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Structural change and inequality in a general equilibrium model of a transition economy

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Abstract

The paper studies the role of economic transition in the evolution of wealth inequality. We build a novel overlapping generations model that features heterogeneous workers and exogenous changes: (i) a structural change shifting employment from manufacturing to services and increasing educational attainment, (ii) TFP growth along the path of macroeconomic convergence and (iii) gains in longevity. Using this model, we quantify the role of structural change in the evolution of wealth inequality in Poland as of 1990. We show that a rise in wealth inequality because of growing longevity is lower in an economy undergoing structural change. Thus, structural change per se lowers wealth inequality, at least initially. We also provide an evaluation of a policy-relevant redistribution instrument.

KEYWORDS

demographic change, inequality, structural change

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1 | INTRODUCTION AND MOTIVATION

We study the effects of income inequality on wealth inequality in an economy undergoing structural change. Economic intuition is clear about the effects on income inequality. Structural change does not affect income inequality, absent economic frictions, because wages fully equalise. In an economy with frictions, structural change ushers a rise in income inequality, at least transiently: wages become more dispersed because some workers are still employed in the declining sector, whereas the rest of the labour force is already working in the emerging ones. This polarization is transitory. When the structural change is over, wages eventually become less dispersed.

Economic intuition is more ambiguous for the effects on wealth inequality. On the one hand, increased income dispersion implies increased dispersion in the ability to accumulate wealth across individuals. On the other hand, workers experience greater uncertainty, which may push them to more precautionary savings, which works towards equalising wealth distribution. The net effect of these two opposing forces is an empirical question. In addition, although the effects on income inequality may be transient, it is not clear whether episodes of structural change have lasting effects on wealth distribution. Finally, the extent to which, if at all, redistribution policies can effectively mitigate the rise in wealth inequality remains to be clarified. We seek to address these questions in a novel general equilibrium model with overlapping generations and exogenous structural change. Our model is able to provide new insights on the implications of the rising longevity and massive adjustment in the sectoral composition of the economy.

The relevance of our research questions is emphasised by broad empirical evidence on the evolution of wealth and income inequality in countries undergoing structural change. It was extensively documented that economies transitioning from central planning to market-based systems have been experiencing a rise in income and wealth inequality (Flemming & Micklewright, 2000; Milanovic, 1998; Milanovic & Ersado, 2012). This rise was attributed to the differences between preferences of social planners (who presumably tend to equalise incomes and reduce wealth accumulation) and market mechanisms (which are characterised by dispersed rewards to workers and strong incentives for wealth accumulation; Munich et al., 2005, Tyrowicz & Smyk, 2019). It is too often overlooked, however, that transition economies experienced profound structural change, not only through the growth of the private sector but largely through the declining role of manufacturing (especially heavy industry) and the boom in market services.

Our paper offers several contributions to the existing literature. First, our novel model sheds light on the nexus between structural change and wealth inequality: structural change *reduces* wealth inequality, at least over the first few decades. Second, the rise in wealth inequality observed in the data is mainly driven by rising longevity. We show the microfoundations of these findings and the role of the general equilibrium. Third, with a structural model, we study whether greater redistribution helps alleviate the rise in wealth inequality. We provide intuition for why income redistribution actually amplifies wealth inequality for finitely lived agents.

We calibrate our study to the case of Poland, a country that underwent an unanticipated transition from a centrally planned to a market economy, accompanied by a massive educational boom. This case is convenient for studying structural change because the beginning of the

transition is timed precisely, reducing the arbitrariness of modelling choices. Furthermore, most changes happened unexpectedly and rapidly, resembling exogenous processes. Finally, Poland is useful as all Central and Eastern European countries underwent a similar combination of structural change, educational boom and demographic change.

There are four important limitations to existing empirical studies, which we aim to bridge with our study. First, data on incomes and wealth during structural change is scant, constraining the ability to study *joint* evolution of income and wealth inequality. A structural general equilibrium model delivers simulated incomes and wealth distributions consistent with the initial conditions and exogenous features of the structural change and demographic transition. Second, observational data rarely permit counterfactual analysis because structural change is typically accompanied by a wide variety of redistribution and structural policies, entangled in a political economy process (see Roland, 2002, Beck & Laeven, 2006, Aristei & Perugini, 2012, 2014, for the context of transition from centrally planned to market economy). Our model permits introducing a counterfactual policy and evaluating the effects of this policy relative to the status quo. Third, a structural model permits to isolate the effects of structural change from the effects of the demographic transition. We can thus account for the compositional and behavioural consequences of changing the population's age structure. Fourth and final, the existing studies do not account for a massive increase in human capital across the transition countries: the share of individuals with tertiary education in a given birth cohort has increased from under 10% to over 50% in less than a decade, which affects the supply and the demand side of skills distribution.

The existing structural literature typically works with infinitely lived agents who engage in the (possibly frictional) process of reallocation from one sector to another (Aghion & Blanchard, 1994; Buera & Kaboski, 2012; Caballero & Hammour, 1996; Castanheira & Roland, 2000; Rogerson et al., 2015).¹ These studies explain the role of human capital accumulation in skill premium and its evolution over time (Buera & Kaboski, 2012). However, across the transition economies in Europe and Central Asia, the majority of the change in employment structures occurred via demographic change: older birth cohorts retiring from declining sectors and young birth cohorts entering emerging sectors (Tyrowicz & Van der Velde, 2018, in fact, job-to-job transitions occurred typically *within* the sector of employment). Models with infinitely lived agents cannot replicate this stylised fact and thus yield insufficient adjustments in income inequality during structural change. To the best of our knowledge, no study offers general equilibrium models with structural change and demographic transition.² Our paper fills this gap in the literature.

Our paper is structured as follows. The theoretical model is presented in Section 2. Since the crux of the mechanisms studied in this paper relates to *changes* along the transition path, we move directly to a full general equilibrium setup. Section 3 describes the calibration and the simulation scenarios in detail. We present the results in Section 4, together with sensitivity checks. The final section concludes, emphasising the contribution to the literature and the policy recommendations emerging from this study.

¹An extensive overview of the existing models is discussed by Herrendorf et al. (2014).

²Guilló et al. (2011) offer a stylized OLG framework of structural change, but in comparative statics. Carmignani and Mandeville (2014) study the effects of structural change on growth, but not on distribution. Studies such as Fougere et al. (2007), Kronenberg (2009), Lisenkova et al. (2013) enrich CGE models with overlapping generations structure to study the implications of rising longevity and declining fertility on demand across sectors in the economy.

2 | THE MODEL

We build an overlapping generations model. In our model, decisions regarding consumption and savings are endogenous, although education and occupational choice are taken from the data and evolve over time, with a distinct path for the subsequent birth cohorts. Our model is in general equilibrium, so household choices imply adjustments to the aggregate wages and interest rates.

Each period in the model corresponds to 1 year. The model features structural change: the manufacturing sector (M) declines and the service sector (S) expands. The model also features a change in the human capital in the economy: the share of individuals with tertiary education (HE) rises and the opposite holds for individuals without university education (LE). Finally, a demographic transition occurs in our model: the arriving young cohorts decline in size and life expectancy rises for subsequent birth cohorts.

To address the issue of inequality, our model features *ex-ante* within cohort heterogeneity and idiosyncratic income shocks (referred to as *ex-post* heterogeneity). *Ex-ante* heterogeneity reflects that individuals differ in skill levels and employment sector. We ignore the decision to invest in human capital and assume that in a given year, a given fraction of individuals arrive in the economy with tertiary education and the rest of that birth cohort arrives without it. Further, we rely on empirical evidence from transition countries that structural change in employment occurred predominantly via the entirely exogenous inter-generational exchange (Tyrowicz & Van der Velde, 2018). To reflect this stylised fact, the young individuals arrive in our model in one of the two sectors and continue in this sector until retirement: M and S . Thus, each arriving birth cohort is populated by four types of agents denoted by $h \in H \equiv \{\{HE, LE\} \otimes \{M, S\}\}$. The relative population share of each type in the economy is denoted by $\chi_{j,h,t}$. The size of the population for each type h for each age j in period t is denoted as $N_{j,h,t}$. It is determined for each arriving birth cohort as it enters the model and is held constant over the life span of this cohort, see Section 3 for details on calibrating these shares.

Households. Individuals' age is denoted by $j \in 1, 2, \dots, J$. They enter the model at the age of 21 and have a period-to-period probability of survival $\pi_{j,t}$, common for all 4 types of individuals. All individuals die with certainty at the age of 100. Individuals discount time with δ . We assume that higher educated individuals (HE) are more patient than individuals without tertiary education (LE), $\delta_{HE} > \delta_{LE}$. Because agents face mortality, there are unintended bequests b_t . In each period, unintended bequests are distributed equally among the remaining individuals.

Incomes. In our setting incomes are exogenous and risky. Each individual has two components of productivity: the *ex-ante* sector-specific productivity denoted by $\xi_{h,t}$ (which is discussed in Section 3); and the idiosyncratic productivity denoted by type-specific $\eta_{j,h,t}$. Wages are equal to the product of marginal labour productivity (w_t defined later) and the two components of individual productivity mentioned above. Hence, they are type-dependent and within-type state-dependent:

$$w_{j,h,t} = w_t \xi_{h,t} \eta_{j,h,t}. \quad (1)$$

Labour supply is inelastic: each agent supplies one unit of labour if $j < \bar{J}$ and 0 otherwise, with \bar{J} denoting the retirement age.

