Youth Unemployment and Aggregate Productivity in Greece

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This Version: October 2025

ABSTRACT——————————————————————————————————
Youth unemployment in Greece remains among the highest in Europe and has shown extreme persistence over the last three decades. This paper employs a search-and-matching model that links early-career joblessness to long-term productivity and wage outcomes through two key mechanisms: costly firm-provided training and permanent skill loss among young workers who remain unemployed for too long. Calibrated to Greek labor-market data, the model reproduces the country's high youth unemployment, long jobless spells, and large training expenditures, and is used to evaluate major institutional and structural changes since the debt crisis. The quantitative results show that reducing worker bargaining power increases employment but lowers wages, while cutting recruiting costs boosts job creation without wage compression. Negative productivity shocks and the emigration of skilled workers both have large, persistent effects on output and employment, with the greatest burden falling on young and low-experience workers. The analysis highlights that Greece's recovery and long-term resilience depend on policies that lower hiring and training frictions (such as youth employment subsidies, apprenticeship programs, and incentives for skilled return migration) rather than on further wage reductions.

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1 Introduction

Greece's labor market over the last three decades exhibits two striking and persistent features. First, youth unemployment is exceptionally high and far more volatile than overall unemployment, exceeding 58% at the height of the sovereign debt crisis (Figure 1). Second, long spells without work are worryingly common at the start of working life: the fraction of young unemployed who remain jobless for more than six or twelve months is persistently large and strongly countercyclical (Figure 2). These features make youth unemployment in Greece a central policy concern. They imply not only large short-term welfare losses but also long-lasting effects on productivity, earnings, and fiscal sustainability, as protracted early-career joblessness erodes human capital, delays skill accumulation, and weakens the tax base for decades to come.
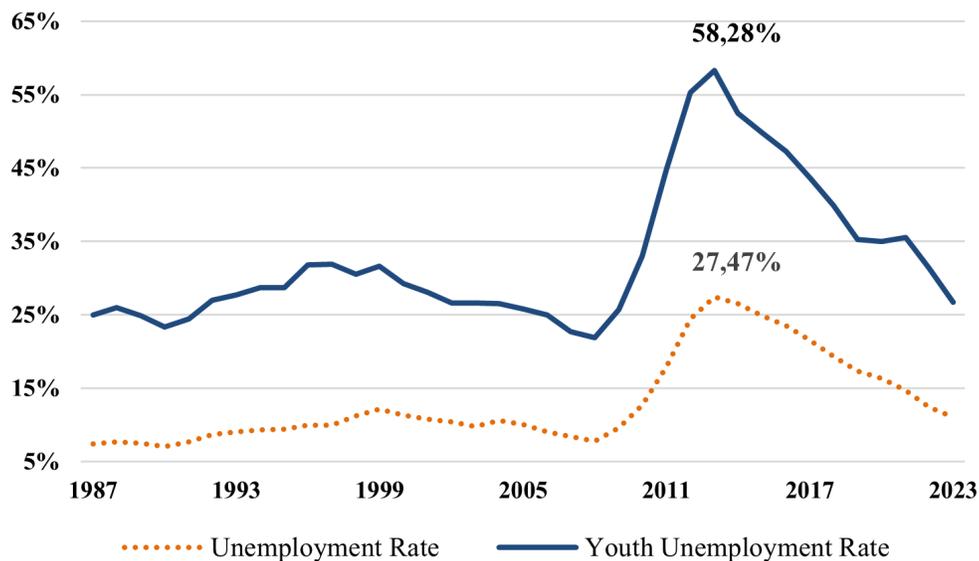

Figure 1. Aggregate unemployment rate and unemployment rate among workers aged 15-24 in Greece; source: Hellenic Statistical Authority Data.

To analyze these issues, we employ a search-and-matching framework that emphasizes the interaction between training costs, unemployment duration, and early-career dynamics. In our model, firms must devote resources to entrant workers who seek their first job, while young workers who remain unemployed for an extended period face a permanent loss of skills. These two forces jointly generate persistent differences in wages, job-finding rates, and productivity between experienced and inexperienced workers, even in the absence of worker heterogeneity at entry. The framework provides a parsimonious way to link short-run fluctuations in youth unemployment to long-run dif-
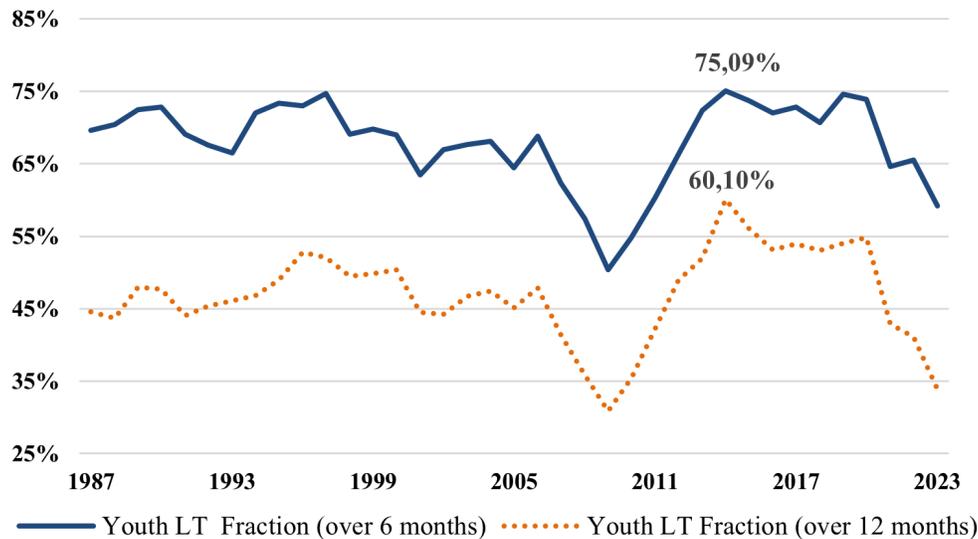
Figure 2. Fractions of workers that are unemployed for longer than 6 and 12 months among workers aged 15-24 in Greece; source: Hellenic Statistical Authority Data.

