Baby Boom and Income Bust: Demographics and Lifetime Income

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Abstract

We study how demographic changes in the US affect men's lifetime incomes through career spillovers. American men's lifetime median incomes have followed a hump-shaped pattern: rising with each cohort entering the labour market from the late 1950s until the 1970s, and subsequently falling. The start of the decline coincides with the entry of the baby boomers who represent a structural break in the size of incoming cohorts. The availability of higher-compensated management tasks increases with the number of lower ranked (younger) workers. So, a larger cohort of workers will increase (decrease) the opportunities of their predecessors (successors), in contrast to the symmetric effect predicted by traditional models. We utilize a simple model to show cross-cohort differences in promotions to higher rank jobs can account for the shape of lifetime median incomes observed in the data. We also show the promotion mechanism is consistent with several other cross-cohort empirical facts.

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1 Introduction

American men's lifetime median incomes have followed a hump-shaped pattern: rising with each cohort entering the labour market from the late 1950s until the 1970s, and subsequently falling Guvenen et al. (2021). As shown in Figure 1[1], population demographics have traced a similar pattern, lagging the path of median lifetime wages by 10–15 years. We will explore how firm organization and promotion structures, in tandem with cohort size, help explain the fall in median male lifetime incomes.

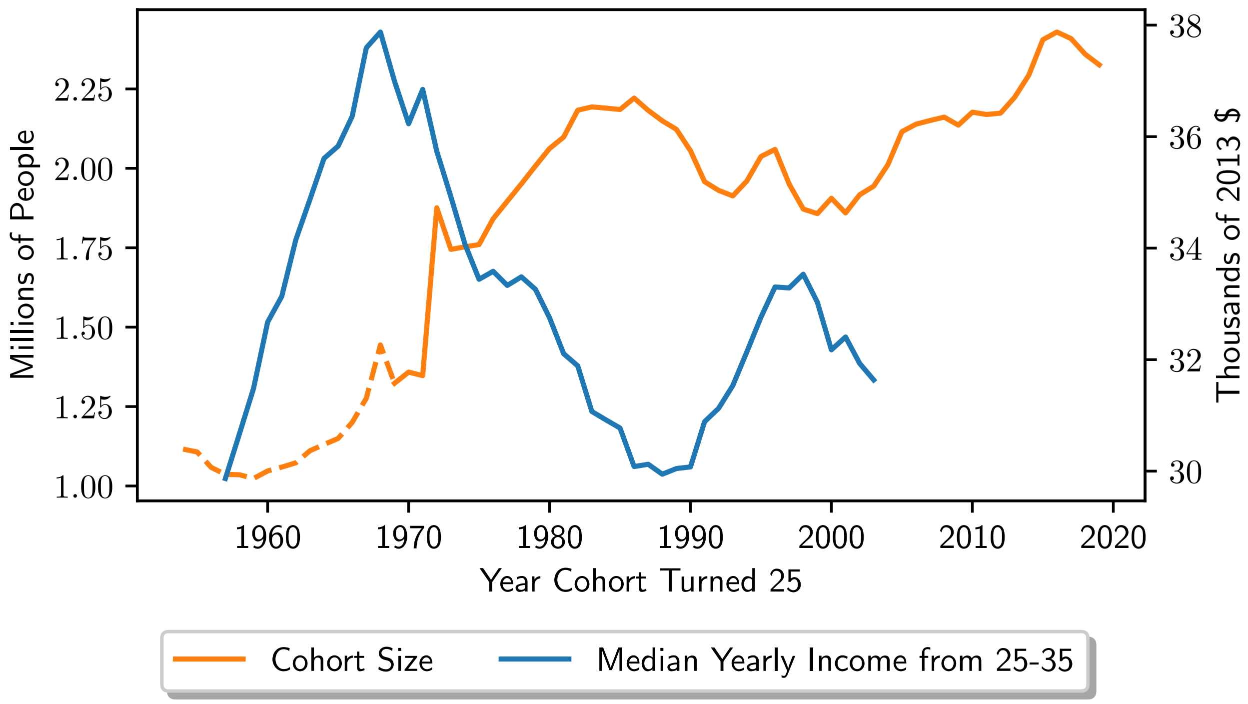

Figure 1: Earnings and cohort dynamics

The dash part of the cohort size line was imputed back based on the size of the cohort in 1969.

The path of an individual's wage over their lifetime is heavily linked to career progression, or taking on more management or supervisory responsibility. As a worker climbs the career ladder, their time shifts away from tasks involved directly with production towards production-enhancing tasks, such as management or training. The availability of these tasks, and the potential for higher wages associated with them, will increase with the number of people to manage. Thus, there may be link between population and wage dynamics across

[1]Note that the median income from 25-35 closely tracks those for longer periods, such as 25-45 and 25-55.

cohorts. For those born prior to large generations, supervisory roles may be easier to obtain, as there are both more young people to manage and relatively few same-age competitors for these roles. In contrast, those born within or after large generations, may face reduced promotion opportunities and thus lower lifetime income. Being born within a large cohort may reduce management opportunities as more individuals are seeking the same, limited, supervisory roles. Being born after a large cohort may further reduce promotion opportunities as prior generations may 'congest' limited management roles.

In this paper, we explore to what extent the interaction between demographic changes and career progression interact to determine the observed patterns in mens' lifetime wages. We first explore this interaction with a model of exogenous promotions. Our model has three main features. First, it has a fixed-proportion organizational structure of multiple promotion rungs, where higher rungs correspond to higher-wage tasks. Second, there are overlapping generations of workers with potentially different sizes. Third, there are random promotions between rungs, where any vacancy in higher rungs is filled with a random promotion from the rung below. In our model, demographic changes impact lifetime wages through promotion opportunities. This occurs through two channels: a fast-track effect and a congestion effect. The fast-track effect increases lifetime wages relative to steady-state by raising promotion probabilities. This effect occurs when large incoming generations lead to increased promotions. Because of the increase in entry-level workers, there is a corresponding increase in the need for more workers in management roles. The congestion effect lowers lifetime wages relative steady-state by depressing promotion probabilities. This effect occurs when retiring generations are small relative to the average population size. Promotion probabilities need to be correspondingly small to fill the smaller retirement vacancies.

We use two simple experiments, a one period baby boom and a permanent baby boom, to show how these two channels impact lifetime wages in response to demographic changes. For both experiments, promotion probabilities initially increase due to the fast-track effect: due to higher numbers of younger workers, all older workers are pushed up the hierarchy more quickly to compensate. In the one period baby boom, this occurs for one period only, and so benefits only those workers who entered before the baby boom. When the baby boom is permanent, the fast-track effect also benefits early baby boom generations, as promotion probabilities remain elevated for longer. After the initial increase in promotions, the probabilities decline and fall below steady-state levels. This is due to the congestion effect, and impacts the boom (in the temporary baby boom) and later-boom generations (in the permanent baby boom) the most.

The mechanisms we outline above link promotion opportunities to population dynamics. While Guvenen et al. (2021) do not explore mechanisms for the pattern of falling lifetime median wages, they do note that a state-level panel regression indicates that median lifetime income seems closely linked to entry cohort size, which supports our hypothesis. They suggest this is consistent with models of imperfect substitutability of labour across age groups, such as Card & Lemieux (2001), or more recently Jeong et al. (2015). In contrast with our proposed mechanism, for which all changes in wages are due to promotions alone rather than movements in relative wages across rungs, in CES-style models all lifetime earnings differences are driven by changes in relative wages. The CES-style argument for why large cohorts experience lower wages relies on the decreasing marginal productivity of a specific age-type of worker; thus when a firm must hire a big cohort, wages fall for markets to clear.

