A Temporary Job Trap:
Labor Market Dualism and Human Capital Accumulation

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Preliminary and Incomplete

July 27, 2019

Abstract

The labor market in most developed countries is characterized by the considerable share of temporary workers and the strong persistence of temporary employment. Motivated by these empirical facts, this paper aims to quantitatively evaluate the performance of the dualized labor market in terms of efficiency, and accordingly develop policies for its improvement. I first build a tractable search-and-matching model which produces equilibrium where those with low human capital levels become temporary workers, and most of them fail to become permanent workers due to the lack of opportunities to invest in human capital through on-the-job training. The structural model is estimated by the simulated method of moments using Korean labor market data. The quantitative analysis based on the estimated model delivers three main findings. First, the welfare of the decentralized economy is 8.9 percent below the level achievable by the social planner. The inefficiency is primarily caused by the dearth of training for temporary workers and the mismatched type of training for permanent workers (both together accounting for at least 63.3 percent of the current efficiency loss), rather than the mismatched employment contract type. Second, providing training subsidies can lead to significant welfare gains. The counterfactual analysis indicates that a 25 percent reduction in training costs results in welfare gains of 7.0 percent, corresponding to the eradication of 71.7 percent of inefficiency arising in the decentralized equilibrium. Lastly, the estimated model predicts that the "shrinking-the-gap" strategy would not be effective as a measure to address the inefficiency of the dualized labor market. According to the policy experiment postulating a 25 percent reduction in firing costs for permanent jobs, the expected net welfare gain amounts to only 2.6 percent, suggesting the necessity of a synthesis between the "shrinking-the-gap" strategy and other policy options to foster on-the-job training.

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1 Introduction

Motivation The decline of typical jobs and the rise of atypical jobs is a prominent feature of the current labor market in most developed countries.[1] Indeed, in 2017, the share of temporary workers among all dependent employees was above 15% in eleven OECD countries, including Spain and Korea where temporary workers accounted for 26.7% and 20.6%, respectively (OECD, 2018). Such a non-negligible portion of temporary employment, combined with its unrevealed impact on the economy, has triggered researchers to examine the dualized labor market and its participants for the last two decades. Among all remarkable findings from various studies on the theme, the following three empirical findings especially attract our attention: 1) having a temporary contract is not a voluntary choice (Bureau of Labor Statistics, 2005, 2018; OECD, 2014), 2) nevertheless, temporary employment status persists strongly—the so-called "temporary job trap" (Autor and Houseman, 2010; Berton et al., 2011; García-Pérez and Muñoz-Bullón, 2011), and 3) strong persistence in temporary employment induces negative consequences, including, at the individual level, unfavorable medium- and long-run economic outcomes (Houseman, 2014) and adverse influences on physical and mental health (Auer and Danzer, 2015), while at the economy-wide level, detrimental effects on productivity (Dolado et al., 2016) and wage inequality (ILO, 2015).

Confronted with the deleterious consequences of temporary employment and its persistence, researchers and policymakers have been grappling with how to improve the segmented labor market. The primary scheme suggested by researchers and implemented by politicians has been to eliminate labor market dualism (henceforth, "dualism") itself,[2] rather than discover and deactivate any mechanism that can illuminate how individuals are unwillingly caught in the temporary job trap. However, as evidently implied by the fact that most developed countries are still struggling with dualism, policies purely aimed at reducing the discrepancy between permanent and temporary contracts have not been effective. The Spanish and Korean government, for instance, attempted to reform the labor market in 2010 and 2015, respectively, by adopting more flexible employment protection regulations for permanent workers on the one hand, and enhancing job security for temporary workers (largely through restrictions on the usage of temporary contracts) on the other hand, but failed to reach a political consensus: both governments encountered strong objections from employers and both permanent and temporary employees (simply due to expected heterogeneous effects of the planned policy change), and as a result, the proposed legislation for the reform was withdrawn in both countries. Meanwhile, in Italy, labor market reforms were enforced by the authorities in 2001 despite fierce political resistance, which unfortunately caused unintended (and thus, undesirable) consequences, as comprehensively documented by Daruich et al. (2017). Obviously, all these experiences not only demonstrate the difficulty of fixing the dysfunctional labor market, but also suggest a reason why it is necessary to consider and investigate a policy scheme that is beyond merely shrinking the gap and pursuing a single employment contract.