ferences in human capital and output, thereby offering a unified explanation for the high and persistent youth joblessness observed in Greece.

The model is calibrated to match key features of the Greek labor market, including high aggregate and youth unemployment, the prevalence of long-term joblessness among new entrants, and the substantial resources devoted to firm-sponsored training. We then use the calibrated economy to conduct a series of counterfactual experiments designed to capture major institutional and structural developments of the past two decades—such as changes in wage bargaining institutions, recruiting costs, productivity, and the emigration of skilled workers. These exercises quantify how policy reforms and macroeconomic shocks propagate through training costs, hiring incentives, and skill loss to affect employment, wages, and output. In doing so, the paper provides a coherent framework for evaluating labor market policies in economies where early-career unemployment is both widespread and highly persistent.

Our quantitative analysis yields four main insights. First, reforms that reduce workers' bargaining power, similar to those enacted during Greece's austerity programs, can substantially raise employment and output, but at the cost of lower wages. Second, policies that lower firms' recruiting costs—such as hiring subsidies or administrative simplifications—achieve comparable employment gains without wage compression, suggesting they are more efficient instruments for job creation. Third, adverse productivity shocks like those experienced during the crisis have disproportionately large and persistent ef-

fects on young workers, amplifying scarring and widening wage gaps. Finally, the emigration of skilled labor—the so-called "brain drain"—further weakens productivity and matching efficiency, with especially pronounced effects in the northern regions of the country where firms and workers face higher perceived risk. Together, these findings highlight the central role of early-career dynamics in shaping both cyclical and structural labor market outcomes.

The policy implications for Greece are clear. Reducing the barriers that prevent young workers from gaining early work experience should be a central priority of labor market reforms. Firms face strong disincentives to hire young workers because training is costly and its benefits are only partially internalized. Targeted subsidies for youth hiring and training, along with well-designed apprenticeship and internship programs, can help offset this distortion and accelerate the transition from school to stable employment. Simplifying hiring procedures and reducing bureaucratic costs would further improve job creation, while policies that retain or attract skilled workers—such as incentives for return migration or regionally targeted investment support—can counteract the long-run losses from brain drain. By focusing on the structural frictions that hinder youth employment, the paper offers a framework for designing policies that foster a more dynamic, inclusive, and resilient Greek labor market.

The remainder of the paper is organized as follows. Section 2 describes the economic environment, outlining the key assumptions of the model and situating them within the existing literature. Section 3 presents the analytical framework and derives the main equilibrium relationships that underpin the model's dynamics. Section 4 details the calibration strategy and the data sources used to discipline the model parameters. Section 5 reports the quantitative results and interprets them in light of recent developments in the Greek labor market. Finally, Section 6 concludes with a discussion of the main findings and their implications for labor market policy in Greece.

2   The Model

The model extends the framework of Adhikari, Geromichalos, Gursoy, and Kospentaris (2024) in several directions. The environment builds upon the Diamond-Mortensen-Pissarides setup. Time is continuous with an infinite horizon, and all agents discount future at rate r. The labor force is normalized to 1. Workers exit the labor market (retire) at Poisson rate δ, and each retired worker is immediately replaced by a young labor market entrant. New young workers enter the labor market as unemployed. The retire-

ment of workers, and their subsequent replacement by an entrant, is crucial in our model, because these new entrants will be a special category, and the length of time they spend being unemployed will have long-term consequences. There is a large mass of *ex ante* homogeneous firms that can enter the labor market with one vacancy. As is standard, the measure of active firms in equilibrium is determined by free entry.

Firms who decide to enter the labor market and search for workers must pay a flow recruiting cost c. Existing jobs get terminated at the job destruction rate λ. Generally, job matches produce an amount p of the numeraire good, but this productivity will be affected by the worker's specific type. Firms who have hired entrant (young) workers must pay a flow training cost κ until the match dissolves. This is our way of modeling the real world observation that firms are often biased against workers who do not have any working experience. Perhaps these young entrants were brilliant students, but they still need training to become *productive workers*. Thus, one possible interpretation is that the κ term is the number of hours other colleagues must spend with the inexperienced workers "showing them the ropes". (For a further justification of this assumption, see Section 2.1.) After losing their very first job workers become automatically experienced, and firms who shall hire them in the future will not need to pay the κ cost ever again.[1]

Since the effective productivity of a young worker is lower than that of an experienced worker (with κ representing the differential), firms are biased against inexperienced workers. As a result, young workers will tend to stay in the pool of unemployment for longer periods of time and have higher unemployment rates, which is precisely what we see in the Greek data (Figure 1). Another crucial, and empirically relevant assumption we will make is that entrants who stay unemployed for a prolonged period of time are in risk of suffering skill loss. We assume that this skill loss is permanent, and we often refer to this phenomenon as the "scar". To keep the model tractable, we will assume that the skill loss of young workers takes place stochastically, at Poisson rate γ; when that shock hits an inexperienced worker her productivity declines by an amount $\tilde{\kappa}$, and that skill/productivity loss follows that specific worker for the rest of her life. The skill loss and the "scar" assumptions are further discussed in Section 2.1.