To highlight the differences between our model and a CES-style model we redo the two simple experiments with the model in outlined in Jeong et al. (2015). Demographics drive wages in this CES-style model by changing the relative supply of substitutable labour. The substatutability of generations in CES-style models is symmetric: the generations above and below a worker are similarly substitutable. This is a stark contrast with our model, where being born before or after a boom generation asymmetrically changes promotion opportunities. The CES mechanism further implies that as cohort sizes fall, newer generations should have relatively higher wages. This is inconsistent with the lag shown in our Figure 1, where earnings and cohort sizes were rising in tandem during the late 1950s through to the early 1970s. Thus, we need a different framework to understand why wages continue to fall despite falling cohort sizes. Our proposed mechanism looks at how adjacent cohort sizes affect the promotion path opportunities, and thus lifetime wages, for a worker of a given generation.

Our main experiment is a simulation of our model feeding in the true path of the male population shown in Figure 1. Our model yields a hump-shaped pattern of lifetime earnings similar to that seen in the true data. This result is robust to the paramaterization of the shape of the firm's rung hierarchy.

Related Literature

An empirical literature documents the existence of career spillovers between workers in nearby rungs of firm hierarchies. Bianchi et al. (2021) uses the 2011 Italian pension reform, which delayed the retirement age by three years, to explore the effects of delayed retirement on the promotion opportunities and wage growth of younger workers. They find that both wage growth and promotion probabilities are harmed by retirement delays. These effects are concentrated amongst older workers, i.e. those whose seniority is just below the lingering retirement-aged workers. Symmetrically, Jäger & Heining (2019) show that following unexpected worker deaths in Germany on average remaining workers' wages and retention probabilities increase. This effect is more pronounced for workers in the same occupation, or those who are most likely to replace the deceased. This is empirical evidence of the existence of the fast-track effect at the firm level. This paper explores the existence of this effect at the macro-level.

For promotion opportunities to impact lifetime earnings requires that compensation is at least partially driven by promotion opportunities rather than individual productivity alone. Another strand of empirical literature documents how lifetime earnings of workers are, at least partially, determined by promotions or external circumstances. For instance, Oreopoulos et al. (2012) shows that workers who begin their careers in recessions are less likely to do well in the long run. Other papers showing the relationship between career outcomes and luck include Kahn (2010), von Wachter & Bender (2006), and Lazear et al. (2016). Suandi (2021) provides empirical evidence supporting our mechanism directly, that luck in promotions is a key determinant to lifetime earnings. Using U.S. Navy personnel data from WWII, Suandi (2021) shows how early promotions shapes future career outcomes. He exploits exogenous promotions associated with successful submarines to look at long-term welfare of sailors who survived the war, finding that promoted sailors tend to live longer and die in wealthier ZIP codes.

Several papers have also documented macroeconomic effects of changes in demographics on labour outcomes. Bianchi et al. (2024) explain rising age-wage gaps across advanced economies by showing that increasing supply of older workers limit promotions of younger workers to better-paying jobs. Maestas et al. (2023) use state-level demographic shifts to show that labour compensation and wages fall with the share of older workers in the U.S.

The rest of the paper is structured as follows. Section 2 presents our exogenous promotions model. Section 3 highlights the intuition of the model by conducting two simplified baby boom experiments: a one-period and a permanent baby boom. This section also highlights the differences of our model with a CES-style model. Section 4 contains our model simulation of the true population path. Section 5 shows how the promotion mechanism is consistent with several other cross-cohort empirical facts. Section 6 concludes.

2 Exogenous hierarchy

The goal of this section is to set up the simplest possible model which attributes all movement in lifetime earnings to the promotions margin, rather than movement in wages. To do so, we set up a simple model with three key features. The first is a representative firm with a fixed-proportion organizational structure consisting of multiple promotion rungs, where higher rungs correspond to higher wage jobs. The second is overlapping generations of workers with potentially different sizes. The third is random promotions between rungs of the firm's hierarchy, where any vacancy in higher rungs is filled with a random promotion from any worker in the rung below. With this framework we can test how changing the distribution of the population across the generations (i.e. more young vs. more old) changes the patterns of lifetime wages for those in each cohort.

2.1 Model Set-Up

The first feature of this simple model is a firm with fixed shares of production along each rung of the promotion ladder. In other words, there is a Leontif production function across promotion rungs. This is the simplest possible setting to determine how lifetime earnings can be affected solely by the interaction between demographics and promotions alone, *without* movements in relative wage between rungs. There are I rungs, each indexed by $i \in \{1, \cdots, I\}$. The production share of each rung is denoted γ_i, with $\boldsymbol{\gamma}$ denoting the vector of the shares of all rungs.

The second feature of the model is overlapping generations. There are G generations, indexed by $g \in \{1, \cdots, G\}$. Each period the eldest generation of the previous period retires, and a new generation enters the labour market. Both entries and retirements can create promotion opportunities. How entries and retirments interact with rungs is sumarized in Figure 2, which gives an example with three rungs. Births (generation $g = 1$) do so by increasing (or decreasing) the total size of the population, and thus the number of available positions at each rung to keep rung proportions the same. All members of the new generation are hired into the bottom rung of firm's promotion ladder, and are unable to be promoted in the period they are born. Retirees (generation G retiring) leave vacancies at all rungs. The firm will fill open job opportunities in a given rung by hiring at random from the rung below. These random probabilities apply equally to all generations within a rung. p_i denotes the probability of being promoted from rung i to rung $i + 1$

We are interested in how the organizational structure of the firm interacts with population demographics to change lifetime income. To determine lifetime income of a worker in this model we need to solve for the promotion probabilities of each rung. With these promotion probabilities, average lifetime income for a worker in a given cohort can be calculated as their wage at a given rung times their average time at that rung over their lifetime. Section 2.2 calculates these promotion probabilities in steady-state, i.e. for a flat age demographics where all cohorts are equal in size. Section 2.3 will calculate these promotion probabilities for non-equal generation sizes, and show how lifetime income differs when cohorts follow a hump-shaped population pattern like the one described in the introduction.

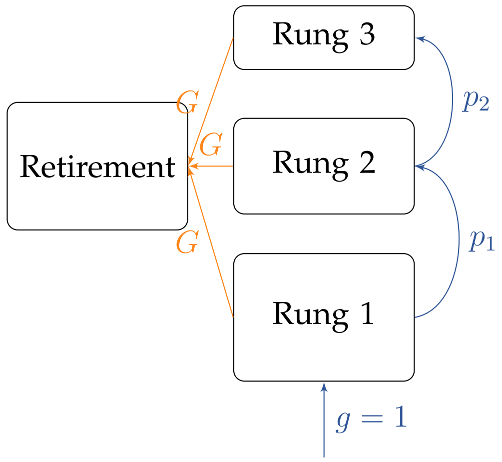

Figure 2: Simple Model: Births, Deaths, and Promotions

2.2 Steady-State

As mentioned above, the key object of interest is the promotion probabilities, which determine the lifetime wages of each cohort. In this section we will solve for these probabilities in a steady-state environment. Here steady-state is where all the generations are of equal size. ω_g denotes the mass in generation g, where $\boldsymbol{\omega}$ is the $G \times 1$ vector of these shares. We normalise the total population in a steady-state with equal cohort sizes to 1, thus in steady-state $\omega_g = \frac{1}{G} \, \forall g$.

p_i represents the probability of promotion from rung i to $i + 1$. This can be otherwise stated as the share of those in rung i with $g < G$ who are in rung $i + 1$ in the next period. The promotion probability is random within a rung, and thus is the same across cohorts at the same promotion level.