The idiosyncratic productivity follows a stochastic AR(1) process:

$$\log(\tilde{\eta}_{h,t}) = \varrho_{\eta,h} \log(\tilde{\eta}_{h,t-1}) + \epsilon_{h,t} \quad (2)$$

where $\epsilon_{h,t} \sim N(0, \sigma_{\eta,h}^2)$. We discretise this process and approximate it by a 5-state discrete-time Markovian process with the transition matrix $\tilde{\Pi}(\tilde{\eta}_{j,h,t} \| \tilde{\eta}_{j-1,h,t-1})$. We extend this transition matrix, which reflects pure income shocks, with the sixth state $\eta_{h,6}$ reflecting unemployment, $\eta_{h,t} \in \{\eta_{h,t,1}, \eta_{h,t,2}, \dots, \eta_{h,t,6}\}$ and $\eta_{h,t,1} = \tilde{\eta}_{h,t,1}, \eta_{h,1} = \tilde{\eta}_{h,2}, \dots, \eta_{h,5} = \tilde{\eta}_{h,5}$. Separation and job finding rates are type-specific and denoted by $\zeta_{h,t}$ and $f_{h,t}$, respectively. The two rates are equal over the first five states. Thus the transition matrix $\Pi(\eta_{j,h,t} \| \eta_{j-1,h,t-1})$ over six states is

$$\Pi(\eta_{j,h,t} \| \eta_{j-1,h,t-1}) = \begin{cases} (1 - \zeta_{h,t}) \tilde{\Pi}(\eta_{j,h,t} \| \eta_{j-1,h,t-1}), & \text{if } \eta_{j,h,t}, \eta_{j-1,h,t-1} \in \{\eta_{h,1}, \dots, \eta_{h,5}\} \\ f_{h,t}/5, & \text{if } \eta_{j,h,t} \in \{\eta_{h,1}, \dots, \eta_{h,5}\} \text{ and } \eta_{j-1,h,t-1} = \eta_{h,6} \\ \zeta_{h,t}, & \text{if } \eta_{j,h,t} = \eta_{h,6} \text{ and } \eta_{j-1,h,t-1} \in \{\eta_{h,1}, \dots, \eta_{h,5}\} \end{cases} \quad (3)$$

Jobless individuals receive unemployment benefits.

Social security. Individuals retire at age \bar{J} . Individuals contribute $\tau w_{j,h,t}$ to social security during the working period. Social security contributions are exempt from labour income taxation. The retired workers receive social security benefits $p_{j,h,t}$. Social security is of a pay-as-you-go character. The budget constraint of social security is given by:

$$\sum_{j=\bar{J}}^J \sum_{h \in H} p_{j,h,t} N_{j,h,t} = \tau w_t L_t + \Xi_t, \quad (4)$$

where Ξ_t denotes the balance of social security, to be financed by the government and L_t denotes aggregate effective labour, defined later by Equation (10).

At retirement, the value of the benefits $p_{j,h,t}$ is obtained as a sum of two components. First, there is a redistributive part that is common for all individuals. It is computed as a fraction ρ_r of the average wage in the economy at the time of their retirement \bar{w}_t (to be defined later). Second, there is a sector-specific component, which uses sector-specific wages. It is computed as a fraction ρ_h of the average sector wage in the economy $\bar{w}_{h,t} = \xi_{h,t} \bar{w}_t$.

After retirement, pensions are indexed with ι share of payroll growth rate Δ_w (to be defined later). Such design of social security in our model, portrayed by Equation (5), reflects Polish legislation.

$$p_{j,h,t} = \begin{cases} \rho_r (\rho_r + \rho_h \xi_{h,t}) \bar{w}_t & \text{for } j = \bar{J} \\ p_{j-1,h,t-1} \times (1 + \iota \Delta_w) & \text{for } j > \bar{J} \end{cases} \quad (5)$$

The free parameter ρ_t permits the matching of varying shares of pensions in GDP across time. By manipulating this parameter, we can also provide counterfactual scenarios concerning the generosity of social security without affecting its redistributive character.³

Budget constraint. Households below the retirement age earn gross labour income $w_{j,h,t}$, subject to social security contribution at the rate τ and labour income tax denoted by τ_ℓ . Note that social security contributions are exempt from labour taxation.

In addition to salary, the income also consists of post-tax capital gain $(1 - \tau_k) r_t a_{j,h,t}$ (with τ_k denoting capital income tax, r_t the interest rate and $a_{j,h,t}$ assets holdings at age j of an individual working in sector h) as well as pension benefits $p_{j,h,t}$, which households receive once they reach the retirement age. There is no income tax on pension benefits. Moreover, since survival rates $\pi_{j,h,t}$ are lower than one, in each period t there are unintended bequests, which are evenly distributed within a birth cohort, $\Gamma_{j,h,t}$. Households purchase consumption goods $c_{j,h,t}$, which are subject to consumption tax $\tau_{c,t}$ and accumulate assets $a_{j+1,t+1}$. Asset markets are incomplete; only assets with risk-free interest rate r_t are available. In summary, the households face the following instantaneous budget constraint:

$$(1 + \tau_{c,t}) c_{j,h,t} + a_{j+1,h,t+1} = (1 - \tau_\ell)(1 - \tau)w_{j,h,t} + p_{j,h,t} + (1 + (1 - \tau_k) r_t) a_{j,h,t} + \Gamma_{j,h,t} \quad (6)$$

with non-negative assets holdings constraint ($a_{j+1,t+1} \geq 0$).

Consumer problem. An individual state of each household at age j at time t $s_{j,h,t}$ can be summarised by the level of private assets $a_{j,h,t}$ and individual productivity determined by $\eta_{j,h,t}$, $s_{j,h,t} = (a_{j,h,t}, \eta_{j,h,t}) \in \Omega_h$. A newborn household in sector h enters the economy with no assets ($a_{1,h,t} = 0$) and at each state $s_{j,h,t}$ the household maximises the expected value of the remaining lifetime utility. The households discount the future with the discount factor δ_h and the conditional survival probability $\pi_{j+1,t+1}/\pi_{j,t}$. In each period, households decide how much to consume and how much to save. We define the optimization problem of the household in a recursive form as:

$$V_{j,h,t}(s_{j,h,t}) = \max_{(c_{j,h,t}, a_{j+1,h,t+1})} \frac{1}{1 - \sigma} c_{j,t}^{1-\sigma} + \delta_h \frac{\pi_{j+1,t+1}}{\pi_{j,h,t}} \mathbf{E}(V_{j,h,t+1}(s_{j+1,t+1}) | s_{j,h,t}), \quad (7)$$

subject to the budget constraint given by Equation (6), formulae for pensions given by (5) and the productivity process given by Equation (3). We denote the probability measure describing the distribution of agents of age j working in sector h in period t over the state space Ω_h as $\mathbb{P}_{j,h,t}$.

The aggregate consumption C_t and aggregate assets A_t are given by:

$$C_t = \sum_{j=1}^J \sum_{h \in H} \left(\int_{\Omega_h} c_{j,h,t}(s_{j,h,t}) d\mathbb{P}_{j,h,t} \right) \chi_{j,h,t} N_{j,t} \quad (8)$$

³Towards the end of the 1990s, most economies in Central and Eastern Europe introduced some form of funding to their social security. These funded pillars were periodically dismantled; in Poland, only a few cohorts and only for a limited number of years contributed to the funded pillar and almost nobody had the chance to claim pension benefits from the funded pillar. For details and mechanism of un-funding social security, see Beetsma et al. (2021).

$$A_{t+1} = \sum_{j=1}^J \sum_{h \in H} \left(\int_{\Omega_h} a_{j+1,h,t+1}(s_{j,h,t}) d\mathbb{P}_{j,h,t} \right) \chi_{j,h,t} N_{j,t} \quad (9)$$

Firms. Supply shares of each type of labour (differing by education and sector) are exogenously determined by $\chi_{j,h,t}$. On the production side, the labour aggregates according to

$$L_t = \sum_{j=1}^{\bar{J}} \sum_{h \in H} \left(\int_{\Omega_h} \xi_{h,t} \eta_{j,h,t} d\mathbb{P}_{j,h,t} \right) \chi_{j,h,t} N_{j,t}. \quad (10)$$

We assume competitive firms. A single consumer product is produced with standard Cobb–Douglas technology. Exogenous technological progress z_t is labour-augmenting, consistent with Smeets Kristkova et al. (2017). The firms produce a single final good using capital and labour as production inputs and generate output according to the production function: $Y_t = K_t^\alpha (z_t L_t)^{(1-\alpha)}$. Firm's maximisation yield formulae for the interest rate r_t and marginal product of labour w_t :

$$r_t = \alpha K_t^{\alpha-1} (z_t L_t)^{1-\alpha} - d \quad \text{and} \quad w_t = (1-\alpha) K_t^\alpha (z_t L_t)^{-\alpha} L_t^{-1} \quad (11)$$

where d denotes the depreciation rate. In this economy, the average wage is given by $\bar{w}_t = w_t L_t / \sum_{j=1}^{\bar{J}} N_{j,t}$. Accordingly, the payroll growth is given by $\Delta_w = w_t L_t / w_{t-1} L_{t-1}$

Government. The government collects three kind of taxes: labour tax τ_ℓ , consumption tax $\tau_{c,t}$ and capital gains tax τ_k . It uses tax revenues to finance government expenditures G_t and services government debt D_t . It is also responsible for balancing the social security Ξ_t .

$$G_t + \Xi_t + r_t D_t = \tau_{c,t} C_t + \tau_\ell (1-\tau) w_t L_t + \tau_k r_t A_t + (D_{t+1} - D_t) \quad (12)$$

Throughout the path, we keep tax rates fixed at their initial steady state levels, calibrated to data. Given the balanced budget imposed by (12), we adjust consumption tax rate $\tau_{c,t}$ as expenses and revenues from other taxes diverge. In quantitative terms, the key sources of the divergence are the changes in the balance of social security given by Ξ_t .

2.1 | Equilibrium and model solving

Next, we define a competitive equilibrium for our economy. Recall that the state of an agent at age j working in sector h at time t is fully characterised by $s_{j,h,t} = (a_{j,h,t}, \eta_{j,h,t}) \in \Omega_h$. Recall that the probability measure describing the distribution of agents of age j in sector h in period t over the state space Ω_h as $\mathbb{P}_{j,h,t}$.