We now provide a description of the various worker types. We will refer to young

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[1] Our "training cost" story is not the only way to capture the fact that firms are biased against inexperienced workers. Another possibility is that employers have asymmetric information about a worker's quality. The asymmetric information problem would be less severe in the case of a worker who has previously held at least one job, since the firm could ask for a reference letter from a former employer. While our approach is certainly not the only way to go, it has two big advantages. First, it leads to a simple and tractable model. Second, it is extremely relevant and easier to quantify, as there is a large literature studying training costs in the labor market. See Section 2.1 for the relevant references.

entrants who just replaced a retired worker as type-0 workers (i.e, they have "0 working experience".) Type-0 workers enter the model as unemployed. If they find their first job quickly, they will become employed type-0 workers, and, as discussed, their effective productivity will be given by $p - \kappa$. After leaving their first job, type-0 workers permanently become type-1 workers, and their productivity at any future job will be equal to p. However, if type-0 workers stay unemployed for a long period of time, they are more likely to be hit by the skill-loss shock; if this happens (before they could find their first job), they will turn into type-$\tilde{0}$ (unemployed) workers. When these types find their first job, they will become type-$\tilde{0}$ employed workers, and their productivity will be equal to $p - \kappa - \tilde{\kappa}$, since these are inexperienced workers who need training (hence the $-\kappa$), *and* they have also suffered skill loss (hence the $-\tilde{\kappa}$). Since in the baseline model skill loss is permanent, when type-$\tilde{0}$ workers find and, eventually, lose their first job, they will turn into type-$\tilde{1}$ workers. This means that at any future job their productivity will be equal to $p - \tilde{\kappa}$. (These workers are now experienced, but the skill-loss scar remains.) This is our tractable way of capturing the empirically relevant observation that early-career conditions have long-lasting effects on workers' productivity and earnings.

To sum up, at any point in time there are $2^3 = 8$ types of workers. First, workers can be unemployed or employed. Next, they can be young or experienced, where an experienced worker is defined as one who has held (and lost) at least one job in the past. Finally, workers can be scarred or not scarred, depending on whether they got hit by the skill loss shock when they first entered the labor market. Notation-wise, the number 0 (1) will denote an inexperienced (experienced) worker, and the "tilde" symbol will denote (variables related to) a worker who suffered skill loss during her youth. For example, $\tilde{f}_0$ is the *job-finding rate* of a young worker who suffered skill loss, $\tilde{f}_1$ is the *job-finding rate* of an experienced worker who suffered skill loss at youth, w_0 is the *wage* of an inexperienced worker who has not suffered skill loss, u_1 is the measure of experienced (non-scarred) *unemployed* workers, $\tilde{e}_1$ is the measure of scarred experienced *employed* workers, and so on.

We follow the standard DMP approach to determine the job-finding rates of workers of different types. There are segmented markets, one for each type of worker. Within each market, there is random search and matching according to a matching function. It turns out that the job-finding rates of the various worker types, can be conveniently expressed as functions of the *queue lengths* of the various types. Thus, we define

$$b_1 \equiv \frac{u_1}{v_1}; \quad \tilde{b}_1 \equiv \frac{\tilde{u}_1}{\tilde{v}_1}; \quad b_0 \equiv \frac{u_0}{v_0}; \quad \tilde{b}_0 \equiv \frac{\tilde{u}_0}{\tilde{v}_0}, \tag{1}$$

where v_i is the measure of vacancies in each labor market of the economy. Notice that the each queue length is simply the unemployment-vacancy ratio for that particular worker type (which is the inverse of the market tightness, typically used in the baseline DMP model). Assuming a Cobb-Douglas specification implies that the job-finding rate of each type of worker is given by $f_i = b_i^{\alpha-1}$, and the arrival rate of workers to the firms in each market is given by $q_i = b_i^{\alpha}$, where the queue lengths are defined as $b_i = u_i/v_i$ in each market.

We close the model with a few more standard assumptions. After the matching has concluded and firms have met the various types of workers, the wage is determined as a fraction η of the match surplus. We will let $\eta \in [0,1]$ denote the bargaining power of the worker. All unemployed workers enjoy a benefit z, which we think of as the utility of leisure and/or the value of home production.[2] Notice that, with the exception of productivity and the consequent differences in job-finding rates, all the other parameters of the model ($\eta, z, \lambda, r, \delta$) are independent of the worker's type. This is intentional, since we want the results to be driven *only* by differences in the workers' experience and whether they suffered skill loss during their youth, which is the focus of our paper.