Figure 3 shows in more detail how promotions work across generations and rungs in an example where $I = G = 3$. Generations g are represented along the horizontal axis and rungs i along the vertical axis. All of generation 1, ω_1, enters the bottom rung at birth. From rung 1, they can be promoted with probability p_1 to rung 2, and otherwise remain in the bottom rung. Generation 2 can be in either rung 1 or rung 2 and can be promoted away from these rungs with common probability p_1 or p_2, respectively. Generation 3 is the only generation who could be in any of the three rungs. The mass at each rung can be obtained by summing across the columns within each row.

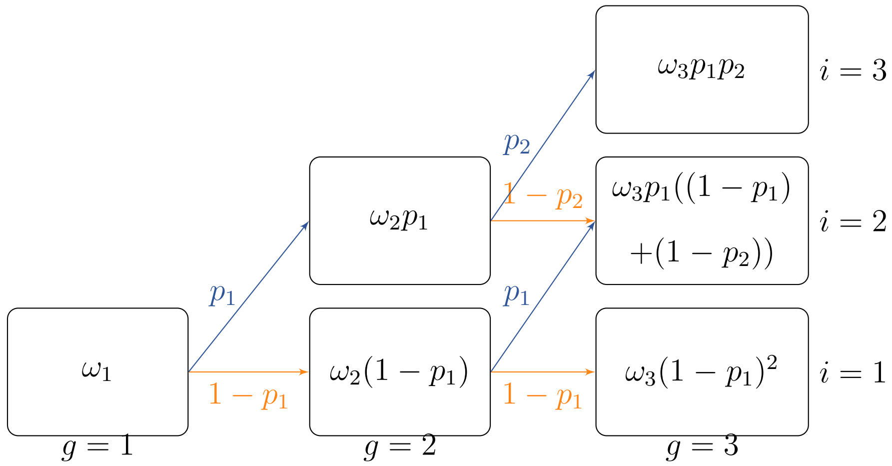

Figure 3: Simple Model: Promotions Across Generations and Rungs

We denote $\boldsymbol{p}$ the $I - 1 \times 1$ vector of promotion probabilities. It is also useful for us to represent these promotion probabilities as a transition matrix, $\boldsymbol{P}$, faced by agents in the economy:

$$\boldsymbol{P} = \begin{bmatrix} 1 - p_1 & 0 & \cdots & 0 & 0 \\ p_1 & 1 - p_2 & \cdots & 0 & 0 \\ 0 & p_2 & \cdots & 0 & 0 \\ \vdots & & \ddots & & \vdots \\ 0 & 0 & \cdots & 1 - p_{I-1} & 0 \\ 0 & 0 & \cdots & p_{I-1} & 1 \end{bmatrix}$$

This transition matrix is $I \times I$, where columns denote the rung you are coming from, and rows the you are going to. By assumption, workers can move up by at most one rung per period and can't be demoted.

In solving this model we take I, G, γ as given and are interested in solving for the endogenous promotion probabilities, $\boldsymbol{p}$. To do so we can write γ in terms of the promotion probabilities. Promotions determine the share of each generation in a given rung, which must add up to the share of the overall workforce in that rung. This is summarized in equation 1.

$$\gamma = \frac{1}{G}\left(I + \boldsymbol{P} + \boldsymbol{P}^2 + \cdots + \boldsymbol{P}^{G-1}\right)\mathbb{1}_1$$
$$= \frac{1}{G}(I - \boldsymbol{P})^{-1}(I - P^G)\mathbb{1}_1 \tag{1}$$

Where $\mathbb{1}_j$, is defined to be a $I \times 1$ vector with a 1 in the j_{th} position and zeros elsewhere, where the first position is indexed by a 1. Here we will have a system of I equations and $I - 1$ unknowns, where one of our equations becomes redundant.

With these promotion probabilities in hand, we can also calculate the distribution of cohorts over rungs. Let $\alpha_{i,g}$ denote the share of generation g employed in rung i, where $\boldsymbol{\alpha}$ is the $I \times G$ matrix of all these shares. Note that $\boldsymbol{\alpha}$ will be upper-triangular, since no cohort can be in a rung greater than their age. Equation 2 summarizes how to calculate each column of $\boldsymbol{\alpha}$ using $\boldsymbol{P}$.

$$\boldsymbol{\alpha}\mathbb{1}_g = \boldsymbol{P}^{G-1}\mathbb{1}_1 \tag{2}$$

2.3 Dynamics

This steady-state solution abstracts from population dynamics of the kind highlighted in the introduction. This section outlines how to solve the model out of steady state. In particular where $\omega_g \neq \frac{1}{G}\forall g$. All model objects will now also be denoted with a subscript t for time.

Let $c_{i,t}$ be the population mass at the beginning of period t at rung i before the new generation arrives/promotions occur, but after the old generation has retired at the end of $t-1$. We define $m_{i,t}$ as the moves into rung i, in terms of mass, where by definition $m_{1,t}$ is the mass of the newly born generation. We further define the total mass of the population at time t as M_t. Then, for each rung $i \in \{1, \cdots, I\}$ the following is true:

$$M_t\gamma_i = c_{i,t} - m_{i+1,t} + m_{i,t}$$

where $m_{I+1,t} = 0$ by construction.

In vector for this becomes:

$$M_t\boldsymbol{\gamma} = \boldsymbol{C}_t - \boldsymbol{S}_1\boldsymbol{m}_t + \boldsymbol{I}_I\boldsymbol{m}_t \tag{3}$$

Where $\boldsymbol{S}_1$ with ones on its first super-diagonal and zeros elsewhere, and $\boldsymbol{I}_I$ is the $I \times I$ identity matrix. Then, the probability of moving from rung i to $i+1$ in period t will be $p_{i,t} = \frac{m_{i+1,t}}{c_{i,t}}$. The definitions of $\boldsymbol{p}_t$ and $\boldsymbol{P}_t$ are analogous to those in Section 2.2, but with the addition of time subscripts on each interior term. As in equation 1 in Section 2.2, the above equation 3 can be used to solve for the promotion probabilities.

With the promotion probabilities, we can calculate the distribution of generations across rungs, $\boldsymbol{\alpha}_t$. A given column of $\boldsymbol{\alpha}_t$ can be written as:

$$\boldsymbol{\alpha}\mathbb{1}_g = \prod_{j=0}^{g-1} \boldsymbol{P}_{t-g}\mathbb{1}_1 \tag{4}$$

This construction is intuitive in that the a given column of $\boldsymbol{\alpha}_t$ is the distribution of that generation across the rungs. Thus it depends on the history of promotion probabilities that generation has faced, represented by history of promotion matrices it has faced.