Definition 1 A **competitive equilibrium** is a sequence of value functions $\left\{ \left((V_{j,h,t}(s_{j,h,t}))_{h \in H} \right)_{j=1}^J \right\}_{t=0}^\infty$, policy functions $\left\{ \left((c_{j,h,t}(s_{j,h,t}), a_{j+1,h,t+1}(s_{j,h,t}))_{h \in H} \right)_{j=1}^J \right\}_{t=0}^\infty$, prices $\{r_t, w_t\}_{t=0}^\infty$, government policies $\{\tau_{c,t}, \tau_k, \tau_\ell, D_{t+1}\}_{t=0}^\infty$, social security parameters $\{\tau, \Xi_t, \rho_t, \rho_r, \rho_h, \zeta_w\}_{t=1}^\infty$, aggregate quantities $\{L_t, A_t, K_t, C_t, Y_t\}_{t=0}^\infty$ and a measure of households $\left\{ (\mathbb{P}_{j,h,t})_{h \in H} \right\}_{t=0}^\infty$ such that:

- **consumer problem:** for each j, h and t the value function $V_{j,h,t}(s_{j,h,t})$ and the policy functions $(c_{j,h,t}(s_{j,h,t}), a_{j+1,h,t+1}(s_{j,h,t}))$ solve the Bellman Equation (7) given prices and government policies;
- **firm problem:** for each t , prices (r_t, w_t) are given by Equation (11);
- **government sector:** the government budget and the pension system constraints are satisfied, that is, Equations (12) and (4) are satisfied;
- **markets clear**

$$\text{labor market : } L_t = \sum_{j=1}^{\bar{J}} \sum_{h \in H} \left(\int_{\Omega_h} \xi_{h,t} \eta_{j,h,t} d\mathbb{P}_{j,h,t} \right) \chi_{j,h,t} N_{j,t};$$

$$\text{capital market : } A_{t+1} = \sum_{j=1}^J \sum_{h \in H} \left(\int_{\Omega_h} a_{j+1,h,t+1}(s_{j,h,t}) d\mathbb{P}_{j,h,t} \right) \chi_{j,h,t} N_{j,t},$$

$$K_{t+1} = A_{t+1} - D_{t+1};$$

$$\text{goods market : } C_t = \sum_{j=1}^J \sum_{h \in H} \left(\int_{\Omega_h} c_{j,h,t}(s_{j,h,t}) d\mathbb{P}_{j,h,t} \right) \chi_{j,h,t} N_{j,t},$$

$$K_{t+1} + G_t + C_t = Y_t + (1 - d)K_t;$$

- **probability measure:** $\forall j, \forall h$ and $\forall t$ the probability measure $\mathbb{P}_{j,h,t}$ is consistent with productivity processes and policy functions.

We solve the consumer problem with value function iterations. For a given initial distribution $\hat{\mathbb{P}}_{1,t}$ at age $j = 1$, time t , transition matrix $\Pi(\eta_{j,t} | \eta_{j-1,t-1})$ and the policy functions $\left\{ a_{j+1,t+1}(\hat{s}_{j,t})_{j=1}^J \right\}_{t=1}^{\infty}$ we can compute the distribution in any successive age j and period t . It can be interpreted as a fraction of cohort of age j at time t residing at each state of the state space $\hat{\Omega}$.⁴ Once we compute distributions and policy functions for each state, we compute aggregate quantities of consumption, labour and savings. To this end, we use the Gaussian quadrature method. To find general equilibrium, we apply the Gauss-Seidel algorithm. In each iteration, we aggregate consumer choices to obtain aggregate capital. It allows us to update factor prices, which we use to solve the consumer problem again. The procedure is repeated until the difference between the aggregate capital from subsequent iterations is negligible, that is, l_1 -norm of the difference between capital vector in subsequent iterations falls below 10^{-12} .

In the paper, we focus on wealth distribution. With this objective in mind, we make several important modelling choices that affect which aspects of structural change we can study. Firstly, to match the incomes to the data, we match the choice of education, occupation and labour supply to the data. To be as data-driven as possible, these processes are governed by parameters rather than independent optimizations. It has the advantage of matching the

⁴We discretize the reduced state space with parsing of the distribution of the assets \hat{A} across four types of households H . Thus, $\hat{\Omega} = \hat{A} \times H$ with $\hat{A} = \{a^1, \dots, a^{n_A}\}$ and $H = \{e^1, \dots, e^{n_H}\}$, where $n_A = 100$ and $n_H = 4$. We interpolate policy and value functions with piece-wise linear functions (using recursive Powell's algorithm). For each discrete $\hat{s}_{j,t} \in \hat{\Omega}$, we find the optimal consumption and labour supply of the agent using the Newton-Raphson method.

economy structure and incomes to the data. However, the downside is that our model is not suitable to deliver novel insights on income inequality, because all drivers of income inequality are taken directly from the data.

To adequately capture the influence of transition on income risk, we match the probability of unemployment directly to the data. We also calibrate taxes to effective tax rates in each period in time, adjusting for empirically observed labour share, thus capturing the potential response of labour supply. Given that we reflect the risk of unemployment in the model and response to taxation, it is sufficient to calibrate labour supply to activity rates and assume inelastic supply.

By contrast, our model features endogenous consumption-savings choice. It allows us to run counterfactual simulations with alternative social security systems to assess the contribution of the pension system reform to wealth inequality. One limitation of our study draws from the fact that we do not have data on mortality across education levels. Heterogeneity in discounting partially addresses your concern.

3 | CALIBRATION AND STATUS QUO

Our study sheds new light on the implications of structural change in the context of demographic transition for the evolution of wealth inequality. We closely match both demographic transition and structural change to the data to adequately capture the magnitudes present in the economy. Thus, our model remains agnostic about the mechanisms that led to the rise in longevity, the decline in manufacturing and the increase in human capital accumulation. Further research would be needed to endogenize these developments in an overlapping generations framework.⁵ Instead, our new model allows us to isolate the extent to which these three changes—specifically the shift from manufacturing to services, improvement in human capital and longer life-spans—affect wealth inequality. The tractability of our model allows us to quantitatively isolate the role of each of these changes using the case of the Polish economy and its transition since 1990 until today.

The model is calibrated to match features of the Polish economy during the 3 decades of economic transition from a centrally planned to a market economy, namely 1989–2020. The model period corresponds to one year. Table 1 summarises calibration parameters, targets and model outcomes. We take the standard approach to calibrate the deep model parameters: the main parameters related to macroeconomic aggregates as well as preferences are determined by matching the model-implied values to the data. However, the key ingredients of our model consist of explicitly introducing the demographic transition and structural economic changes in terms of education and employment. This section describes in detail how we proceed.

Demographics. Population evolution data comes from the United Nations. It is also the source of the demographic projection until 2100. After this horizon, we make a technical assumption that the population stabilises regarding age structure. We use the birth cohort size in 1989 and subsequent mortality rates and fertility to reproduce population numbers for each year as input data. In most scenarios, $\pi_{j,t}$ evolves according to the data and demographic project.

⁵ Factors such as technological innovation, consumer preferences and government policies may be driving structural transformation. Incorporating these factors would add complexity and reduce the tractability of the model. As a result, these dynamics remain exogenous in our approach.

TABLE 1 Calibrated parameters.

Macroeconomic parameters		Calibration		Target	Value	Model outcome
Income shocks		HE	LE			
$q_{h,\eta}$	Persistence	0.9548	0.9016	Estimation		
$\sigma_{h,\eta}$	Variance	0.0098	0.0347	Estimation		
α	Capital share	0.33		Literature		
Calibrated for $t \in <0,10>$ using the targets from 1990s						
	Risk preference	For $\theta = 2$	For $\theta = 4$	Literature		
g	Government	17%		Expenditure ^a	17% ^b	17%
τ_ℓ	Labour tax	12.2%	12.1%	Revenue ^a	7.3% ^b	7.3%
τ_c	Consumption tax	16.1%	14.6%	Revenue ^a	10.7% ^b	10.7%
τ_k	Capital tax	15.8%	13.0%	Revenue ^a	4.0% ^b	4.0%
\bar{J}	Retirement age	62 years			OECD	
τ	Social security contr.	10.5%	9.5%	Benefits ^a	7.5% ^b	7.4%
ρ_r	Redistributive ρ	24%		legislation		
ρ_h	Individual ρ	17.5%	17.5%	$Subsidy_{t=0}/Y_{t=0}$	0.0%	-0.02%
ι	Indexation	25% of payroll growth		legislation		
Calibrated using the targets from the final steady state						
δ	Discounting rate	0.973	0.943	r in $t = T$	3%	3.1%
d	Depreciation rate	5.8%		$\Delta K/Y$ in $t = 1$	-	19.0%
$\{\delta_{LE}; \delta_{HE}\}$	δ multiplier	{0.976; 1.024}	{0.95; 1.05}	Wealth gini	65	65

Note: ^a denotes ratios as a % share of GDP; ^b denotes OECD as a data source. Tax rate calibrations following Mendoza et al. (1994), see Table A1, using the averages of tax shares in GDP from 1995 to 1999. The final steady state investment rate is unknown. Throughout the 1990–2020 period, the investment rate fell slightly short of 19% of GDP on average, whereas the initial steady state investment rate implied by our model is 18%.

The scaling factor of pensions $\rho_t = 1$ for $t \in <0,10>$. In the baseline scenario, ρ_t adjusts to match the expenditure as the share of GDP along the transition path. In the counterfactual scenario, we keep ρ_t constant throughout the transition path.

Consumption tax rate τ_c equals the calibrated value for the first 10 periods of the model. After that, it adjusts freely to balance the budget, given other tax rates, government expenditure, social security balance and debt.

There are no historical data for $\pi_{j,t}$ separately for individuals differing with respect to education or sector of employment, so we assume $\pi_{j,t}$ common for all h types in each birth cohort.⁶ In scenarios without an increase in longevity, we keep constant at the level of 1989 $\forall t$.

⁶Given that mortality varies by education, the effects of structural change on wealth distribution could be mediated by the share of tertiary educated individuals. However, empirical evidence emphasizes the role of education in determining income and thus potential wealth. The evidence that individuals with tertiary degrees exhibit differential savings behaviour, ceteris paribus, is less compelling. Our model features the quantitatively relevant channel. Note that in line with the data, discounting differs between tertiary educated households and those without a university degree.

Idiosyncratic productivity shocks (η). No panel data on income is available for Poland.⁷ We estimate the idiosyncratic component using the Socio-Economic Panel (SOEP) for another transition economy: Eastern Germany. The idiosyncratic component is specified as a first-order autoregressive process. We estimate the stochastic process separately for individuals with a tertiary degree (*HE*) and less than a university education (*LE*). Likewise, we estimated the processes for the services and manufacturing sectors, but no statistically significant differences were present in the data between sectors. We obtain autoregression $\rho_{\eta,HE} = 0.9548$ for the individuals with a tertiary degree and $\rho_{\eta,LE} = 0.9016$ for the others. Likewise, we obtain the variance for those with and without tertiary education at variance $\sigma_{\eta,HE} = 0.0098$ and $\sigma_{\eta,LE} = 0.0347$, respectively. Those results align with Fehr et al. (2013) regarding high-skilled individuals. However, our estimates for low-skilled ones yield lower autoregressive coefficients and higher transitory standard deviations. Those differences may come from the fact that Fehr et al. (2013) distinguish three education levels (higher, medium and lower education), whereas we combine medium and lower into the LE category. The productivity shocks are constant over time and birth cohorts.