2.1   Discussion of Modeling Choices and Literature Review

To begin with, a crucial feature of our framework is the assumption that firms need to devote resources to train young workers. These resources capture the fact that the experienced workers have to take time away from production to teach the necessary traits to the entrants. Examples of these traits include the ability to work in teams, follow instructions, understand and complete a task, or how to network. There is a plethora of recent empirical papers documenting the importance of firm-provided training in the labor market. Ma, Nakab, and Vidart (2022), in a cross-country study, document that firm-provided training is a key determinant of workers' human capital. (See Herkenhoff, Lise, Menzio, and Phillips (2024) for a complementary interpretation of the workers' human capital component.) Faccini and Yashiv (2022), using German and Swiss data, estimate that training costs (in the form of opportunity costs incurred by managers and coworkers incurred to make new hires as productive as experienced workers) are the dominant source of all hiring costs. Bertheau, Larsen, and Zhao (2023), using linked survey-administrative data from Denmark, find that one-third of employers consider the time to train new recruits

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[2] While the range of realistic values for z is discussed in detail in Section 4, z is not in principle required to be lower than the productivity of every worker type. Consider for example a type-0 worker. That worker may well choose to work for a firm even if we had $z \geq p - \kappa$. The reason is that working for a firm would allow this worker to become experienced and secure a higher wage in the future.

as a major obstacle.

Moreover, there is a literature that highlights the empirical relevance of the externality identified in this paper, namely, the idea that firms underhire inexperienced workers, since they are not fully compensated for the social benefit of the training they provide (Becker, 2009; Acemoglu, 1997; Acemoglu and Pischke, 1999).[3] The literature sometimes refers to this as the "future employer externality"; see Acemoglu (1997) and Lentz and Roys (2024). An important empirical finding in this line of work is that firms provide general training which is not fully offset by lower wages; see Acemoglu and Pischke (1998), Loewenstein and Spletzer (1998), and Autor (2001). Pallais (2014) aptly surveys this literature and concludes that "...neither the theoretical nor the empirical literature shows that firms recoup the full value of their training investments resulting in their providing the optimal level of training" (p. 3568).

Next, there is compelling empirical evidence documenting that skill loss during the early unemployment spells has persistent negative effects on a worker's career. Arellano-Bover (2022) shows that early-career unemployment shocks have negative effects on measured cognitive skills several decades later. Similarly, Dinerstein, Megalokonomou, and Yannelis (2022), using quasi-experimental variation in unemployment duration at the beginning of teachers' careers in Greece, document strong negative effects of the length of unemployment on teachers' performance measured by students' test scores. More generally, there is a large empirical literature, summarized by Von Wachter (2020), that highlights the persistence of the effects of labor market conditions upon entry for young workers on multiple outcomes later in their careers.

In the model, we have assumed that the unemployment spells after the first one have no effect on a worker's productivity. We have made this assumption for various reasons. First, the consequences of unemployment for the skills of experienced workers is well-studied elsewhere and its inclusion would only make the model unnecessarily complicated.[4] More importantly, there is evidence that skill loss may be of limited importance in older ages. For instance, Cohen, Johnston, and Lindner (2023) find no indication for a decline in skills over the unemployment spell in the overall population in Germany and for the older workers in the US. In the authors' own words, "This suggests that the negative consequences of unemployment might be a more relevant concern *at younger ages*" (p. 5, emphasis added).

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[3] Moen and Rosén (2004) and Lentz and Roys (2024) provide conditions for the efficient provision of training to workers.

[4] For references on skill loss in unemployment, see Pissarides (1992), Ljungqvist and Sargent (1998), Coles and Masters (2000), Ortego-Marti (2016), Flemming (2020), and Kospentaris (2021), among others.
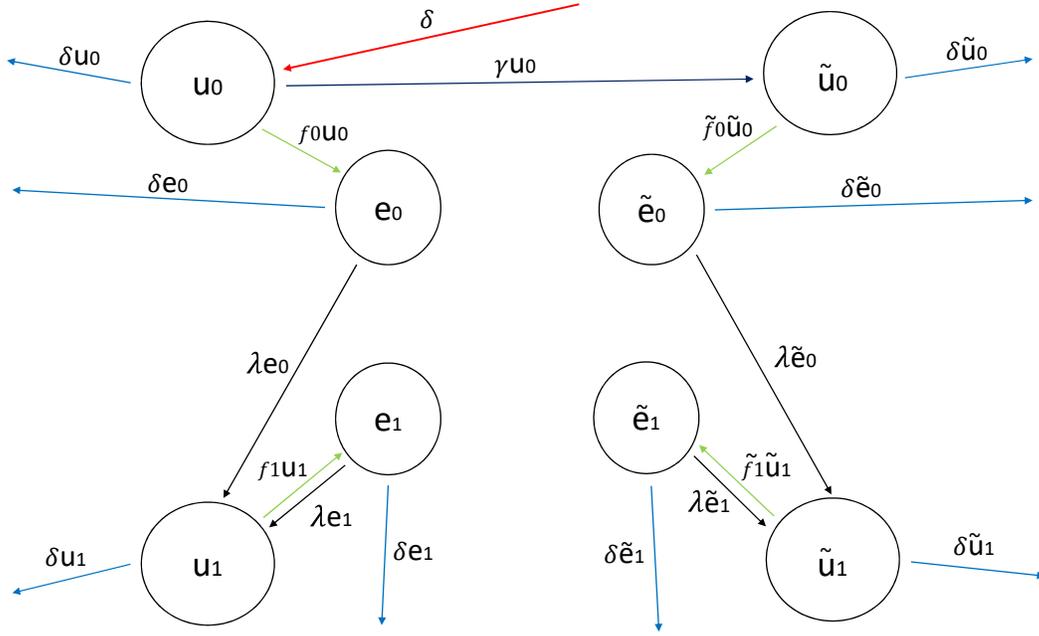
Figure 3. Worker flows in and out of the various states.