Average rung ($\bar{r}$) of a generation that retires at the end of period T can be written as follows:

$$\begin{aligned}
\bar{r} =& \frac{1}{G}\sum_{g=1}^{G} \mathbf{1}^\intercal \boldsymbol{\alpha}_{T-G+g}\mathbf{1}_g \\
=& \frac{1}{G}\left(\mathbf{1}^\intercal \mathbf{1}_1\mathbf{1}_1^\intercal\mathbf{1}_1 + \mathbf{1}^\intercal \boldsymbol{P}_{T-G+1}\mathbf{1}_1\mathbf{1}_2^\intercal\mathbf{1}_1 + \mathbf{1}^\intercal \boldsymbol{P}_{T-G+2}\boldsymbol{P}_{T-G+1}\mathbf{1}_1\mathbf{1}_3^\intercal\mathbf{1}_2 + \dots\right) \\
=& \frac{1}{G}\left(\mathbf{1}^\intercal \mathbf{1}_1 + \mathbf{1}^\intercal \boldsymbol{P}_{T-G+1}\mathbf{1}_1 + \mathbf{1}^\intercal \boldsymbol{P}_{T-G+2}\boldsymbol{P}_{T-G+1}\mathbf{1}_1 + \dots\right) \\
=& \frac{1}{G}\mathbf{1}^\intercal\left(1 + \boldsymbol{P}_{T-G+1} + \boldsymbol{P}_{T-G+2}\boldsymbol{P}_{T-G+1} + \dots\right)\mathbf{1}_1
\end{aligned} \tag{5}$$

2.4 Promotion probability decomposition

In this section we decompose the promotion probabilities into a 'fast-track' and 'congestion' effect. Let $R_{i,t}$ denote the mass of workers retiring from rung i at the end of period t. Then, we can re-write the flow of workers moving into rung i as follows:

$$m_{i,t+1} = \gamma_i(M_{t+1} - M_t) + R_{i,t} + m_{i+1,t+1} \tag{6}$$

Or, the number of workers promoted into rung i is determined by the number of workers that need to be replaced due to vacancies created (by the retireesm $R_{i,t}$, or by promotions, $m_{i+1,t+1}$) as well as by positions created by population growth ($\gamma_i(M_{t+1} - M_t)$).

This equation can be rolled forward and turned into a promotion probability, generating:

$$p_{i-1,t+1} = \frac{(M_{t+1} - M_t)\bar{\gamma}_i + \bar{R}_{i,t}}{\gamma_i M_t - R_{i-1,t}} \tag{7}$$

Where $\bar{\gamma}_i$ denotes $\sum_{j=i}^{I} \gamma_j$ and $\bar{R}_{i,t}$ denotes $\sum_{j=i}^{I} R_{j,t}$.

Finally, this probability can be compared to steady-state:

$$p_{i-1,t} - p_{i-1} = \frac{(m_{1,t+1} - \bar{R}_{1,t})\bar{\gamma}_i}{\gamma_i M_t - R_{i-1,t}} + \left(\frac{\bar{R}_{i,t}}{\gamma_i M_t - R_{i-1,t}} - \frac{\bar{R}_i}{\gamma_i M - R_{i-1}} \right) \tag{8}$$

The first term, $\frac{(m_{1,t+1} - \bar{R}_{1,t})\bar{\gamma}_i}{\gamma_i M_t - R_{i-1,t}}$, is the fast-track effect. When population growth is high (such as when there is a large incoming generation, $m_{i,t+1}$), promotion probabilities increase relative to steady-state because of all the vacancies that are created to ensure the correct ratio of upper-rung level employees to lower-rung level employees. When there are many inexperienced or young workers, workers above them get fast-tracked to management. This effect does not exist in steady-state, where the population in constant.

The second term, $\frac{\bar{R}_{i,t}}{\gamma_i M_t - R_{i-1,t}} - \frac{\bar{R}_i}{\gamma_i M - R_{i-1}}$, is the congestion effect. When retirements ($\bar{R}_{i,t}$) are low relative to the overall population available for promotion ($\gamma_i M_t - R_{i-1,t}$), this pushes down promotion probabilities as too few vacancies are created. This is a congestion effect, as too few workers retiring means the upper rungs are congested with generations of workers who have yet to retire. Because retirements are the only source of promotions in steady-state, the congestion effect is also what determines steady-state promotions, $\frac{\bar{R}_i}{\gamma_i M - R_{i-1}}$.

2.5 Parameters

For both our simple model experiments, discussed in 3, and the full economy simulation in 4, we will consider a model with 5 rungs ($I = 5$) and 30 overlapping generations ($G = 30$). We chose 30 generations by assuming that generations work for 30 years, from ages 25–55. To discipline both the size and wage of the rungs, we make use of the work of Baker et al. (1994). Baker et al. (1994) use decades of a firm's personnel data to identify promotion rungs within the firm. Their findings, which we will use as the parameters for the size of rungs and wages in our simple model, are summarized in Figure 4. The size of the rungs is decreasing and concave: as the rungs increase, the share of the workforce in the rung decreases, and decreases by more with each subsequent rung. Wages, on the other hand, are increase and convex: wages increase with rung and by more with each subsequent rung. In section 4 we show that our results for the full simulation are robust to the shape of rung sizes.

Figure 4: Disciplining Rungs using Baker et al. (1994)

3 Simple model experiments

In this section we conduct two simple experiments to highlight the intuition of how demographics and promotions interact to shape lifetime wages in this simple model. The first experiment will be to shock one generation to be ϵ larger, and all generations before and after to be the steady-state size of one. This one-time shock makes it easy to disentangle how bigger generations impact wages in the exogenous promotions model. The second experiment will shock all future generations to be ϵ larger starting at time t. [Intuition as to why]

3.1 Simple experiment I: One Period Baby Boom

We use the strategy outlined in Section 2.3 to calculate the promotion probabilities at each time period, and translate this into average lifetime wages, which reflect how long on average a given cohort spends at each rung. The results can be seen in the blue line in Figure 5, where generation 30 is the one shocked larger. The effects are asymmetric: those born before the shocked generation experience higher wages relative to steady-state, and those born in and after the boom experience lower wages relative to steady-state. This is due to the promotion probabilities, which are shown in Figure 6.