The productivity shocks are augmented by the unemployment risk. We use the quasi-panel features of the Labour Force Survey for Poland to obtain the flow measures for the labour market. We calibrate $\zeta_{h,t}$ and $f_{h,t}$ to match the separation and hiring rates in the data. Note that both these parameters vary over time. We calibrate these parameters in two steps. First, we estimate the aggregate separation and hiring rates following Shimer (2012), an exercise similar to Strawiński (2009). These estimates are subsequently adjusted to reflect the specificity of sectors and education levels. In other words, each of the four ex-ante heterogeneous groups has its own separation and hiring probabilities, consistent with Polish data.

Note that the separation and the hiring rates vary over time, which is in line with the changes in the Polish economy. For the years 1990–2020, we follow the data. As of 2020, we take the technical assumption that the hiring and separation rates converge to the average levels observed during the past decade, which implies the unemployment rate of 4.7% in the long run. The match between the unemployment rate implied by our model and the data is portrayed in Figure 1.

Ex-ante heterogeneity (h, χ). Central and Eastern European transition countries have undergone massive education booms: growing demand for tertiary education was satisfied through newly emerging institutions. Tertiary enrolment increased massively. We reflect those changes by the increasing share of individuals with higher education in each birth cohort arriving to the labour market. Likewise, massive demand for skilled labour in services has increased the share of each new birth cohort working in that sector. These changes in education and sector of employment—the ex-ante heterogeneity—govern the structural change in our model economy. We use the Polish Labour Force Survey between the earliest available years, 1994 and 2020, to obtain the shares of salaried workers employed in manufacturing and services. We do that separately for the individuals with and without a tertiary degree. We thus obtain four target shares: $\chi_{M,HE}, \chi_{M,LE}, \chi_{S,HE}, \chi_{S,LE}$. We use the data for 1994 to determine the initial employment shares.

In our model, the change in the structure of employment occurs via the labour market entry of new cohorts and the exit of the elderly. For the first 40 years, the exits of the elderly are

⁷Antman and McKenzie (2007) provide a way to obtain the permanent component if a rotating panel is available. However, a panel is necessary to obtain the estimates of the idiosyncratic income process as described by Equations (2) and (3).

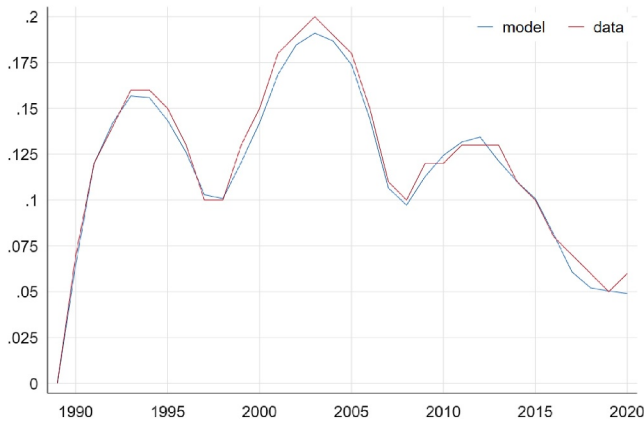


FIGURE 1 Unemployment rate (model vs. data). The unemployment rate from data versus the rate implied by the model, given job finding and separation rates displayed in Figure A1. Data are obtained from the Polish Labour Force Survey, following the ILO definition of unemployment. The model is calibrated to replicate the overall activity rate for consistency. [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1111/eort.12443)]

determined by the initial employment shares. The entry shares among the youth were set to match the aggregate evolution of the employment structure. We utilise the data for the youth entry from the Polish Labour Force Survey and model implied exits of the elderly.

Our approach results in a good match to the data, as summarised in Figure 2, which portrays data and model shares in total economy. Note that our calibration takes from the data *youth* employment shares and the economy evolves subsequently according to the model as described above. The total economy employment shares are thus implied by the model. The match between the model and the data is surprisingly close, given that the model is parsimonious relative to sometimes abrupt shifts in the economy.

Productivity growth (γ_t). The model specifies labour augmenting growth of technological progress $\gamma_{t+1} = z_{t+1}/z_t$. This progress captures the consequences of R&D activity, entering the global value chains and spillovers from FDI, as well as processes outside the scope of this paper. We use the data for 1989–2019 to capture the time-varying nature of technological progress. We use the TFP calculation from Penn World Tables (CTFP variable). We apply HP filtering to smooth the original data and ease the computational difficulty. For the years 2020 and later, we take levels implied by long-term projections of the Ageing Work Group of the European Commission. The implied technological progress amounts to 1% per annum as of 2070. Note that human capital accumulates in our model as the share if each birth cohort which acquires tertiary education increases. This is another channel of growth. The estimates of TFP from Penn World Tables combine human capital investment as well as innovation into one calculation. Given that human capital channel is separate in our model from the innovation channel, the productivity growth is adjusted for the changes in the labour composition according to the following equation:

$$\tilde{\gamma}_t = \gamma_t / \frac{\sum_{j=J}^J \sum_{h \in H} \xi_{h,t} \chi_{j,h,t} N_{j,h,t}}{\sum_{j=J}^J N_{j,h,t}}. \quad (13)$$

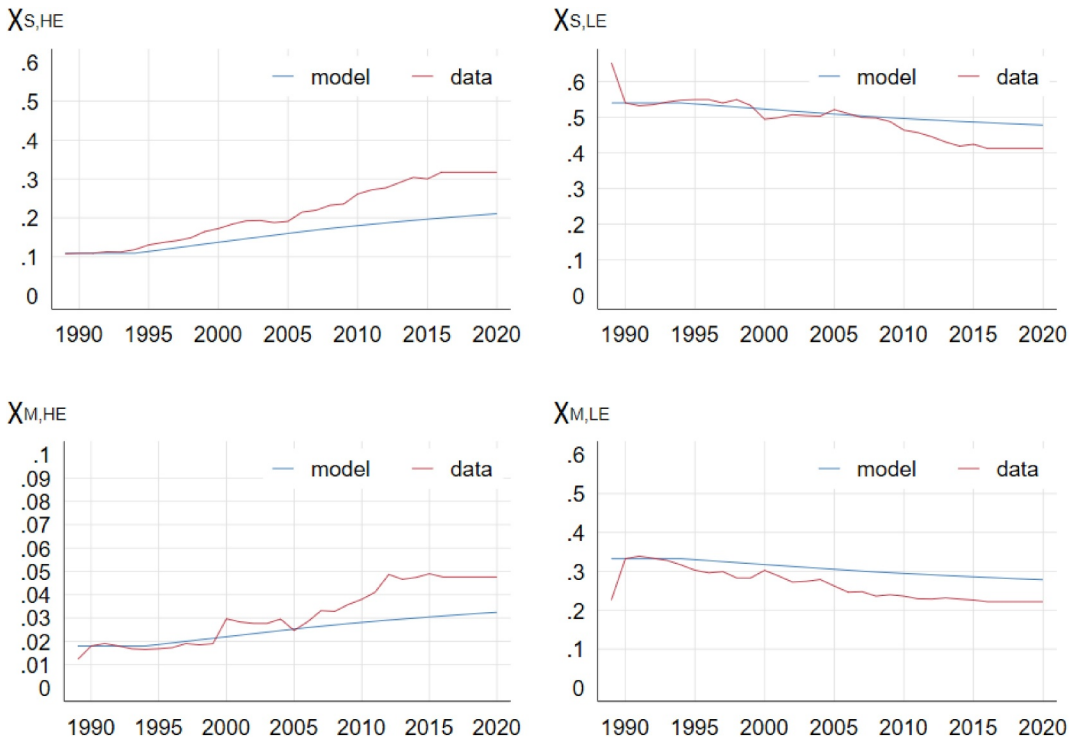


FIGURE 2 Employment shares. The initial shares were established using 1994 data from the Polish Labour Force Survey. The shares are fed into the model and gradually converge to levels. [Colour figure can be viewed at wileyonlinelibrary.com]

Preferences. The discount factor δ was set at 0.9740 to match the interest rate of 3% in the final steady state. To reflect the differences in longevity, we set that discount factor higher for HE individuals and lower for LE individuals. We calibrate the h -type specific adjustment of δ such that wealth inequality in our model matches wealth inequality in the data. There are no measures of wealth inequality for 1989. The earliest available estimates suggest a Gini coefficient on wealth close to approximately 60 (Davies et al., 2011). The implied multiplier of δ for $h = HE$ amounts to 1.024 (which implies $\delta_{HE} = 0.9960$) and for the $h = LE$ agents it is 0.976 (which implies $\delta_{LE} = 0.9496$).

Following the empirical evidence, the risk preference parameter θ should be set at values between 2 and 4 (Brown et al., 2021). For the lower estimates, the individuals are, on average, risk-neutral. For the higher estimates, the individual exhibits sizeable levels of risk aversion. The risk aversion parameter is particularly relevant in our study, given that the structural change on the aggregate translates to altered income uncertainty for individuals. With higher levels of risk aversion, precautionary motives will play a more dominant role than in the case of lower risk aversion. To address this issue, we present the results for these two extreme values, with the premise that they represent the lower and upper bounds on the role of precautionary motives. The risk preference parameter θ is common across types.

Social security parameters. Retirement age eligibility occurs at 62, the average effective retirement age over this period, following OECD. We follow Mendoza et al. (1994) to set the contribution rate to social security, using OECD data to obtain the share of social security contributions in GDP.

We calibrate the benefits side of social security stepwise. Recall that ρ_t is the free parameter allowing us to vary the generosity of social security in line with the data. We thus set $\rho_{t=1} = 1$, that is, fix this parameter in the initial steady state. The legislation sets the redistributive component of the pension benefit as $\rho_r = 0.24$ and this parameter did not change over time. Knowing the two parameters, we set ρ_h to balance the social security in the initial steady state. It implies $\rho_h = 0.175$. We fix this parameter for the entire transition path; along the transition, it is ρ_t that varies to match the share of benefits in GDP.

Taxes and public debt. Taxes are calibrated using Mendoza et al. (1994) approach using the average of the OECD data for Poland for the first decade of transition (1990–2000). The capital income tax was set to 15.8% to match the 4.0% ratio of the capital income tax revenues to GDP. The marginal tax rate consumption was set to 16.1% to match the 10.7% ratio of consumption income tax revenues to GDP in the initial steady state. At the transition path and in the final steady state, the tax rate is adjusted to balance the government budget constraint given by Equation (12). The labour tax rate is set to 12.2% to reflect the ratio of labour tax revenue to GDP of 7.3%. The data on ratios between tax revenues and GDP come from the OECD data, see Table A1. We set the government expenditure to GDP ratio in the initial steady state to 0.27 to close the budget and match the debt to GDP ratio at 60%.