3   Analysis of the Model

3.1   Beveridge curves

Having described the economic environment, we are ready to proceed with the analysis of the model, starting with the derivation of the Beveridge curves. For this task, it is useful to inspect Figure 3, which illustrates the worker flows in and out of every state. While at first glance the figure may look complicated (workers could be in one of eight possible states), the logic is simple. New entrants come into the labor market as type-0 unemployed workers at rate δ; this is indicated by the red arrow at the top of the graph. Then, at any state of the world, workers could get hit by the retirement shock and exit the labor market; these are the light blue arrows pointing away from the eight "bubbles" representing the various states. There are also four black arrows starting from employment and pointing to unemployment bubbles; clearly, these are flows initiated by the job destruction shock. Notice that job destruction always leads to the bubble of "experienced unemployed", which may be scarred ($\tilde{u}_1$) or not scarred (u_1). Green arrows indicate work-

ers who found a job and are moving from unemployment to employment. As discussed, the rate at which this transition takes place is different for each worker type and governed by the Petrongolo and Pissarides (2001) matching process. Finally, the dark blue arrow starting at u_0 and pointing to $\tilde{u}_0$ captures the crucial group of workers who stayed in the "inexperienced unemployed" pool for too long and got hit by the skill loss shock.

Equating the flows in and out of each state, and after some algebra, we can show that the steady state measure of workers in the various states are as follows:

$$u_0 = \frac{\delta}{\delta + \gamma + f_0},$$

$$\tilde{u}_0 = \frac{\gamma}{\delta + \tilde{f}_0} \cdot \frac{\delta}{\delta + \gamma + f_0},$$

$$e_0 = \frac{f_0}{\delta + \lambda} \cdot \frac{\delta}{\delta + \gamma + f_0},$$

$$\tilde{e}_0 = \frac{\tilde{f}_0}{\delta + \lambda} \cdot \frac{\gamma}{\delta + \tilde{f}_0} \cdot \frac{\delta}{\delta + \gamma + f_0},$$

$$u_1 = \frac{\lambda f_0}{(\gamma + \delta + f_0)(\delta + \lambda + f_1)},$$

$$e_1 = \frac{f_1}{\delta + \lambda} \cdot \frac{\lambda f_0}{(\gamma + \delta + f_0)(\delta + \lambda + f_1)},$$

$$\tilde{u}_1 = \frac{\lambda \gamma \tilde{f}_0}{(\delta + \tilde{f}_0)(\gamma + \delta + f_0)(\delta + \lambda + \tilde{f}_1)},$$

$$\tilde{e}_1 = \frac{\tilde{f}_1 \lambda \gamma \tilde{f}_0}{(\delta + \lambda)(\delta + \tilde{f}_0)(\gamma + \delta + f_0)(\delta + \lambda + \tilde{f}_1)}.$$

3.2 Value Functions

We move to the steady state value functions, and we start with the firms. The value functions of vacant firms in each market are:

$$rV_0 = -c + q_0(J_0 - V_0),$$

$$r\tilde{V}_0 = -c + \tilde{q}_0(\tilde{J}_0 - \tilde{V}_0),$$

$$rV_1 = -c + q_1(J_1 - V_1),$$

$$r\tilde{V}_1 = -c + \tilde{q}_1(\tilde{J}_1 - \tilde{V}_1).$$

Note that all the remaining value functions, namely employment and unemployment value functions for each type of worker and value functions for productive firms are

identical to the value functions provided in the baseline model except now the arrival rates will be adjusted as discussed above.

Of course, free entry implies that in equilibrium we must have $V = 0$ in each market. That is, for each market, we have a free entry condition. Namely, in equilibrium, we have $V_0 = \tilde{V}_0 = V_1 = \tilde{V}_1 = 0$. This implies

$$c = q_0 \left(\frac{p - \kappa - w_0}{r + \lambda + \delta} \right), \tag{2}$$

$$c = \tilde{q}_0 \left(\frac{p - \kappa - \tilde{\kappa} - \tilde{w}_0}{r + \lambda + \delta} \right), \tag{3}$$

$$c = q_1 \left(\frac{p - w_1}{r + \lambda + \delta} \right), \tag{4}$$

$$c = \tilde{q}_1 \left(\frac{p - \tilde{\kappa} - \tilde{w}_1}{r + \lambda + \delta} \right). \tag{5}$$