The necessity of a policy that would neutralize the temporary job trap, thereby addressing dualism, evokes two stylized facts on temporary workers (see Figure 1 below). First, in most countries, there exists a

[1] Typical and atypical jobs are primarily represented by permanent and temporary jobs, respectively (OECD, 2014). The two major differences between these two types of jobs are whether a job termination date is undetermined or predetermined at its starting date, and whether red-tape firing costs that are incurred when a worker is dismissed are burdensome or not (in a relative sense).

[2] One of the most recent studies on this type of policy alternative is Dolado et al. (2018), who have proposed a unified employment contract that is characterized by employment protection increasing with tenure, and explored the effects of replacing the currently-used two types of contracts with the proposed integrated one in the context of Spain, as earlier discussed by Cahuc (2012) for the French labor market.

negative relationship between the probability of being temporary workers and the education level (Charlot and Malherbet, 2013; OECD, 2014). Second, workers on temporary contracts generally receive less on-the-job training (henceforth, "training") than their permanent counterparts (OECD, 2014; Cabrales et al., 2017). Remarkably, these two salient features of temporary workers suggest a mechanism that can illuminate how individuals are unwillingly caught in the temporary job trap: *the less-educated are more likely to become temporary workers, and then most of them are caught in the temporary job trap due to the lack of opportunities to invest in their human capital through training.*[3] This interpretation, of course, is not a novel understanding since the role of training as a catalyst for the transition from temporary to permanent employment has been already demonstrated and underscored by numerous empirical works (e.g. European Commission, 2004; Berton et al., 2011; Cabrales et al., 2017, among others).[4] Nonetheless, shedding new light on (the dearth of) training in the workplace seems to be necessary and essential because, to the best of my knowledge, there have been no studies that have built a structural model with the "training mechanism" embedded and highlighted, and used it to derive policy implications in a systematic way.

Objectives Motivated by both the unsuccessful past experiences in directly removing dualism and the missing piece in the literature on temporary employment and training, this paper first develops a tractable model that, by incorporating endogenous human capital accumulation on the job, can potentially generate the temporary job trap and the "temporary job scar"—the persistent response of wages to holding a temporary job.[5] Then I verify the function of the training channel in the consolidation (or collapse) of dualism by quantifying its role in the temporary job trap and scar. The final objective of this paper is to evaluate, in terms of the expected allocational and distributional consequences, a range of policy alternatives, especially including a set of policy options that encourage training and can be possibly synthesized with the "shrinking-the-gap" strategy or an optimal unemployment benefit program, in the context of Korea.

The Korean labor market is a suitable laboratory to conduct counterfactual policy experiments because it is the epitome of a labor market featuring dualism and consequent challenges (Dao et al., 2014; Jones and Fukawa, 2016; Schauer, 2018). Furthermore, in order to improve the labor market, the government is considering a series of policy measures, including a mandatory transition of temporary jobs into permanent jobs under certain circumstances, a tax levied on the excessive use of temporary contracts, and a minimum wage raise.[6] Therefore, this paper can provide Korean policymakers with predictions of the effects of the proposed policy changes, as well as comparisons with those of alternative schemes designed to foster training.

Benchmark model Before spelling out a model with endogenous human capital accumulation on the job, I begin with a simple benchmark model to highlight the fundamental trade-off between permanent and temporary contracts when workers are *ex-ante* heterogeneous with respect to their human capital levels. The model resembles a standard random search-and-matching model (e.g. Mortensen and Pissarides, 1994), but

[3]Education is the main source of human capital accumulation before labor market entry, and that permanent jobs typically require high levels of skills (Kahn, 2018), both making the proposed mechanism more plausible.