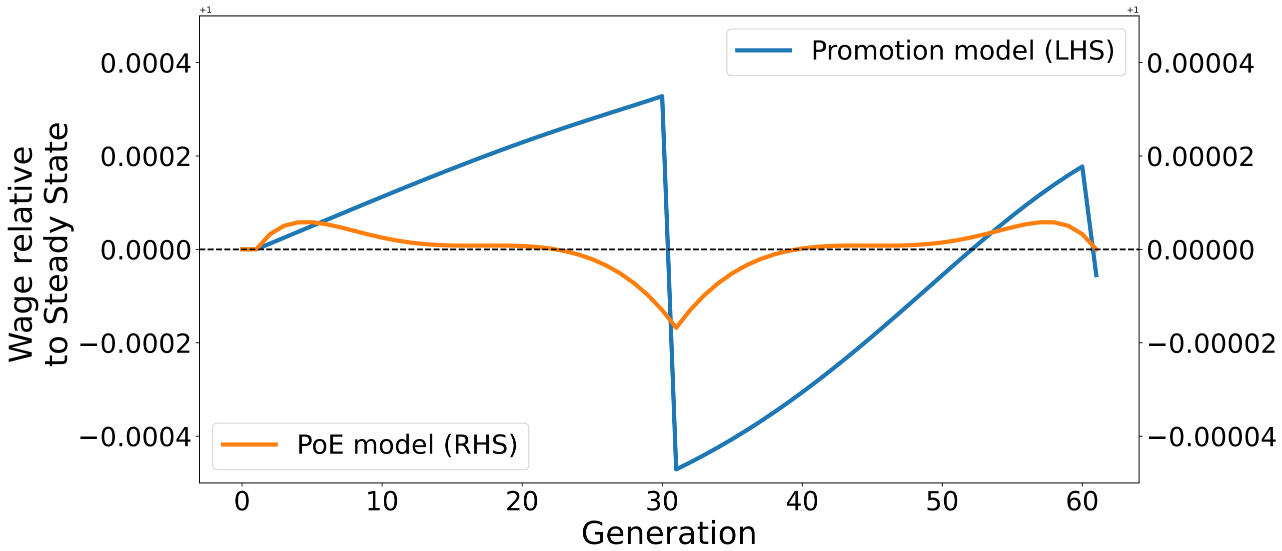

Figure 5: One Period Baby Boom: Average Lifetime Wages

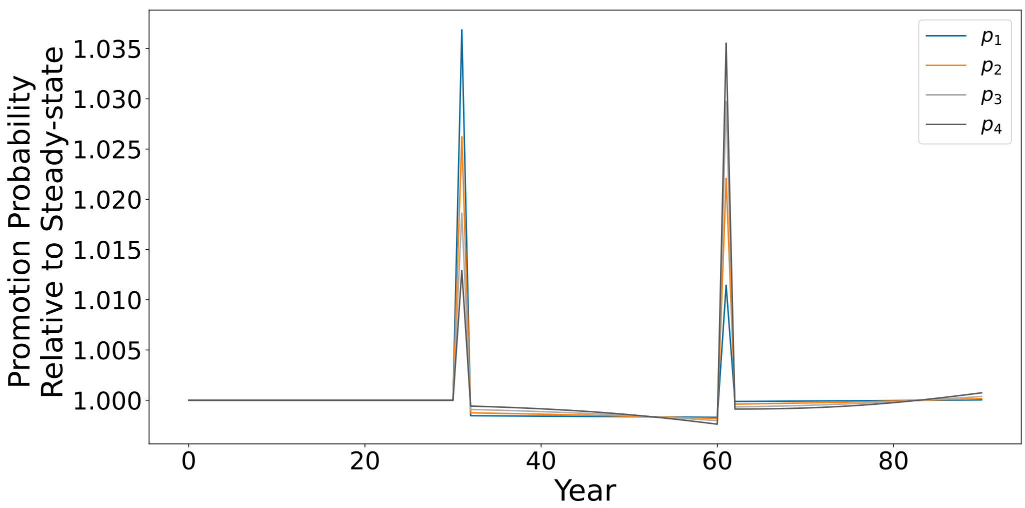

Figure 6: One Period Baby Boom: Promotion Probabilities

In a temporary baby boom, the labour force increases when the baby boom generation enters the labour market and remains flat until they retire, when the labour force reverts to its initial steady-state level. In the period the large generation enters, the initial steady-state promotion probabilities are too low, as the proportion of workers in higher rungs immediately drops due to the increase in population. Because the new large generation must work in the bottom rung in their youth, the elder generations are promoted quickly to ensure the correct share of workers in management. We call this the fast-track effect. These greatly increased promotion probabilities are what increases the lifetime wages of the generations born before the baby boom, as they are the only generations that are able to be promoted. The older generations closest to the baby booms benefit the most, as they are promoted very early in life and can spend more time at higher rungs.

For the rest of the years that the baby boom generation remains in the labour force, all promotion probabilities remain depressed below their steady-state values. While the baby boom generation is in the labour force, the generations retiring are smaller than the average population per generation, and so promotion probabilities need to be lower than steady-state to prevent too many workers being promoted. We call this the congestion effect. Because of the lack of promotions, both the shocked generation and those born directly afterwards receive lifetime earnings substantially below steady-state levels. The effect is worst for the baby boomers and those closest to them.

When the baby boom generation retires they leave relatively larger vacancies. Promotion probabilities increase to fill these vacancies. This is why generations born after the baby boomers retire have lifetime wages above steady-state.

Our simple model is able to capture the intuition and external empirical evidence discussed in the introduction: that cohorts born before large generations will receive higher wages via promotion, and those born in or after will be harmed by congestion effects.

3.2 Simple experiment II: Permanent Baby Boom

As in section 3.1, we calculate the promotion probabilities at each time period, and use these to calculate average lifetime wages. The results can be seen in the blue line in Figure 7, where generation 30 is the first shocked generation. Unlike the temporary baby boom, not only do the generations before the boom benefit, but the first generation of the baby boom benefits the most. When the baby boom is permanent the promotion probabilities rise for more than just one period. This can be seen in figure 8.