We also have four value functions for productive firms in the various states, i.e., for firms who matched with the four different types of workers (type 0, $\tilde{0}$, 1, and $\tilde{1}$). These are given as follows:

$$r J_0 = p - \kappa - w_0 - \lambda J_0 - \delta J_0, \tag{6}$$

$$r \tilde{J}_0 = p - \kappa - \tilde{\kappa} - \tilde{w}_0 - \lambda \tilde{J}_0 - \delta \tilde{J}_0, \tag{7}$$

$$r J_1 = p - w_1 - \lambda J_1 - \delta J_1, \tag{8}$$

$$r \tilde{J}_1 = p - \tilde{\kappa} - \tilde{w}_1 - \lambda \tilde{J}_1 - \delta \tilde{J}_1. \tag{9}$$

Next, consider the value functions of workers in the various states. Let U (W) denote the value function of an unemployed (employed) worker. The remaining notation is standard. (For example, $\tilde{W}_1$ is the value function of a worker who is employed, has had some work experience, but was hit by the skill loss shock during her youth.) The value functions for unemployed workers in the various states are given by:

$$r U_0 = z + f_0(W_0 - U_0) + \gamma(\tilde{U}_0 - U_0) - \delta U_0, \tag{10}$$

$$r \tilde{U}_0 = z + \tilde{f}_0(\tilde{W}_0 - \tilde{U}_0) - \delta \tilde{U}_0, \tag{11}$$

$$r U_1 = z + f_1(W_1 - U_1) - \delta U_1, \tag{12}$$

$$r \tilde{U}_1 = z + \tilde{f}_1(\tilde{W}_1 - \tilde{U}_1) - \delta \tilde{U}_1. \tag{13}$$

The value functions for employed workers in the various states are given by:

$$rW_0 = w_0 + \lambda(U_1 - W_0) - \delta W_0, \tag{14}$$

$$r\tilde{W}_0 = \tilde{w}_0 + \lambda(\tilde{U}_1 - \tilde{W}_0) - \delta\tilde{W}_0, \tag{15}$$

$$rW_1 = w_1 + \lambda(U_1 - W_1) - \delta W_1, \tag{16}$$

$$r\tilde{W}_1 = \tilde{w}_1 + \lambda(\tilde{U}_1 - \tilde{W}_1) - \delta\tilde{W}_1. \tag{17}$$

Notice that inexperienced workers who lose their first job now move to the pool of experienced unemployed workers. (That is precisely why the terms U_1 and $\tilde{U}_1$ appear on the right-hand side of equations (14) and (15)).

Having described the value functions of all economic agents in detail, we are now ready to study the bargaining problems in the various types of meetings.

3.3 Wage Curves

We assume that in each market the wage is a fraction η of the output of each worker-firm match:

$$w_0 = \eta(p - \kappa) \tag{18}$$

$$\tilde{w}_0 = \eta(p - \kappa - \tilde{\kappa}), \tag{19}$$

$$w_1 = \eta p, \tag{20}$$

$$\tilde{w}_1 = \eta(p - \tilde{\kappa}). \tag{21}$$

3.4 Definition of Steady State Equilibrium

The four free entry condition mentioned above coupled with eight Beveridge curves and the four wage curves determine the steady state equilibrium. The steady state equilibrium with random search and bargaining in segmented markets consists of unemployment levels for each type, $(u_0, \tilde{u}_0, u_1, \tilde{u}_1)$, queue length levels for each type, $(b_0, \tilde{b}_0, b_1, \tilde{b}_1)$, and wages in each market, $(w_0, \tilde{w}_0, w_1, \tilde{w}_1)$, satisfying the four free entry conditions, the four wage curves and the four Beveridge curves for the different types of unemployed workers.

4 Calibration

We calibrate the benchmark model at a monthly frequency. Several parameters are set exogenously to their direct empirical counterparts or by following the literature. We normalize the match output p to 1 and set the discount rate r to 0.0042, consistent with an annual interest rate of 5%. We set the elasticity of the aggregate matching function with respect to unemployment α to 0.4 as in Flemming (2020) and many others. To be consistent with the stylized facts on income shares, the workers' bargaining weight η is set equal to 2/3 (Gollin, 2002). Finally, we set the skill loss shock intensity γ to 1/12, which implies that an unemployed entrant spends on average twelve months in unemployment before their skills depreciate. We chose the twelve months interval to be consistent with the definition of "long-term unemployment" according to the Greek Public Employment Service (OAED) which is consecutive unemployment of twelve months and over.

Parameter	Description	Value	Source
r	Discount Rate	0.0042	Annual Interest Rate of 5%
p	Match Output	1	Normalization
α	Matching Function Elasticity	0.4	Flemming (2020)
η	Worker Bargaining Power	0.66	Gollin (2002)
γ	Skill Loss Intensity	1/12	Definition of LTU

Table 1: Exogenously set parameters.

The remaining six parameters are calibrated through the model and their values are reported in Table 2. The vacancy creation cost c, the worker exit/entry rate δ, and the separation rate λ are chosen to make the model consistent with the following labor market moments, respectively: i) the aggregate unemployment ($u_0 + \tilde{u}_0 + u_1 + \tilde{u}_1$), ii) the fraction of young workers in the unemployment pool ($(u_0 + \tilde{u}_0)/(u_0 + \tilde{u}_0 + u_1 + \tilde{u}_1)$), and iii) the fraction of long-term unemployed among young workers ($\tilde{u}_0/(u_0 + \tilde{u}_0)$). Next, we follow Shimer (2005) and set the opportunity cost of employment z to 40% of average worker productivity. Regarding the size of skill loss $\tilde{\kappa}$, we employ the estimates of Ortego-Marti (2016, 2017) which imply a monthly 1.22% drop in worker wages while the worker is unemployed.