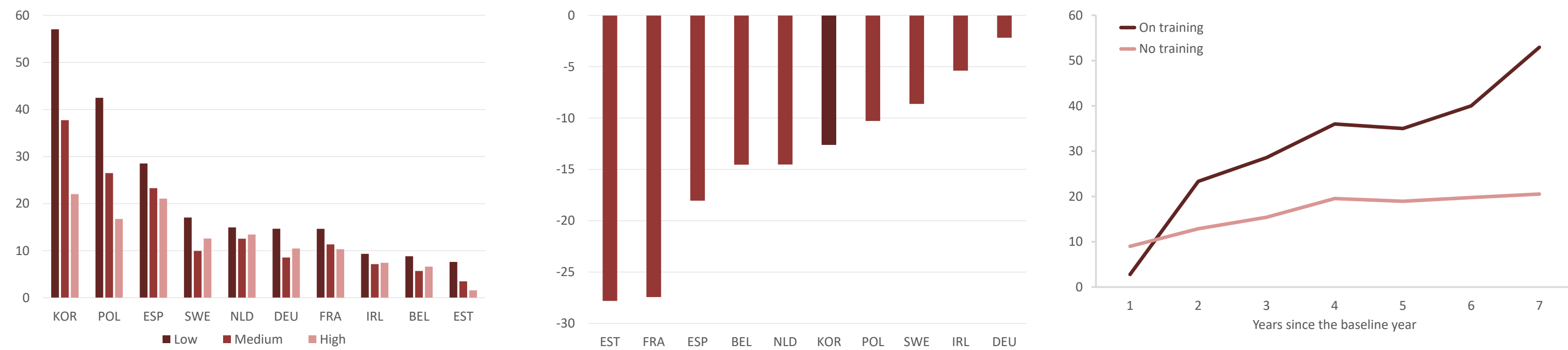
[4]Daruich et al. (2017) have also conjectured that the limited training opportunities for temporary workers can be a key contributor to persistent temporary employment and resulting (long-term) earning losses of those who entered the labor market after the 2001 Italian reform that facilitated the use of temporary contracts; see Section 6.3.4 therein for detailed discussion.

[5]Following a similar spirit, the temporary job trap can be interpreted as the persistent response of employment to holding a temporary job.

[6]The availability of panel data (Korean Labor and Income Panel Study; accessible at `https://www.kli.re.kr/klips_eng/index.do`—last visited on January 24, 2019) containing detailed information about training experiences is another reason that makes Korea an attractive choice for this study.

Figure 1: Features of temporary employment

(a) Temporary employment by education level (b) Temporary employment and training (c) Transition to permanent employment



Notes: (a) The figure is drawn based on the data collected by the OECD on people aged 25-54 in 2011-12. The classification of the level of education is different country by country, and readers interested in details are referred to the original source: `http://dx.doi.org/10.1787/888933132659`. The original source does not include relevant data from Korea, for which alternative data provided by the National Statistical Office of Korea are used. (b) The figure indicates the estimated percentage difference in the probability of receiving on-the-job training between temporary and permanent workers in 2012. The original data collected by the OECD can be accessed at `http://dx.doi.org/10.1787/888933132811`, in which Korea is reported to have minus 4.0 percentage points. However, the number is not statistically significant at conventional significance levels, and thus, an alternative estimate (minus 12.6 percentage points) suggested by the National Statistical Office of Korea is reported. All online references were accessed on July 27, 2019. (c) The figure shows the rate of conversion to permanent employment for two groups of temporary workers in Korea: those receiving on-the-job training at least once for the past three years, and those never receiving over the same period. The horizontal axis corresponds to years since the baseline year (2006) when workers were grouped according to their training experience. For details on the data (the KLIPS) used for the plot, see Section 4.1.