Validation. As portrayed in Figure 2, our model replicates the evolution of employment shares in the economy by education and sector of employment well. Another untargeted feature of the economy which we replicate well is both consumption and income inequality in the initial steady state. We achieve an income Gini coefficient of approximately 0.33 and a consumption Gini coefficient of approximately 0.25, consistent with the World Income Inequality Database. Our model generates a rise in income inequality in the base scenario of 11.3 Gini points (which is equivalent to a rise from 0.33 to 0.443). According to the data, equivalent measures of income inequality have risen to 0.48). Thus, our model replicates the overall evolution of income inequality accurately.

4 | RESULTS

We analyse wealth inequality. We present results in three substantive parts. First, we discuss the role of structural change and demographic change in the evolution of wealth inequality. We then explain the mechanisms behind the observed trends. Finally, to gauge the efficacy of available policies in reducing inequality, we present the results for a counterfactual scenario.

4.1 | Trends in wealth inequality

The structural change in our model occurs in two forms: first, the TFP growth varies over time and second, there is an adjustment in employment shares due both to rising educational attainment and the decline in the role of manufacturing. This structural change occurred parallel with the demographic change: rising survival rates translate to stronger incentives for old-age saving *ceteris paribus*. These two main processes are the main drivers of the adjustment in inequality. We show the evolution of wealth inequality in Figure 3: the left panel shows the results for calibrations with $\theta = 2$ and the right panel shows them with $\theta = 4$. For ease of interpretation, we present the level of inequality relative to the initial steady state. This way, it is

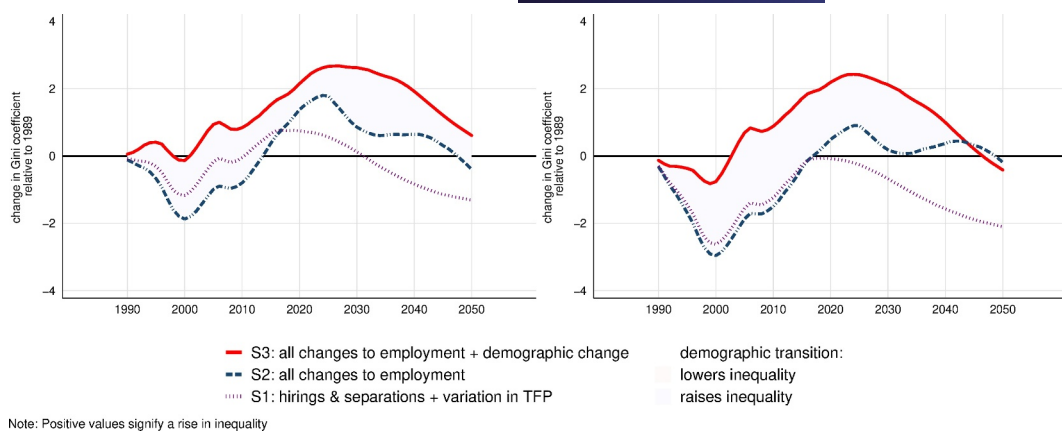


FIGURE 3 Wealth inequality (over time). The left panel shows the results for a calibration with $\theta = 2$ and the right panel shows them for a calibration with $\theta = 4$. Scenarios are additive: every following scenario includes the transition path of the previous scenario. The line denoted as “S1” accounts for time-varying evolution in TFP across manufacturing and services. The line denoted “S2” accounts *additionally* for an increase in educational attainment and a decline in manufacturing shares. The line denoted “S3” accounts *additionally* for a rise in survival probabilities. The shaded area between the penultimate and the ultimate line quantifies the pure role of demographic change in an economy undergoing structural change. [Colour figure can be viewed at wileyonlinelibrary.com]

intuitive to compare the role of structural change and demographic change: positive values signify a rise in inequality and negative values signify a decline in inequality. The scale reflects the percentage points on the Gini wealth inequality index.

We take the following steps to quantify the role of the two main processes in the growth of inequality. We start by simulating a model in which the only change occurring along the transition is the separation and the hiring rate. All other exogenous factors are kept constant at the initial steady state level. It is our benchmark. We then simulate a model which *additionally* includes a first component of the economic change: the technological progress varies as it did in the data. This scenario is denoted in Figure 3 as S1. Next, we *additionally* consider the change in the structure of employment following the patterns portrayed in Figure 2. This scenario is denoted as S2 in Figure 3. Finally, we include scenario S3 with all these changes and *in addition* the demographic change. In this scenario, we allow the data-driven evolution of economic structures and the data-driven evolution of the survival rates. The individuals have longer lifespans than in the benchmark, which is reflected in their accumulation and dis-saving patterns. The shaded area between the penultimate and ultimate lines displays the role of demographics. In contrast, the distance between the zero line and the line shows the role of a rise in educational attainment and a decline in the manufacturing sector.

The left panel of Figure 3 reveals that wealth inequality would have been lower absent demographic change. Specifically, the first 2 decades of economic transition would observe a decline in wealth inequality by as much as two percentage points relative to the pre-transition levels (three percentage points for $\theta = 4$ calibration). Demographic change contributes an additional two percentage points during this period to the Gini wealth index (approx. 2.5% points for $\theta = 4$ calibration). As a result, towards 2020, the inequality because of rising longevity is approximately two percentage points higher than in the pre-transition situation.

As demographic structure stabilises, the relative role of rising longevity declines, whereas the role of structural change intensifies. This shift in dynamics has long-term implications.

Towards the later decades, the gradual increase in tertiary education and shift towards the service sector from the manufacturing sector gained importance. They contribute a greater share of the total change in inequality. In roughly 5 decades of demographic and economic change, the Gini wealth index is higher by three percentage points than in the pre-transition starting point.

Overall, the fact that the economy underwent structural change actually *lowered* wealth inequality in the initial decades, whereas the effects of rising longevity eventually faded out. In other words, wealth inequality would have increased more if the economy had only undergone demographic change but not structural change during the same period. Structural change reduces the growth in wealth inequality to about half of what it would have been without a change in employment and educational structure. These effects are large compared to the role of TFP. Our model predicts a further rise in wealth inequality as the rise in longevity progresses.

The calibration with higher risk aversion reveals a steeper rise in wealth inequality because of demographic change and a larger downward effect from the structural change in the first 3 decades of the transition. The downward pressure from TFP is quantitatively the most relevant driver of the effects of structural change on wealth inequality during this period. These results in the high-risk aversion calibration ($\theta = 4$) are driven by the fact that the precautionary motive is stronger relative to calibration with lower risk aversion. A higher precautionary motive amplifies the role of longevity and reduces the role of change in employment structure. This is because employment structure is deterministic, whereas surviving until old age becomes a powerful driver for asset accumulation (as a means of reducing the higher valued risk of old-age poverty).

Note that the evolution portrayed in Figure 3 reflects a combination of the exogenous structural change and demographic change on the one hand and adjustment in macroeconomic variables on the other. We delegate the figures portraying the evolution of the macroeconomic variables to the Appendix in the interest of space, discussing the main patterns below.

4.2 | Macroeconomic adjustment

Structural change occurs by reallocating labour to sectors with higher labour productivity, which raises effective labour supply. The evolution of effective capital stock (K_t/z_t) is portrayed in Figure B1. First, the effect of unemployment on capital formation is very small. On the one hand, consumers want to save more because of unemployment risk, that is, the precautionary savings motive. On the other hand, unemployed consumers have less income, so they save less. Quantitatively, the overall effect is a slight decline in capital stock, see the black dashed line. Note that the scenarios with TFP growth cannot be directly compared to scenarios without TFP growth because z_t is higher in those scenarios. The role of TFP growth is straightforward: since consumers' incomes grow faster, they save less. Thus, the aggregate capital declines because of faster TFP growth, see the violet dotted line and the subsequent ones.⁸

The structural change has some effect on aggregate capital, but it is not economically large. With a higher effective labour supply, returns to the capital increase. Thus, consumers want to

⁸Note that our consumers have perfect foresight. Thus, they accommodate for any variation in TFP. In reality, TFP variation is more of an aggregate shock, for which the consumers may want to make precautionary provisions, thus, in general, raising further voluntary savings.

save more, see the blue dash-dotted line. By contrast, rising longevity fosters old-age saving, thus raising capital stock, as seen in the red solid line. Higher risk aversion amplifies savings accumulation for old age because of the precautionary motive. This evolution of capital is portrayed in Figure B1. The total rise in capital because of demographic change amounts to roughly 35%, which is commensurate with the rise in longevity. The rise in the capital is higher for $\theta = 4$ calibration, reaching as much as a 50% increase.

In our study, we found that the behaviour of the interest rate is closely linked to capital adjustments. However, the interest rate mirrors capital per effective unit of labour, not aggregate capital. This is a crucial distinction. As shown in Figure B2, the rise of capital stock because of increasing longevity takes time to accumulate before it affects the K/L ratio and, consequently, the interest rate. This delay causes the interest rate to deviate by up to 2% points over a 3-decade horizon. This means that the structural change channel comes into play immediately, whereas the demographic change channel operates with a delay.

Finally, recall that any fiscal balance change must be compensated by consumption tax rate adjustments to maintain a stable debt-to-GDP ratio. Structural change and demographic change both imply fiscal consequences. For example, even if only transitory, a rise in the interest rate increases debt servicing costs. It thus triggers a rise in τ_c unless it is fully compensated by a rise in revenues from other taxes. Unlike the case of the interest rate, the tax rate adjusts immediately to demographic change. This is because a rise in longevity increases savings and thus immediately lowers consumption. Unless the government revenue from taxing capital gains compensates for a decline in consumption, τ_c has to rise. This evolution is portrayed in Figure B3. Despite an immediate decline in tax rates because of structural change, the gradual introduction of demographic change pushes the tax rates up in the long run, primarily because of a decline in consumption share in GDP. The rise of the consumption tax rate is lower in the $\theta = 4$ calibration because the rise in the capital income tax base is larger in this calibration (Figure B4).

To summarise, structural change raises interest rates, amplifying differences in asset holding within birth cohorts, thus raising within-cohort inequality. With higher interest rates, all cohorts save more, which reduces between-cohort inequality and works towards reducing the Gini coefficient on wealth. In addition, taxes decline during structural change. Figure 3 shows that the forces that reduce inequality quantitatively dominate. Demographic change in the form of rising longevity suppresses the interest rates and causes the taxes to rise, which amplifies inequality (Figures C1–C4).