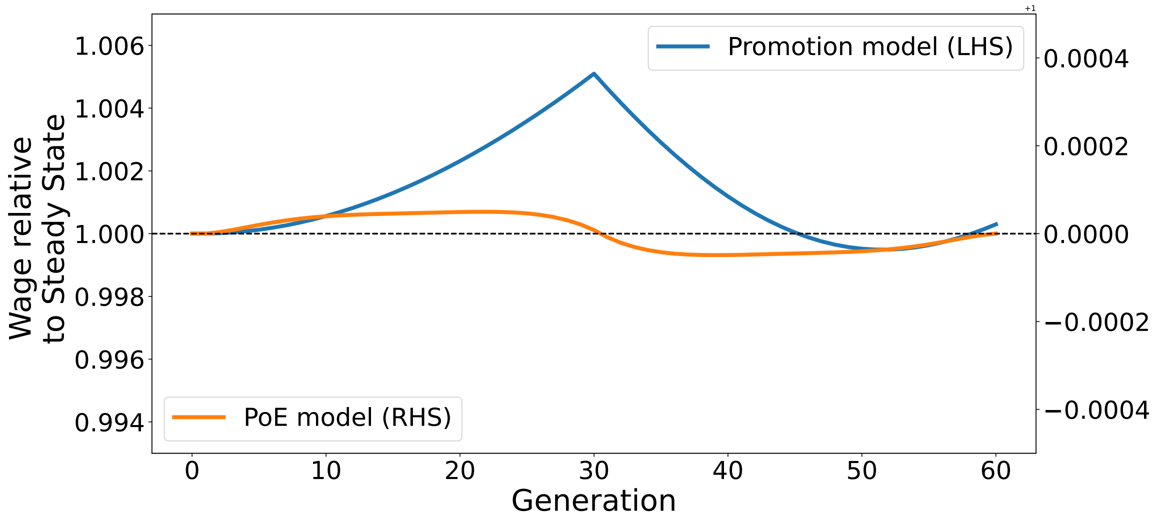

Figure 7: Permanent Baby Boom: Average Lifetime Wages

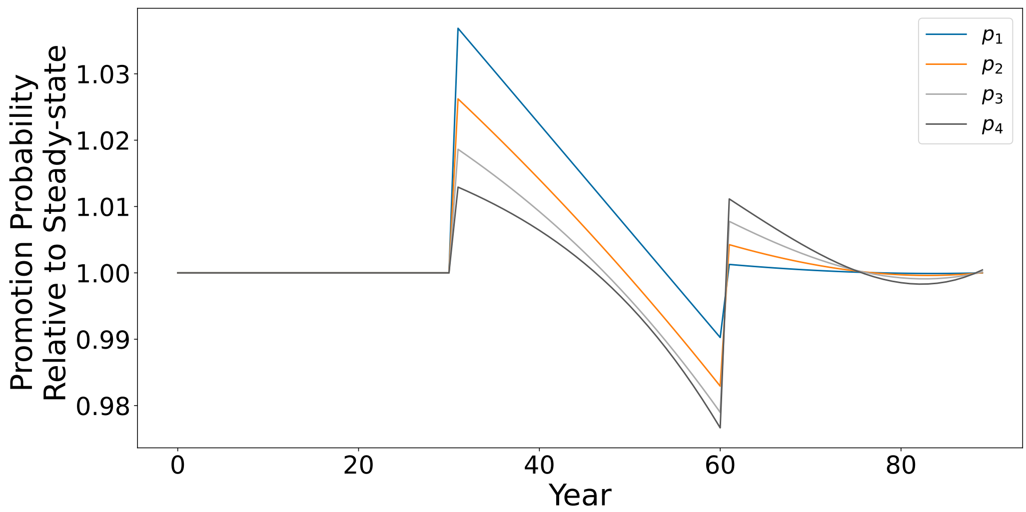

Figure 8: Permanent Baby Boom: Promotion Probabilities

In a permanent baby boom, the labour force increases for every period until the last pre-boom generation retires. Similar to the temporary baby boom, there are two forces at play that change the steady-state probabilities following the baby boom: a fast-track and congestion effect. On the one hand, the steady-state promotion probabilities are pushed higher for several periods after the boom, as the proportion of workers in the higher rungs continues to be relatively low as the population increases. On the other hand, the generations retiring are relatively small, and thus smaller promotion probabilities are needed to fill the vacancies they create in higher rungs. Initially, the first of these two effects dominates, and as time progresses the second does.

The persistently higher promotion probabilities following the beginning of the baby boom is what leads to the high lifetime incomes of first baby boom generation and their predecessors. As the promotion probabilities decrease, so do the lifetime wages for future generations.

3.3 Comparison with CES

In the simple promotions model above, demographics impact lifetime wages solely through promotions, leaving the wages at each rung of the firm hierarchy constant. Another model used to study the interaction between demographics and lifetime wages is a CES-type of model, which does not feature promotions and instead impacts lifetime wages through movements in relative wages alone. In this section we will compare the differences in the predictions of a CES-style and a promotion-style model generates in lifetime wages. To do so, we will use the model in Jeong et al. (2015), called the price of experience model. This model uses two inputs to production: labour (L_t) and experience (E_t). Workers of different ages, education, gender and years of work are able to supply these inputs differentially. In particular, older workers supply relatively more experience and younger workers relatively more labour. Thus, as demographics change, the relative supply of these inputs will affect relative wages and ultimately lifetime earnings.

The aggregate production function is:

$$Y_t = (L_t^\mu + \delta E_t^\mu)^{\frac{1}{\mu}}$$

Where L_t and E_t are aggregate labour and experience, respectively, summing over the supplies of labour and experience of all generations. The supplies of labour and experience as a function of age in our comparison are summarized in Figure 9.[2]

[2]Jeong et al. (2015) estimate the labour and experience supply schedules as a function of age and time

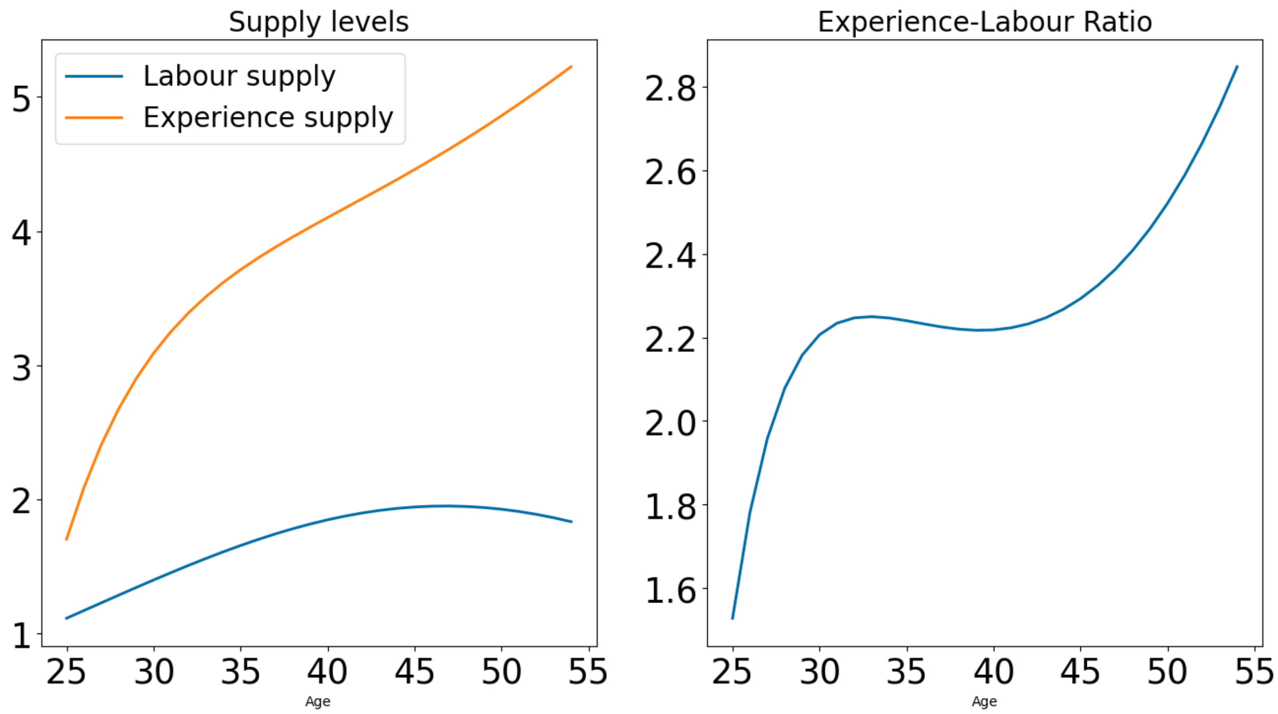

Figure 9: Supply Schedules of Labour and Experience

These age-supply schedules allow for more complex patterns of substitution between age groups than a simple CES model. As noted in Appendix A9 of Jeong et al. (2015), the effect of an increase in the size of one cohort on the wage of another is governed by the relative supply of labour and experience of both groups in aggregate. This is because the

worked. We assume our population to be made up of college-educated men of various ages, and calculate the labour and experience supply schedules using the parameters estimated for this demographic group. The paper assumes that labour supplied is determined directly by age, whereas total experience supplied is comprised of a level of experience as a function of total years worked and a return to experience determined by age. Given an individual's age, j_{it}, and years of experience, e_{it}, Jeong et al. (2015) estimate the following supply schedule parameters:

$$
\begin{aligned}
\hat{\ell}_{it} &= \exp\left(\lambda_{0,\ell} + \lambda_{1,\ell} j_{it}^2 + \lambda_{2,\ell} j_{it}^2\right) \\
\hat{e}_{it} &= \underbrace{\exp\left(\lambda_{0,e} + \lambda_{1,e} j_{it}^2 + \lambda_{2,e} j_{it}^2\right)}_{\text{Return to Experience}} \underbrace{\left(e_{it} + \theta_1 e_{it}^2 + e_{it}^3 + e_{it}^4\right)}_{\text{Level of Experience}} \\
&= \hat{\ell}_{it} \exp\left(\lambda_{0,\frac{e}{\ell}} + \lambda_{1,\frac{e}{\ell}} j_{it}^2 + \lambda_{2,\frac{e}{\ell}} j_{it}^2\right) \left(e_{it} + \theta_1 e_{it}^2 + e_{it}^3 + e_{it}^4\right)
\end{aligned}
$$

The parameters for the experience supply schedule can be normalized by the labour supply schedule parameters. We assume all workers work continuously beginning at the age 22, thus $e_{it} = a_{it} - 22$.

returns to labour and experience depend directly on the aggregate labour–experience ratio:

$$R_{L,t} = \left(1 + \delta \left(\frac{E_t}{L_t}\right)^{\mu}\right)^{\frac{1-\mu}{\mu}} \qquad\qquad R_{E,t} = \delta \left(\left(\frac{E_t}{L_t}\right)^{-\mu} + \delta\right)^{\frac{1-\mu}{\mu}}$$

If both cohorts supply relatively more of the same input relative to the aggregate ratio, then they are substitutable. In this case an increase in size of one age group will lower the wage of the other. On the other hand if a cohort's labour to experience ratio is above the aggregate ratio, and the other's is below, then the two age groups are complements. Here, an increase in size of one age group will raise the wage of the other. Due to this dependence on the aggregate labour–experience ratio, the size of a third cohort will affect the wage derivative of the first cohort with respect to the size of the second.Even the sign of this derivative is dependent of the distribution of age group sizes.

