{N}_{m,t}$..

Second, we look at relative prices. Notice that with no labor mobility frictions $\tilde{p}_{s,t} = A_{m,t}/A_{s,t}$. Next, from Theorem 1 we know that labor mobility frictions slow down reallocation, thus $N_{m,t} < \tilde{N}_{m,t}$. Therefore, from equation (15)

$$p_{s,t} > \tilde{p}_{s,t} = A_{m,t}/A_{s,t}.$$

Finally, we show the average wage inequality across sectors with mobility frictions. We are going to use the fact that $p_{s,t} > A_{m,t}/A_{s,t}$. Substituting from equation (3) we obtain

$$\bar{w}_{s,t} = p_{s,t}A_{s,t} > A_{m,t} = \bar{w}_{m,t}.$$

□

Proof of Proposition 2.

For brevity we drop the time index on wages. Since $w_m = e\bar{w}_m$ and $w_s = e\bar{w}_s$ it follows from Assumption 1 that the distribution functions for wages in manufacturing F_m and services F_s are strictly concave and strictly monotone for $w \in [w_m^{med}, w_s^{med}]$, where $w_m^{med} = e^{med}\bar{w}_m$ denotes the median wage in manufacturing and $w_s^{med} = e^{med}\bar{w}_s$ in services. Since $N_m w_m + (1 - N_m)w_s$ is a mixed random variable, its distribution is given by $N_m F_m(w_m) + (1 - N_m)F_s(w_s)$.

For the proof we need to show that

$$N_m F_m(N_m w_m^{med} + (1 - N_m)w_s^{med}) + (1 - N_m)F_s(N_m w_m^{med} + (1 - N_m)w_s^{med}) > \frac{1}{2}$$

First, from strict convexity

$$N_m F_m(N_m w_m^{med} + (1 - N_m)w_s^{med}) + (1 - N_m)F_s(N_m w_m^{med} + (1 - N_m)w_s^{med}) >$$
$$N_m^2 F_m(w_m^{med}) + (1 - N_m)N_m F_m(w_s^{med}) + (1 - N_m)N_m F_s(w_m^{med}) + (1 - N_m)^2 F_s(w_s^{med})$$

Thus it is enough to show that the second term is larger than $1/2$. Rearranging it gives us the inequality we need to prove

$$N_m^2 F_m(w_m^{med}) + (1 - N_m)N_m F_m(w_m^{med}) + (1 - N_m)N_m(F_m(w_s^{med}) - F_m(w_m^{med}))$$
$$+(1 - N_m)N_m(F_s(w_m^{med}) - F_s(w_s^{med})) + (1 - N_m)N_m F_s(w_s^{med}) + (1 - N_m)^2 F_s(w_s^{med}) > \frac{1}{2}$$

Using the fact that $F_m(w_m^{med}) = F_s(w_s^{med}) = 1/2$ and simplifying further, the formula above becomes

$$(1 - N_m)N_m(F_m(w_s^{med}) - F_m(w_m^{med})) - (1 - N_m)N_m(F_s(w_s^{med}) - F_s(w_m^{med})) > 0$$

Since $F_m(w_m^{med}) = F_s(w_s^{med})$ we can reformulate

$$(F_m(w_s^{med}) - F_s(w_s^{med})) - (F_m(w_m^{med}) - F_s(w_m^{med})) > 0$$

Consider a case $w_s^{med} > w_m^{med}$ then $F_m(w) \geq F_s(w)$ and the equation above becomes

$$F_m(w_s^{med}) - F_s(w_s^{med}) > F_m(w_m^{med}) - F_s(w_m^{med})$$

which is true following from the fact that F_m and F_s are strictly concave and strictly monotone for $w \in [w_m^{med}, w_s^{med}]$.

Consider a case $w_s^{med} < w_m^{med}$ then $F_m(w) \leq F_s(w)$ and the equation above becomes

$$F_s(w_m^{med}) - F_m(w_m^{med}) > F_s(w_s^{med}) - F_m(w_s^{med})$$

which is true following from the fact that F_m and F_s are strictly concave and strictly monotone for $w \in [w_m^{med}, w_s^{med}]$. □

Proposition 5. *Preferences given by equation* (17) *are single-peaked.*

Proof. Note that

$$W_\tau(\tau_t, e, \kappa) = -2\tau_t \mathit{\Gamma} e\bar{w}_{\kappa,t} + (\sum_\kappa N_{\kappa,t}\bar{w}_{\kappa,t} - e\bar{w}_{\kappa,t})$$

Define

$$\tau_t^\star(ew_{k,t}) = \begin{cases} \frac{(\sum_\kappa N_{\kappa,t}\bar{w}_{\kappa,t} - e\bar{w}_{\kappa,t})}{2\mathit{\Gamma} e\bar{w}_{\kappa,t}}, & \text{for } \frac{(\sum_\kappa N_{\kappa,t}\bar{w}_{\kappa,t} - e\bar{w}_{\kappa,t})}{2\mathit{\Gamma} e\bar{w}_{\kappa,t}} \in [0,1] \\ 1, & \text{for } \frac{(\sum_\kappa N_{\kappa,t}\bar{w}_{\kappa,t} - e\bar{w}_{\kappa,t})}{2\mathit{\Gamma} e\bar{w}_{\kappa,t}} > 1 \\ 0, & \text{for } \frac{(\sum_\kappa N_{\kappa,t}\bar{w}_{\kappa,t} - e\bar{w}_{\kappa,t})}{2\mathit{\Gamma} e\bar{w}_{\kappa,t}} < 0 \end{cases}$$

Since for all $1 \geq \tau_t > \tau_t^\star$, $W_\tau(\tau_t, e, \kappa) < 0$ and $\tau_t^\star \geq \tau_t \geq 0$, $W_\tau(\tau_t, e, \kappa) > 0$ these preferences are single peaked. □

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Preference for redistribution during structural change with labor mobility frictions

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Preference for redistribution during structural change with labor mobility frictions

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Abstract
Thorough structural change occurs periodically across world economies. In a parsimonious overlapping generation setup with political economy, we present a novel result: structural change not only exacerbates the rise in inequality but also strengthens the preference for redistribution. Labor mobility frictions are instrumental in this mechanism.

Keywords:
structural change, labor mobility frictions, redistribution

JEL Classification
H10, Z1

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