4.3 | Counterfactual scenario: Higher generosity of social security

The growth of wealth inequality is driven particularly strongly by the demographic transition. During the first 3 decades of transition, the generosity of social security declined substantially. The effective replacement rate declined from roughly 60% to approximately 30%, reinforcing the precautionary motive related to rising longevity. We use our model to provide insights into the evolution of wealth inequality in the counterfactual scenario when the generosity of social security remains constant. This counterfactual analysis is relevant for two reasons. First, in the baseline simulations presented in Section 4.1, old-age savings prove to be the main force behind rising inequality. Second, in the face of rising inequality, stakeholders typically consider redistribution scenarios intended to reduce the dispersion of incomes or wealth. In our setup, labour supply is exogenous and idiosyncratic shocks drive variation in income. In contrast, wealth is endogenously accumulated and is used to smooth these shocks and co-finance old-age consumption. Thus, studying the role of social security is relevant from both the model and the policy perspective.

The counterfactual scenario keeps the replacement rates unchanged relative to the initial status quo and the social security is eventually twice as large as it is in the main simulations. Two mechanisms start operating. The first mechanism is related to the income effect: expecting higher old-age pension benefits, the individuals who receive adverse income shocks are less concerned about accumulating wealth for the old age. Similarly, individuals who receive favourable income shocks are more concerned about accumulating wealth for old age to maintain smooth consumption. Thus, this mechanism implies that greater generosity of social security *raises* dispersion in wealth accumulation and, consequently, wealth inequality. The second mechanism is related to a wealth effect: higher pension benefits for all reduce the overall incentives to save for old-age consumption. Thus, the overall accumulation of capital is reduced, narrowing the gap between people close to retirement (and the peak of wealth accumulation) and people at the extreme ends of the age spectrum (very young or very old) whose accumulated assets are close to zero.

To summarise, greater generosity of social security raises within cohort dispersion of wealth but reduces the between cohort dispersion in wealth. It is an empirical question of which of the two effects dominates. Furthermore, structural change's role is unclear a priori. On the one hand, structural change reinforces the within-cohort dispersion of wealth. On the other hand, the general equilibrium effects associated with the structural change, as discussed in Section 4.2, attenuate its direct effect on wealth inequality.

The results portrayed in Figure 4 demonstrate that the forces raising inequality quantitatively dominate the forces towards attenuating it. With more generous social security, the Gini coefficient on wealth would have increased by as much as five percentage points or 50% more than when social security generosity declined in line with the data. The paramount role of income effect is consistent with the earlier results that demographic change may be the key driver of the early rise in wealth inequality, as the structural change leads to reduced inequality in the early decades of

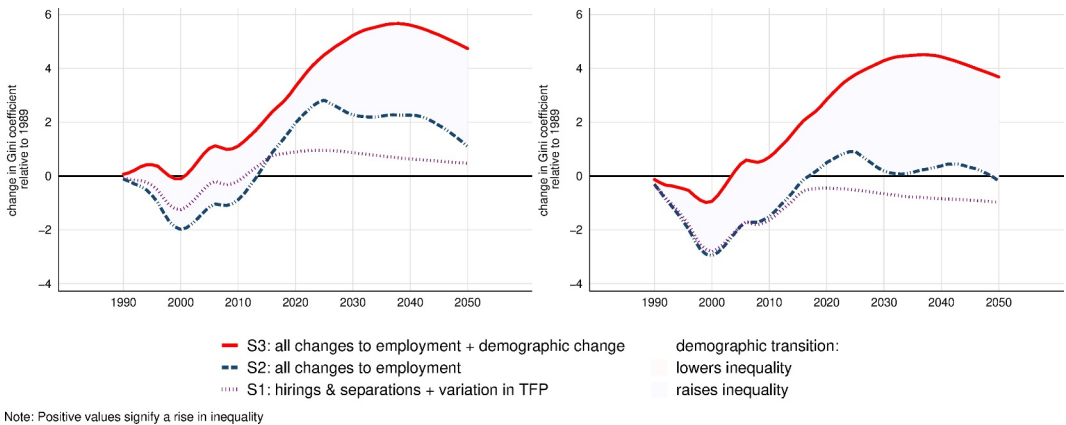


FIGURE 4 Wealth inequality in a counterfactual economy with more generous social security. The left panel shows the results for a calibration with $\theta = 2$ and the right panel shows them for a calibration with $\theta = 4$. Scenarios are additive: every following scenario includes the transition path of the previous scenario. The line denoted as “S1” accounts for time-varying evolution in TFP across manufacturing and services. The line denoted “S2” accounts *additionally* for an increase in educational attainment and a decline in manufacturing shares. The line denoted “S3” accounts *additionally* for a rise in survival probabilities. The shaded area between the penultimate and the ultimate line quantifies the pure role of demographic change in an economy undergoing structural change. The behaviour of macroeconomic indicators in the counterfactual economy with more generous social security is reported in Appendix C. [Colour figure can be viewed at wileyonlinelibrary.com]

transition. As the demographic change is fully realized and structural change progresses, the rise of wealth inequality steepens. This rise is larger with more generous social security.

Note that the rise in inequality is larger in calibrations with moderate risk aversion (left panel) compared to the high-risk aversion environment (right panel). Also, the role of structural change is larger for $\theta = 2$ simulations. Indeed, a larger contribution from the structural change is the key driver of the higher rise in wealth inequality in the left panel. This is because, in our setup, lower generosity of pension benefits is consistent with lower transfers to households, equivalent to providing households with less insurance against income uncertainty. All households—rich and poor—raise their savings, which reduces wealth inequality. Hence, the precautionary motive can have an attenuating effect when all households raise savings and an amplifying effect when only some of the households raise savings.

4.4 | Discussion of the results

The focus of our analysis is on the implications of the demographic transition and structural change for wealth inequality. Our model takes these changes as given and provides a general equilibrium quantification of their effects on wealth inequality. We then isolate the role of specific changes through counterfactual decompositions. Although the demographic transition and structural changes are matched closely to the data, our model shies away from attempting to determine what was driving those changes. If they were indeed endogenous and matched the data, the implications of the model for wealth inequality should remain similar, as neither education nor sector of employment are per se objectives of the households. With endogenous structural change, one could potentially seek the optimal rate of labour reallocation and compare it to the actual one, both in terms of welfare and in terms of implication for, for example, wealth and income inequality. This is certainly a fruitful direction for future research.

In particular, a deeper understanding of the choice of education could be fruitful. Most of the countries in the region experienced a massive educational boom, with a rapidly growing rate of tertiary enrolment. Although we prioritize tractability over complexity and introduce educational boom via an exogenous rise in tertiary enrolment. This assumption is relatively innocuous from the perspective of our research question—the implications for wealth inequality. In other words, endogenizing the choice of education would substantially affect the main conclusions of our model. However, demography-driven wealth inequality could still provide interesting insights into the dynamics of investment in human capital. Specifically, even if accumulation of assets and human capital are substitutes, they are imperfect: the former provides insurance against income shocks and enables higher consumption past retirement, whereas the latter raises earnings potential.

We model income uncertainty via the risk of unemployment and income shocks during the working periods. We take a standard approach to model income shocks. Estimates of income shocks for Poland are missing, but with data available and sufficiently granular, income shocks could be specific to education, sector of employment as well as time, birth cohort or age group. Such refined treatment of income shocks—currently impossible because of lacking data—could interact with life-time optimization patterns, shifting the wealth accumulation patterns between the phases of working ages.

Our income uncertainty is modelled as an AR(1) process. Although this is a parsimonious approach, it still allows the model to quantify the effects of various sources of income inequality during transition. Factors such as trade unions, collective bargaining and wage-setting institutions may play significant roles in shaping income distribution. We approximate the income dynamics

with an AR(1) process, remaining agnostic about the drivers of the shocks and their persistence. In fact, a variety of possible mechanisms could manifest in the form of our income dynamics.

Our model also features a relatively parsimonious modelling of labour market frictions and focuses on the implications of income inequality for wealth inequality. Although we incorporate the risk of unemployment (highly heterogeneous across households) and earned income risk, we do not disentangle the causes of unemployment and our modelling of wages is based on market clearing. Thus, the model does not accommodate various labour market institutions, for example, union dynamics or labour market frictions and endogenizing such dynamics falls outside the scope of the present study. This is a limitation, but in some sense, it lends our model greater generalisability to other countries in Central and Eastern Europe. Although the rise in longevity was similar across the region, the evolution of labour market institutions was highly diversified and subject to multiple policy overhauls.

5 | CONCLUSIONS

Our objective in this study was to isolate the role of structural change in an overlapping generations economy. Our setup is consistent with empirical regularities observed for Central and Eastern Europe: most of the change in employment structure occurred via demographics (older cohorts leaving the declining sectors and younger cohorts with better educational outcomes joining the rising sectors).

With finitely-lived agents, changes in employment structure have different implications for the intra-temporal and inter-temporal choice compared to infinitely lived agents. First and foremost, the inequality between cohorts is absent in models with infinitely lived agents. Admittedly, age and life expectancy at retirement are important determinants of individual asset-holding patterns and between-cohort differences. It takes an overlapping generations model to be able to reproduce these patterns and quantify them in a computational general equilibrium setup. Second, with finitely-lived agents, reallocation occurs instantaneously unless some specific friction is introduced, preventing the emergence of income inequality and its transmission to wealth inequality. Empirical evidence shows that the structural change occurs mainly via generational exchange: the older agents exit the labour market over time and the choices of the young agents are different. Thus, in an OLG setup, the reallocation is by design gradual, reflecting the empirical patterns.

Our research underscores the importance of demographic change, particularly rising longevity, in the decision-making of finitely-lived agents. The prospect of longer lifespans at retirement incentivises greater wealth accumulation, thereby increasing the between-cohort inequality in wealth. This highlights the significant role of demography in driving changes in wealth inequality, irrespective of whether structural change occurs. Our study contributes to the existing literature, which has primarily focused on the link between structural change and inequalities in incomes and wealth in models with infinitely-lived agents.

Our findings show that structural change per se lowers wealth inequality, at least initially. This finding is interesting because the intuition based on the Kuznets curve suggests the opposite. During structural change, income inequality is expected to rise and propagate to inequality in wealth. However, with finitely lived agents, given the empirical regularity that the probability of changing sector declines with age, this intuition is no longer valid. Younger agents are the ones who change sectors and older agents remain in the old sector. This friction slows structural change down, leading to our main finding that wealth inequality declines.