Finally, to discipline the training cost parameter κ we match annual training expenses of 2.5% of Greek GDP, a similar order of magnitude as total vacancy creation costs which are usually estimated to be 1-2% of GDP (see, e.g., Michaillat and Saez 2021). Using a different calibration strategy, Masui (2023) also estimates training costs to be close to vacancy creation costs, which provides a sanity check for our strategy. As can be seen in

Parameter	Description	Value
c	Vacancy Cost	52.4105
δ	Worker Exit Rate	0.0036
λ	Separation Rate	0.0167
z	Unemployment Value	0.2309
$\tilde{\kappa}$	Skill Loss Scar	0.1370
κ	Training Cost	0.0837

Table 2: Internally calibrated parameters.

Table 3, the model exactly matches the calibration target (the difference between model-implied and data moments is in the order of 10^{-8}).

Target	Data	Model
Unemployment Rate	13.1%	13.1%
Unemployed Youth/Unemployed	25.8%	25.8%
Long-term Unemployed Youth/Unemployed Youth	46.9%	46.9%
Value of Non-Employment/Average Productivity	40%	40%
Wage Loss for Six Months Unemployment	14.7%	14.7%
Training Expenses/GDP	2.5%	2.5%

Table 3: Matching the calibration targets.

5 Quantitative Results

This section quantifies the implications of the model through a series of counterfactual experiments designed to capture key structural and policy shocks relevant to the recent experience of the Greek economy. We focus on aggregate output (Y), the aggregate unemployment rate (u), type-specific masses of unemployed workers ($u_0, \tilde{u}_0, u_1, \tilde{u}_1$), and equilibrium wages across worker types ($w_0, \tilde{w}_0, w_1, \tilde{w}_1$). The quantitative results of the baseline model can be found in Table 4.

Y	u	u_1	$\tilde{u}_1$	u_0	$\tilde{u}_0$	w_1	$\tilde{w}_1$	w_0	$\tilde{w}_0$
0.58	13.1%	0.0626	0.0342	0.0177	0.0156	0.67	0.58	0.61	0.52

Table 4: The baseline economy.

The baseline economy reproduces salient features of the Greek labor market: very high unemployment rates, particularly among young workers, and a marked wage gap

between experienced and low skilled individuals. Our next step is to vary key structural parameters in the model to capture institutional reforms, productivity shocks, and the effects of migration and brain drain. The quantitative results are summarized in Table 5 and we comment on each experiment in a separate subsection. For aggregate output and wages, the results are presented as percentage deviations from the baseline model, while for the unemployment measures we provide the corresponding levels for each experiment.

Variable	Labor Institutions	Vacancy Cost	Productivity Drop
Y	12.30%	10.29%	-42.20%
u	10.3%	10.7%	18.4%
u_1	0.0548	0.0561	0.0712
$\tilde{u}_1$	0.0229	0.0246	0.0556
u_0	0.0150	0.0155	0.0227
$\tilde{u}_0$	0.0102	0.0109	0.0346
w_1	-10%	0%	-25%
$\tilde{w}_1$	-10%	0%	-28.97%
w_0	-10%	0%	-27.28%
$\tilde{w}_0$	-10%	0%	-32.08%

Table 5: Quantitative effects of various model experiments.

5.1 Labor Institutions

We begin by examining the effects of the institutional changes implemented under Greece's austerity programs, notably the suspension of collective bargaining rights (Law 1876/1990). In the model, this corresponds to a reduction in the workers' bargaining power parameter η. A lower η compresses workers' share of the match surplus, lowering equilibrium wages by roughly 10% across all worker types. The resulting decline in labor costs stimulates vacancy creation, raises market tightness, and lowers unemployment. Aggregate output increases by 12.3%. This experiment illustrates a classic DMP mechanism: labor market liberalization enhances job creation and output, but at the expense of real wages. The result aligns with the Greek experience, where reforms that reduced wage rigidity improved employment dynamics but generated concerns over income distribution and job quality. All in all, this scenario shows that government interventions, under specific circumstances, can yield positive outcomes with respect to output and unemployment but can also be controversial as it results in lower wages.

5.2 Vacancy Cost

Next, we analyze reforms that reduced firms' recruiting costs—such as active labor market policies and regulatory simplifications introduced during the first two adjustment programs implemented in the Greek economy to cope with the sovereign default crisis. In the model, this corresponds to a reduction in the vacancy cost parameter c. Lowering c increases the profitability of job creation, leading firms to post more vacancies and improving job-finding rates. Output rises by 10.3%, while unemployment declines. Because wages depend on the bargaining rule rather than vacancy costs directly, they remain effectively unchanged. Overall, this counterfactual underscores that reductions in hiring frictions can deliver substantial output gains without wage compression.