To compare with our promotions model, we re-do the two experiments in sections 3.1 and 3.2.

Experiment I is the one-period baby boom. Results for the impact of a one-period baby boom in the price of experience model can be seen in the orange line of Figure 5. In stark contrast with the promotions model, the response of the generations before and after the shocked cohort are close to symmetric. This is due to the symmetry of signs of the cross derivate of wages and cohort size. So, a larger aged 25 group will have the same signed effect on the wage of the aged 40 group as a large aged 40 group on aged 25 wages. Second, the lifetime wages are higher for generations furthest from the shocked generation, as these are the most complementary generations. This CES-based model is unable to generate the asymmetry in the effect of a large cohort in a one-period baby boom, which our promotions model succeeds in doing.

Experiment II is the two-period baby boom. Results for the impact of a two-period baby boom in the price of experience model can be seen in the orange line of Figure 7. The price of experience model generates asymmetric effects in response to a permanent baby boom. All generations before the boom benefit as there are large persistently younger generations to act as labour complements to their experience. Similarly, all generations after the boom suffer because there is a consistently higher supply of close-substitute generations depressing their wages.

Demographics drive wages in this CES-style model by changing the relative supply of substitutable labour. The substatutability of generations in CES-style models is symmetric. In contrast, dempographics affect wages in the promotions model via the fast-track and congestion effects outlined above. Tehse two effects apply asymmetrically to different generations, as each benefit or hurt those higher or lower on the hierarchy. The overall impact of demographics on wages in the promotions model is not necessarily asymmetric as congestion and promotion effects can offset each other. Both models are capable of generating asymmetries in lifetime wages, depending on the shape of the demographic shock. In the next section, we see how well the simple promotions model alone is able to match the path of lifetime wages when we simulate the model with the *true* population path.

4 Promotions model & Lifetime Income Dynamics

In this section we run an experiment using the actual population path to see whether our model can account for the lifetime earnings dynamics documented by Guvenen et al. (2021) in Figure 1. To do so we will need to choose a richer calibration than what we used above to highlight the model mechanisms. For the population data we use age by sex data from the National Cancer Institute's Surveillance Epidemiology and End Results Program (SEER) to calculate the size of annual male cohorts. Note that in this section we denote all cohorts by their year of entry into the labour market (i.e. the year they turned 25), rather than their birth year.

The SEER dataset starts in 1969, so we interpolate back from cohorts over the age of 25 in 1969 to predict the missing cohort sizes. To do this we adjust each cohort's 1969 population by the average relative difference between cohort size at 25 and 50 for all cohorts who turn 25 in 1969 or after. To estimate the model, we begin the economy in steady-state where all preceding cohorts are equal in size to the 1969 cohort. We then feed the labour-force entry size of cohorts as a time series. This time series of cohort sizes can be seen in Figure 1.

The results for average lifetime wages across cohorts can be seen in Figure 10. The blue line shows the model simulation result, and the red line shows the data from Guvenen et al. (2021). The average wage features a hump shape, with those who turned 25 in the early 1970s achieving the highest lifetime earnings. These results match the empirical evidence from Guvenen et al. (2021) well, with the decline after falling much faster and below the level of the earliest cohorts.

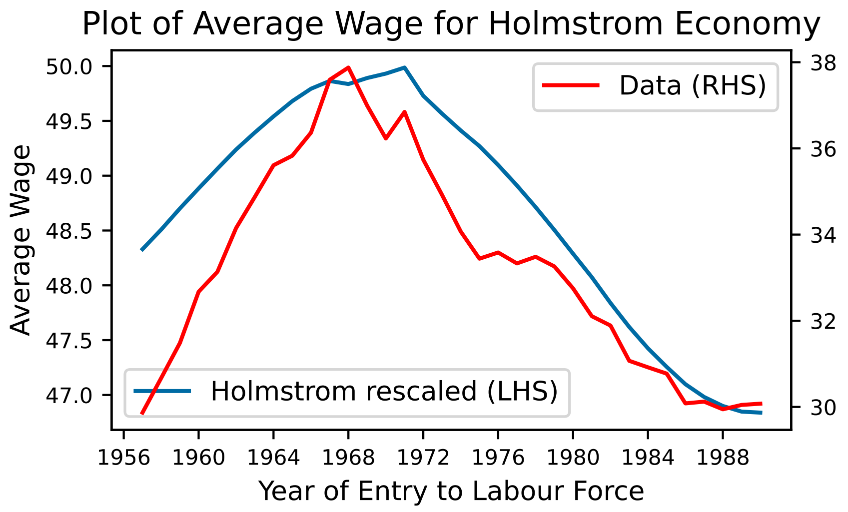

Figure 10: Promotions Model Lifetime Incomes with True Population Path

These results are also fairly robust to the parameterization of γ. In Figure 11 we outlined two alternative shapes for the gamma distribution: one concave and one convex. In Figure 12 we compare the results of the model simulation using the same population path, but instead using these alternative shapes of the rung distribution. The overall shape of the result still hold. The concavity of the rung distribution seems to affect the level of relative lifetime wages, rather than the dynamic response to the population path.

5 Cross-cohort empirical evidence

5.1 Wages across years and cohorts

We estimate a regression at the cohort-time level of average real wages on a polynomial of age, as well as time and cohort fixed effects. Subscript c denotes cohort, measured as the year a cohort entered the labour force at age 25. Subscript t denotes the year. Age is a linear

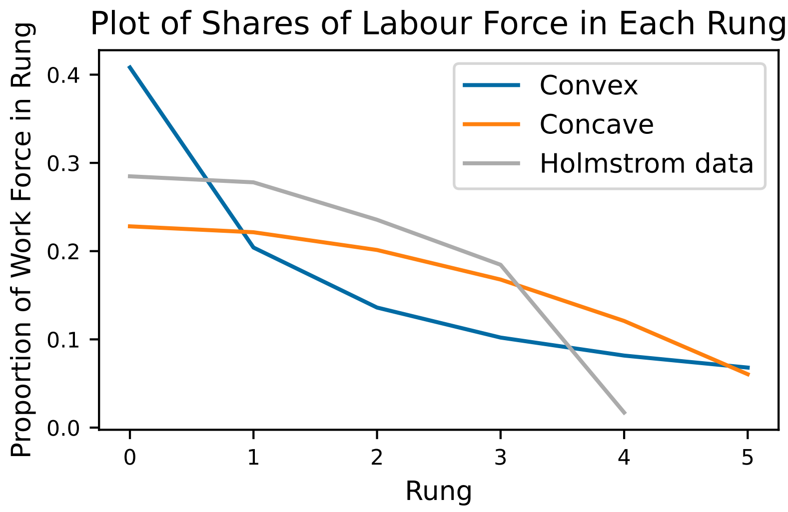

Figure 11: γ distribution from Baker et al. (1994)