In addition, although rising longevity implies a rise in wealth inequality, this rise is lower in an economy undergoing structural change. In fact, structural change reduces the growth in

wealth inequality to about half of what it would have been without change in the sectoral and educational composition of the labour force. Theoretically, a more protracted and profound structural change than the one we studied could effectively counterweight the effects of rising longevity on wealth inequality.

The new findings of our paper are of concern to policy-making. Our innovative model reveals that redistributive policies at an old age (in our case, more generous social security) actually exacerbate wealth inequality instead of mitigating it. This counterintuitive result underscores the complex trade-offs that governments face in equalising lifetime incomes and wealth during structural change, particularly when accompanied by a rise in longevity. It calls for careful consideration in the design of redistributive instruments. This finding is especially pertinent as structural change is often linked to compensating redistribution towards individuals affected by asymmetric job destruction and lower job creation. In addition to labour market policies, governments also engage in redistribution towards working-age individuals (e.g., increasing the generosity and duration of unemployment benefits, higher social assistance, etc.). Although these transfers may alleviate poverty and income inequality, they can amplify the initial rise in wealth inequality through general equilibrium effects and the demography channel.

Our model delivers several novel results, but it also raises new questions. First, structural change is exogenous in our setup. With an exogenous labour supply, all adjustments in our model occur via intertemporal choice. A model with endogenous structural change could deliver lower effects on wealth inequality, but this attenuation may be quantitatively immaterial, especially with labour market frictions.

Second, because of data limitations, our calibration does not account for birth cohort-specific income uncertainty. Preliminary research into the US data demonstrates that later generations have higher variation and lower persistence of income shocks than earlier generations. This additional channel of structural change, especially in an endogenous setup, may reveal further non-linearities in the relationship between structural change, longevity and wealth inequality. Third, structural change can involve a change in the consumption basket. In such setups, felicity from aggregate consumption is not a sufficient statistic and studying consumption inequality with diverse consumption goods can deliver further insights.

Although our model is specifically calibrated to Poland's transition from a centrally planned to a market economy, many of the structural forces examined—such as sectoral shifts, educational attainment and demographic changes—are common across other transition economies. However, we recognise that the model's generalisability may be limited in contexts with different institutional settings, reform paths or government interventions. We acknowledge this as a limitation and encourage future research to explore how varied economic structures or policy environments might influence the model's outcomes. Despite these limitations, we believe our findings offer valuable insights into the key mechanisms driving wealth inequality during structural transitions.

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[Correction added on 14 February 2025, after first online publication: Open Access funding enabled and organized by Projekt DEAL.]

CONFLICT OF INTEREST STATEMENT

The authors declare no competing interests.

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APPENDIX

A. | Calibration

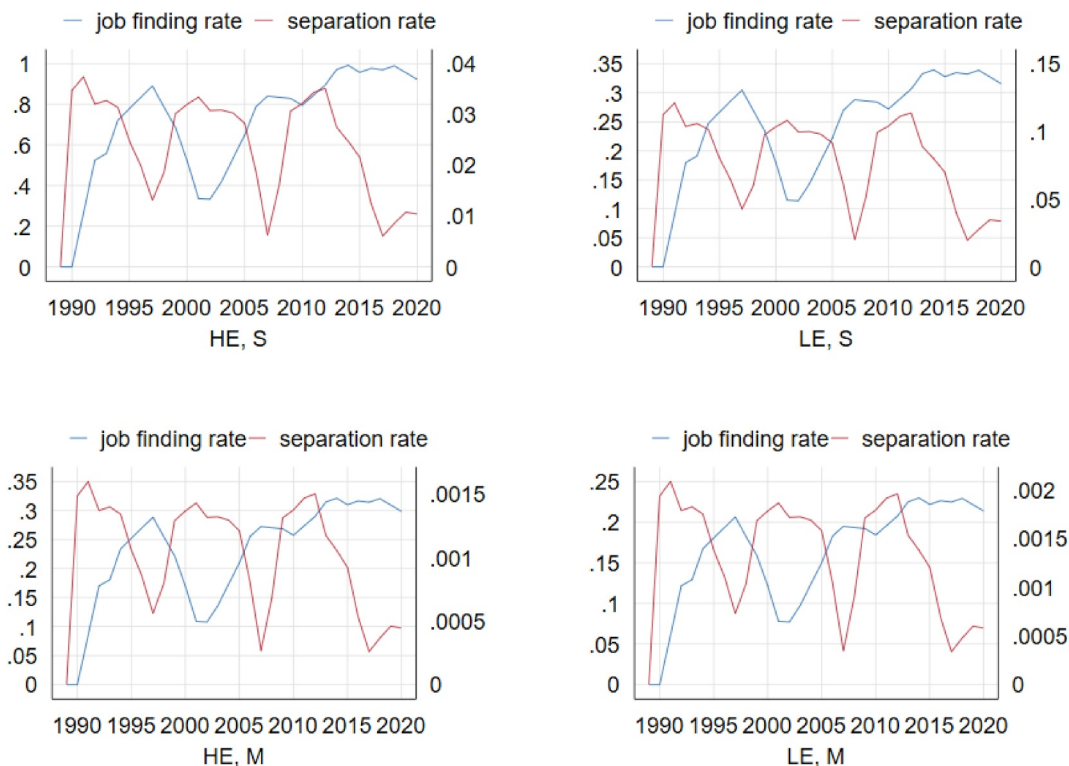


FIGURE A1 Job flows. The graph reports separation and hiring rates across education levels and sectors. The rates were obtained using self-reported changes from the previous year. The data come from the Polish Labour Force Survey. [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE A1 Tax revenue.

Macroeconomic parameters		Calibration		OECD code
		For $\theta = 2$	For $\theta = 4$	
τ_l	Labour tax	12.2%	12.1%	1110
τ_c	Consumption tax	16.1%	14.6%	5110, 5121
τ_k	Capital tax	15.8%	14.6%	1120, 1200, 4100, 4400

Note: Tax rates calibration follows Mendoza et al. (1994), using the averages of tax shares in GDP from 1995 to 1999.

B. | Macroeconomic changes

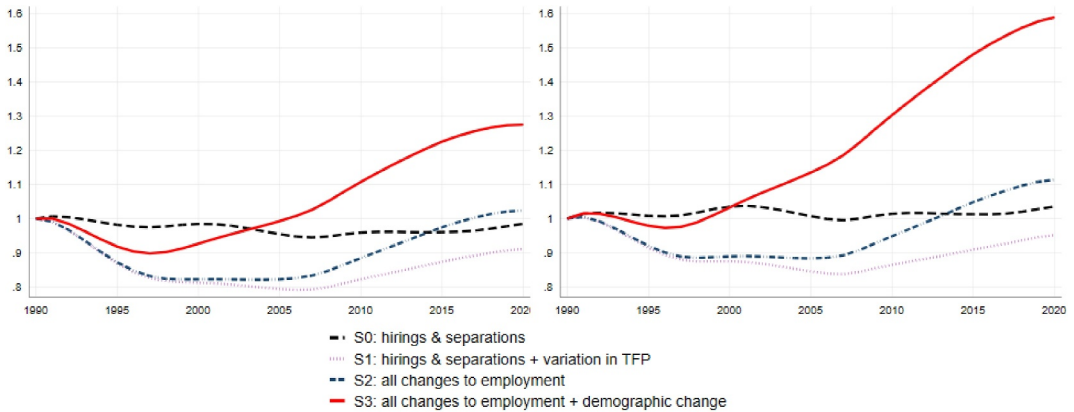


FIGURE B1 Aggregate stationary capital (K_t/z_t): structural change versus demographic change. Figure reports the aggregate capital across scenarios for the two calibrations considered in the study: $\theta = 2$ and $\theta = 4$. The changes in the capital are expressed as a ratio to the 1990 level, for example, 1.2 denotes a 20% increase. [Colour figure can be viewed at wileyonlinelibrary.com]

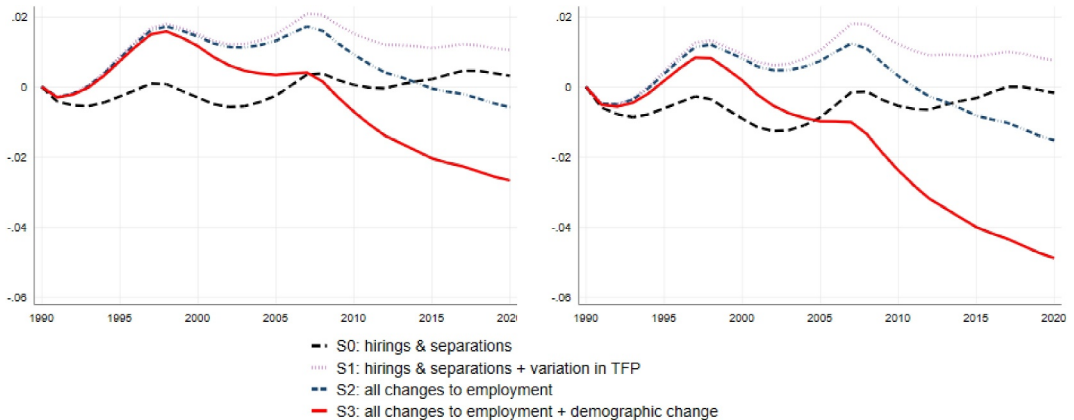


FIGURE B2 Interest rate (r_t): structural change versus demographic change. Figure reports the interest rates across scenarios for the two calibrations considered in the study: $\theta = 2$ and $\theta = 4$. The changes in interest rates are expressed in terms of difference to the 1990 level, for example, 0.02 denotes two percentage points increase. [Colour figure can be viewed at wileyonlinelibrary.com]