Table 1: A snapshot of the reduced-form analysis results

(a) Determinants of temporary employment

	(1)	(5)
Level of edu.		
Secondary	−0.488***	−0.293***
	(0.063)	(0.075)
Tertiary	−1.133***	−0.734***
	(0.071)	(0.096)
Char. of workers	N	Y
Char. of jobs	N	Y

(b) Determinants of receiving training

	(1)	(3)
Contract type		
Temporary	−0.494***	−0.295***
	(0.080)	(0.084)
Char. of workers	N	Y
Char. of jobs	N	N

(c) Determinant of conversion to perm

	(4)	(6)
Training exp.		
(extensive)	0.189**	0.255**
	(0.092)	(0.112)
Char. of workers	Y	Y
Char. of jobs	Y	Y

Notes: The tables summarize the results obtained from the reduced-form analysis (using probit models) reported in Appendix B.2, and thus, the column numbers in (a)–(c) correspond to those in Tables 7–9, respectively. For complete results and detailed commentaries, see Tables 7–9 in Appendix B.2 and the notes therein.

there are no productivity shocks for the sake of clarity while there are two types of employment contracts, one of which can be chosen by a matched worker-firm pair, as in Berton and Garibaldi (2012), Lepage-Saucier et al. (2013), and Cahuc et al. (2016). The two types of contracts are characterized by two policy parameters: red-tape firing costs incurred only for permanent contracts, and the predetermined employment duration applying only to temporary contracts.

In this environment, qualitative analysis delivers three important implications. First, permanent and temporary contracts can coexist in equilibrium. In such a case, a worker-firm pair prefers the latter to the former if and only if the expected surplus loss due to the fixed duration of the temporary contract is less than the expected firing costs of the permanent contract. Second, the decentralized economy where permanent and temporary contracts cohabit cannot attain the social optimum. In fact, relative to random search models with one-sided heterogeneity and a single type of contract (e.g. Davis, 2001; Ljungqvist and Sargent, 2012, Chapter 28), achieving efficiency is more challenging under the coexistence of permanent and temporary contracts because an additional condition required for efficiency emerges.[7] Note that, as its corollary, the Hosios (1990) condition cannot ensure efficiency in the benchmark case, in contrast to a standard random search model with homogeneous agents and a single type of contract. Last but not least, the benchmark model portrays well what is observed in the real world, albeit not all of it. For example, the model predicts a positive correlation between the share of temporary contracts among all employment relationships and the employment protection legislation gap between permanent and temporary contracts, which is consistent with what is observed in the data (e.g. Figure 1 in Charlot and Malherbet, 2013). However, it is obvious that different incentives (depending on the type of contract) to invest in human capital and the role of training as an accelerator for the temporary-to-permanent conversion cannot be explored, despite a plethora of evidence of their significance, within this simple framework, a common limitation shared with all models studied in the literature.[8]

Extended model The benchmark model that allows the coexistence of permanent and temporary contracts is extended to incorporate human capital accumulation on the job. Following an early work of Becker (1964), I introduce two types of human capital, specific and general, to offer a matched worker-firm pair the following six options: $\{$*permanent, temporary*$\}$ $\times$ $\{$*specific training, general training, no training*$\}$.[9] Although all the other features are inherited from the benchmark model, two of them have to be emphasized in the present context where *specific or general* human capital can be accumulated *endogenously* through training. First, labor market imperfections (frictions) in the model create a match-specific rent (surplus) that will be shared by the worker-firm pair. Consequently, in the same vein as Acemoglu and Pischke (1999), there is an incentive for both parties to invest in either specific or general training as long as its expected benefits outweigh the costs involved in it. Second, as in Flinn et al. (2017), the production function has

[7]That is, in addition to two already incompatible conditions (namely, a condition for the efficient creation of vacancies, and a condition for the efficient allocation of workers), a condition for the efficient choice of contract has to be satisfied as well for the decentralized economy to achieve efficiency. Thus, the "fundamental tension" (Davis, 2001) becomes more severe when two types of contracts are available.

[8]The only exception is the model in Berton and Garibaldi (2012) (and its variant in Cabrales et al., 2017), where a firm can improve its productivity (after an adverse shock) by investing in specific training. However, it is assumed that there is no wage gap between permanent and temporary workers, which, together with unmodeled general training, makes their framework too simple to deal with the issues raised in this paper.