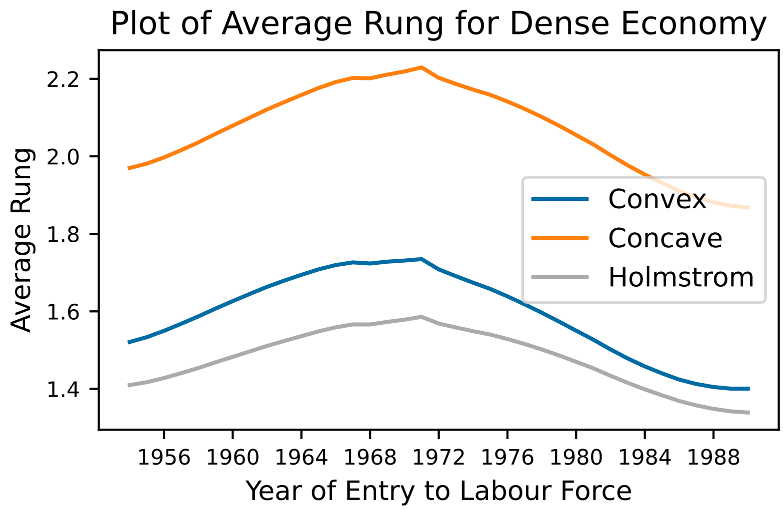

Figure 12: Promotions Model Lifetime Incomes: Alternative Rung Structures

function of cohort and time, $a_{c,t} = t - c + 25$. The $\boldsymbol{\beta}$ parameters are the coefficients of the polynomials of age. γ_c and τ_t resptively denote cohort and time fixed effects.

$$w_{c,t} = \beta + \beta_1 a_{c,t} + \beta_2 a_{c,t}^2 + \beta_3 a_{c,t}^3 + \beta_4 a_{c,t}^4 + \gamma_c + \tau_t$$

The cohort and time fixed effects are our parameters of interest. Results can be seen in Figure 13, with the time fixed effects on the lefthand side and the cohort fixed effects on the righthand side.

Cohort fixed effects have been increasing steadily, while year fixed effects show a hump-

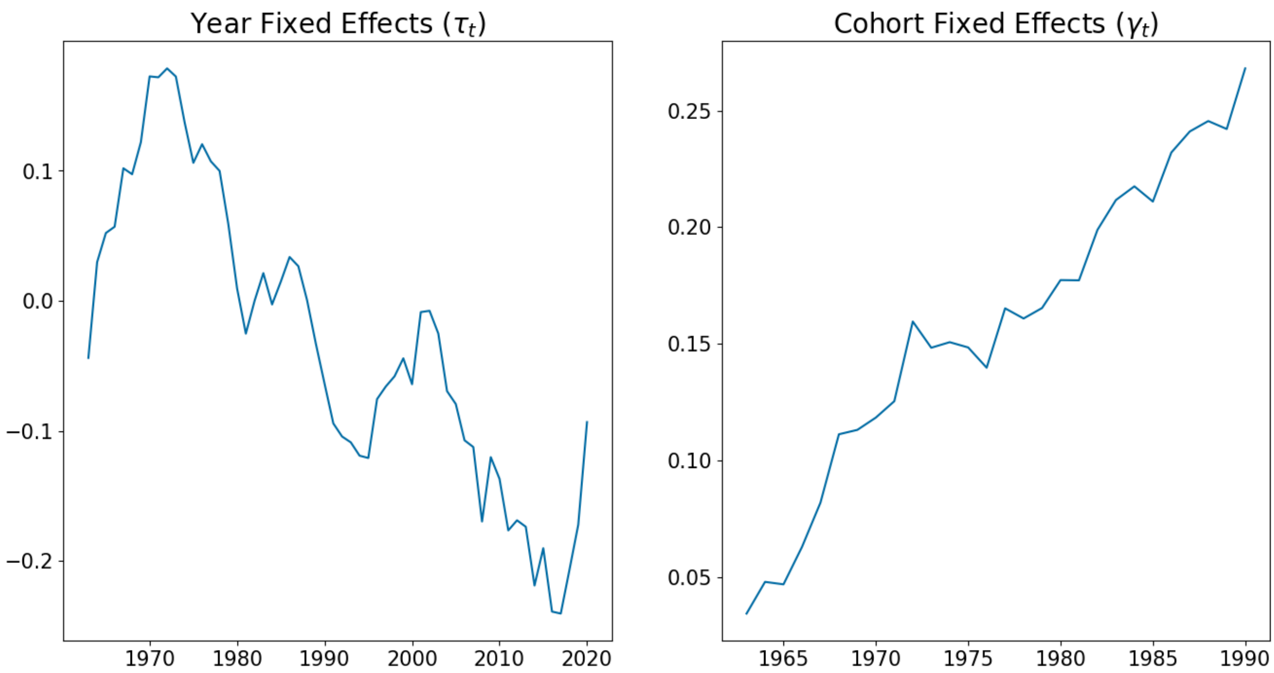

Figure 13: Time and Cohort Fixed Effects

shaped pattern similar to the pattern of lifetime incomes. A higher year fixed effect implies that the average wage of *all* cohorts in that year are higher. This would happen if a particularly large cohort entered the labour market in our model: all other cohorts lifetime wages would increase due to the fast-track effect. This would also happen in years of particularly slow retirement: all cohorts would suffer due to the congestion effect.

6 Conclusion

This paper studies how demographic changes in the US affect men's lifetime incomes through career spillovers. We explain recent patterns in men's lifetime median incomes documented in Guvenen et al. (2021) with the demographic shock of the baby boom. American men's lifetime median incomes have followed a hump-shaped pattern: rising with each cohort entering the labour market from the late 1950s until the 1970s, and subsequently falling. The start of this decline coincides with the entry of the baby boomers who represent a structural break in the size of incoming cohorts. Our intuition for how career spillovers explain this link is as follows: the availability of higher-compensated management tasks increases with the number of lower ranked (younger) workers. So, a larger cohort of workers will increase (decrease) the opportunities of their predecessors (successors), in contrast to the symmetric effect predicted by traditional models.

Our paper shows that a simple exogenous promotions model can both capture this intuition and match patterns seen in the data. We also show the promotion mechanism is consistent with several other cross-cohort empirical facts.

There are several avenues for us to further pursue this work. First, there are features not included in the model that we would like to add. In the above promotions model, we sought the simplest possible framework to capture the intuition that promotions alone could impact how demographics However, this exercise assumes that the structure of the firm's hierarchy is invariant to the population distribution, which may be unreasonable. If workers improve their management skills with experience as the workforce ages there will be a greater supply of management skill. Firms may react by increasing the size of the highest rungs which could drive down their value, and by extension the wages paid to them. We also pursued the simplest possible shock in demographics: changes to the male population. However, this period also witnessed two more changes that would affect the size of the labour force: the increased participation of women in the labour market, and the delays to retirement age of newer generations. Both these changes could contribute to our mechanism.

We also have more empirical goals for this project. First, we would like to identify 'rungs' in the data. We know from the literature that this is a reasonable assumption at the firm-level, but would like to see evidence of this on the economy as a whole. With these rungs in hand, we can also look at how compensation changes over rungs. For these goals, we will use the BLS National Compensation Survey. We would also like to use data on flows between occupations/rungs to look at how promotions differ by cohort.

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