5.3 Productivity Drop

The Greek economy contracted by nearly 25% during the 2008–2016 crisis. To replicate this episode, we reduce the productivity parameter p by one quarter. The consequences are severe: output falls by 42%, unemployment rises to 18%, and wages decline by 25–30%, with the sharpest drop among young and scarred workers. Lower productivity shrinks the total match surplus, discouraging vacancy creation and worsening job-finding rates. Firms' profitability falls, and the wage-setting rule transmits this shock directly to workers' pay. The disproportionate impact on young and scarred workers mirrors the dynamic mechanism at the center of our model, namely that early-career shocks generate long-lasting employment and earnings losses.

5.4 Brain Drain

Between 2009 and 2020, the Greek labor force declined by roughly 8%, primarily due to large-scale emigration of high-skill workers. This exodus reduced average human capital, increased firms' training needs, and weakened the efficiency of the labor market. We capture these effects through two experiments: an increase in the training cost parameter (κ) and a decrease in the efficiency of the matching function. The results are presented in the first and third column of Table 6.

An increase in training cost κ lowers output by 6%, while aggregate unemployment remains broadly unchanged. The adjustment operates mainly through wages: inexperienced and scarred workers—those requiring or imposing training costs—face wage declines of 7–9%. Experienced workers' wages remain stable. This reflects firms' need to divert productive resources toward training activities, which depresses both entry-level

pay and overall productivity.

Next, a reduction in matching efficiency generates even larger adverse effects. Output falls by about 25%, and unemployment rises across all worker types as firms struggle to find suitable applicants. Because the wage determination mechanism is unaffected, wages remain largely unchanged. The results highlight how the exodus of skilled workers ("brain drain") either through increased training costs or lower matching efficiency can substantially depress aggregate activity even without wage adjustments.

Variable	TC	TC-South vs North	ME	ME -South vs North
Y	-6.04%	-8.92%	-24.94%	-28.30%
u	13.3%	13.9%	20.4%	21.4%
u_1	0.0595	0.0610	0.0753	0.0763
$\tilde{u}_1$	0.0355	0.0386	0.0703	0.0754
u_0	0.0189	0.0195	0.0235	0.0241
$\tilde{u}_0$	0.0189	0.0207	0.0351	0.0381
w_1	0%	0%	0%	0%
$\tilde{w}_1$	0%	0%	0%	0%
w_0	-7.24%	0%	0%	0%
$\tilde{w}_0$	-8.51%	0%	0%	0%

Table 6: Quantitative effects of increases in training cost and deductions in matching efficiency for different discount rates.

5.5 Brain Drain and Regional Disparities

The observed large-scale worker emigration did not have the same impact on all parts of Greece. The north and south parts of the country, in particular, have quite different structural and economic characteristics. Hence, the effects of brain drain in each region are expected to be different. We proxy the structural differences across the North and South of Greece with differences in discount rates (capturing differences in risk attitudes and the levels of risk aversion in each part of the country). For the South of the country, containing Athens, Crete, and other relatively wealthy parts, we use the baseline discount rate, while we raise the parameter $r = 0.0052$ for the North, reflecting higher perceived risk and shorter planning horizons among firms and workers in that part of the country.

Under this adjustment, output falls further relative to the baseline brain drain scenarios: by an additional 2.9% when training costs are elevated and by an additional 3.4% when matching efficiency declines. These declines mirror the rises in the unemployment

rates, while wages remain stable since the discount rate does not enter the wage equation. These results emphasize that the economic consequences of emigration are spatially uneven, disproportionately burdening regions already characterized by lower capital inflows and weaker agglomeration economies.

6   Conclusion

This paper uses a search-and-matching model that links early-career labor-market experiences to long-term productivity and employment outcomes to analyze youth unemployment in the Greek labor market. Firms face training costs when hiring new entrants, and young workers who remain unemployed for too long risk a permanent loss of skills. These mechanisms create persistent differences between experienced/old and inexperienced/young workers in terms of wages, job-finding rates, and productivity. The model reproduces key features of the Greek labor market, including high youth unemployment, long spells of joblessness among entrants, and substantial resources devoted to on-the-job training.

Counterfactual exercises illustrate how various institutional and structural features of the Greek economy affect these outcomes. Reductions in worker bargaining power, mimicking Greece's austerity-era reforms, stimulate hiring and increase output but compress wages. Lower recruitment costs—such as those achieved through active labor-market policies—raise employment and output without wage losses. In contrast, negative productivity shocks, like those experienced during the 2008–2016 crisis, generate sharp declines in output and disproportionate job and income losses for young and low-experience workers. Simulations of brain drain show that the emigration of skilled workers depresses output by raising firms' training needs and reducing matching efficiency, with the effects especially pronounced in Greece's northern regions, where higher risk perceptions further discourage hiring.

The policy implications of this paper follow directly from the afore-mentioned mechanisms. The Greek government should focus on raising job creation and match quality rather than reducing wages. Targeted subsidies for firms that train and hire young workers can offset the externality that discourages the hiring of inexperienced workers. Reducing bureaucratic hiring costs and investing in efficient job-matching systems would lower frictions and improve overall productivity. Measures that stabilize demand for young workers during downturns—such as hiring credits, temporary wage subsidies, or guaranteed first-job programs—can prevent scarring effects that permanently reduce

lifetime earnings. Finally, policies that attract or retain skilled workers, including return-migration incentives and region-specific investment support, would mitigate the output losses associated with brain drain. Together, these measures address the structural bottlenecks highlighted by the model, promoting a more resilient and inclusive labor market.

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