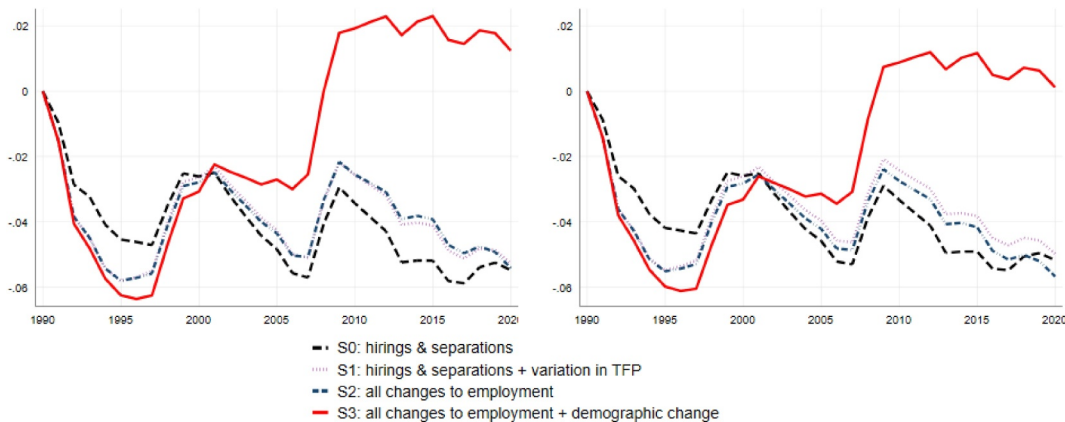


FIGURE B3 Consumption tax (τ_c): structural change versus demographic change. Figure reports the consumption taxes across scenarios for the two calibrations considered in the study: $\theta = 2$ and $\theta = 4$. The changes in consumption tax rates are expressed in terms of the difference to the 1990 level, for example, 0.02 denotes two percentage points increase. [Colour figure can be viewed at wileyonlinelibrary.com]

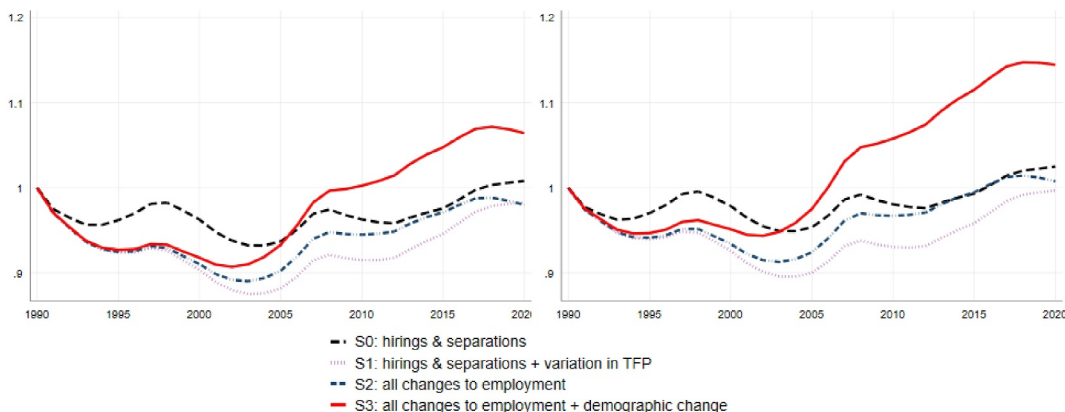


FIGURE B4 Mean (effective) wage: structural change versus demographic change. Figure reports the effective mean wages across scenarios for the two calibrations considered in the study: $\theta = 2$ and $\theta = 4$. The effective wage is wage divided by total factor productivity. The changes in effective mean wage are expressed as a ratio to the 1990 level, for example, 1.2 denotes a 20% increase. [Colour figure can be viewed at wileyonlinelibrary.com]

C. | Macroeconomic changes in the counterfactual economy

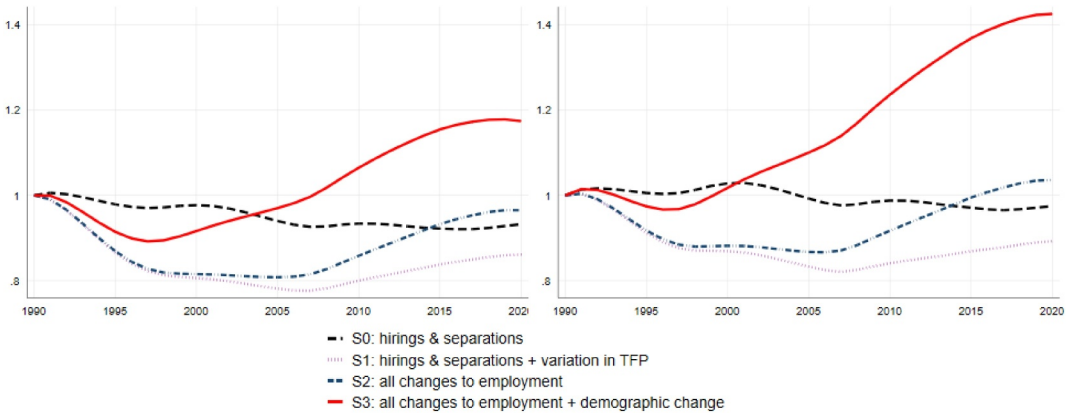


FIGURE C1 Aggregate capital: structural change versus demographic change. Figure reports the aggregate capital across scenarios for the two calibrations considered in the study: $\theta = 2$ and $\theta = 4$. The changes in the capital are expressed as a ratio to the 1990 level, for example, 1.2 denotes a 20% increase. [Colour figure can be viewed at wileyonlinelibrary.com]

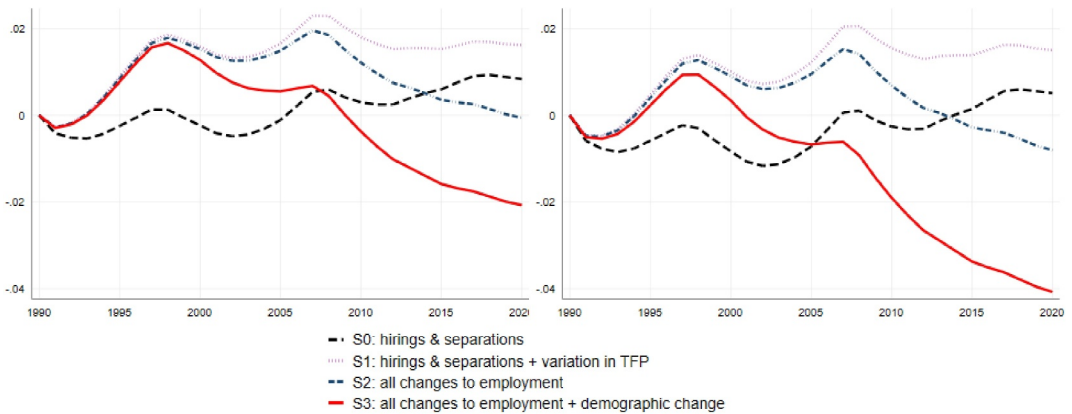


FIGURE C2 Interest rate: structural change versus demographic change. Figure reports the interest rates across scenarios for the two calibrations considered in the study: $\theta = 2$ and $\theta = 4$. The changes in interest rates are expressed in terms of difference to the 1990 level, for example, 0.02 denotes two percentage points increase. [Colour figure can be viewed at wileyonlinelibrary.com]

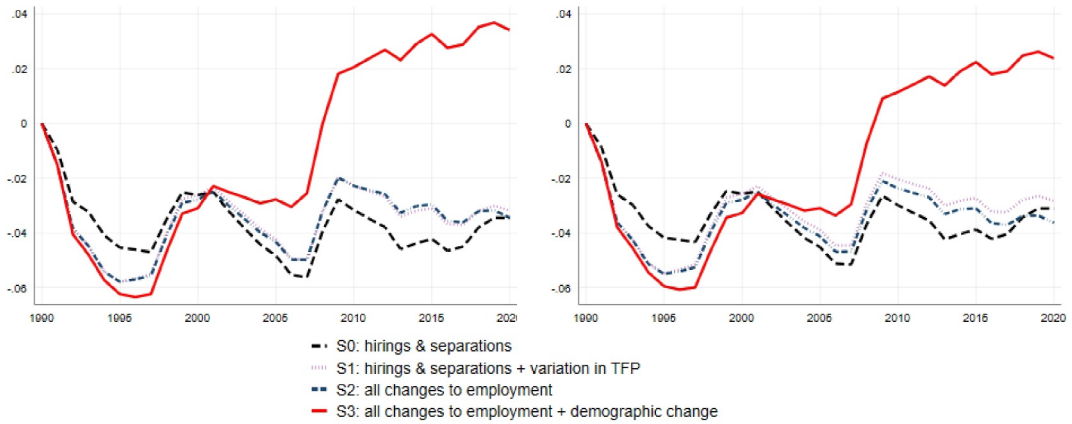


FIGURE C3 Consumption tax: structural change versus demographic change. Figure reports the consumption taxes across scenarios for the two calibrations considered in the study: $\theta = 2$ and $\theta = 4$. The changes in consumption tax rates are expressed in terms of difference to the 1990 level, for example, 0.02 denotes two percentage points increase. [Colour figure can be viewed at wileyonlinelibrary.com]

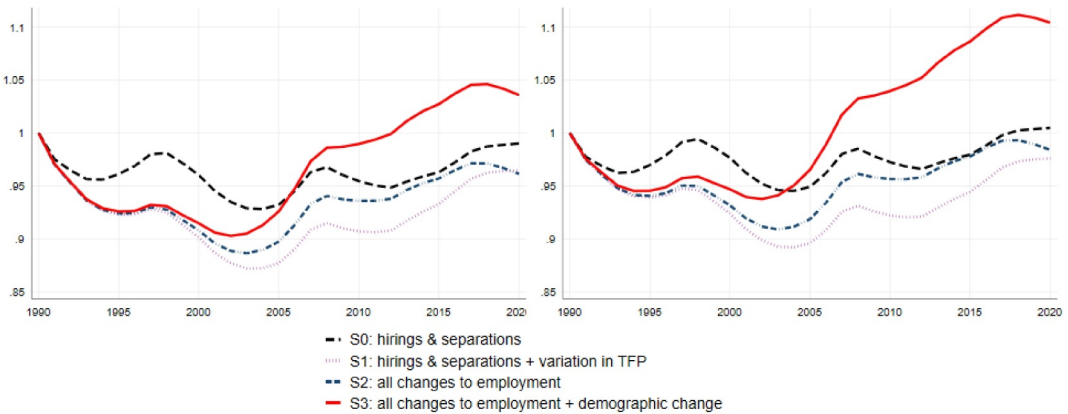


FIGURE C4 Mean (effective) wage: structural change versus demographic change. Figure reports the effective mean wages across scenarios for the two calibrations considered in the study: $\theta = 2$ and $\theta = 4$. The changes in effective mean wage are expressed as a ratio to the 1990 level, for example, 1.2 denotes a 20% increase. [Colour figure can be viewed at wileyonlinelibrary.com]