[9]In other words, besides the type of contract (permanent versus temporary), a worker-firm pair can decide whether to invest in training or not (the extensive margin of training). If the former is preferred, then the type of training (specific versus general) can also be chosen, whereas the amount of training (the intensive margin of training) cannot.

the form of *(specific human capital level)* × *(general human capital level)*, and its complementarity between specific and general human capital provides the work-firm pair with an incentive to balance them in the training decision.[10] Therefore, combined with the assumption that every worker starts a new job with the same level of specific human capital, the complementary production function exhibits the possibility that, unless the initial specific human capital level, which is common to all workers in the model, is too high or low, permanent and temporary workers are more likely to invest in specific and general human capital, respectively, in equilibrium,[11] as empirically supported by Garda (2013) and Berton et al. (2016).[12]

A theoretical investigation based on the extended model reveals three significant properties. First, workers and firms on the temporary contract have less incentive to invest in training (regardless of its type), compared with their permanent counterparts.[13] This prediction from the model is intuitive: *ceteris paribus*, the period during which the temporary worker-firm match can reap the benefits from training is truncated by the predetermined employment duration, making them reluctant to invest in any type of training. Second, regardless of the contract type, the decision made by the worker-firm match for specific training coincides with the social planner's choice; however, their decision for general training does not—in fact, the underinvestment problem arises. The socially optimal choice for specific training and the socially nonoptimal choice for general training can be explained by the same theoretical mechanism developed in the literature for the case where only a single type of contract is available:[14] there exists a positive externality associated with general training. Indeed, the benefits from general training are shared by the worker's future employers although they pay nothing for their benefits, which causes decentralized decisions to deviate from the social optimum in the case of general training.[15] Note that such a market failure regarding underinvestment in general training, together with the inefficiency originated from dualism, justifies government intervention in the segmented labor market. Lastly, contrary to the benchmark model, the extended model can reproduce the temporary job scar, which is witnessed in the data, through the human capital channel. Consequently, the extended model can be employed, for instance, to study the wage gap between permanent and temporary workers, as pursued in the quantitative analysis part.

[10] Technically speaking, given a production function $f(y, z) = yz$ with y and z being the specific and general human capital level, respectively, it is more beneficial to increase z by a small amount, provided $y > z$ for instance, because such an increase will result in production gains of y, which is obviously larger than z, the marginal gains from increasing y by a small amount.

[11] Regarding this reasoning, a closely related theoretical study is Wasmer (2006), who has established that, under the presence of search frictions, the stricter employment protection is, the more specific human capital is accumulated (in comparison with general human capital). Although the theoretical result has been derived from the economy with a single type of contract, the insight is applicable to the current context. To be specific, if only a single type of contract is available, the complementary production function will lead the high-skilled and the low-skilled to invest in specific and general training, respectively, under appropriate parameter values. Meanwhile, if the single contract type diverges into two types of contracts (permanent versus temporary), then such a tendency resulting from the complementarity will be intensified due to the employment protection gap. That is, borrowing the terminology of Wasmer (2006), the high-skilled will become permanent workers and stay in the "S-regime" where strict employment protection (low turnover) and specific human capital bolster each other, while the low-skilled will become temporary workers and reside in the "G-regime" where lenient employment protection (high turnover) and general human capital reinforce each other.

[12] Note, however, that without appropriate restrictions on parameter values, the complementary production function *per se* does not necessarily lead to a sorting of permanent and temporary workers into specific and general training, respectively. Nevertheless, as will be pointed out later, the estimation results (obtained without imposing any restrictions on parameter values) indicate that there exists such a tendency.

[13] In the case of specific training, Berton and Garibaldi (2012) and Cabrales et al. (2017) also have reached the same conclusion.

[14] Cahuc et al. (2014), for instance, present a textbook-style model and related analysis; see Chapter 14 therein.

[15] As for specific training, the investment decision is made after the match is formed, and accumulated specific human capital (if any) is completely destroyed when the match is separated. Therefore, the matching process (especially, labor market tightness—the equilibrium object) does not affect the investment decision, and the benefits from specific training are not shared by any third party (i.e. future employers of the worker), both together leading to the socially optimal choice for specific training.

Estimation results I anchor the model to Korean labor market data (Korean Labor and Income Panel Study, 2002–2016). The model is structurally estimated by the simulated method of moments. Overall, the prominent features of the data are well captured by the estimated model. Especially, the model successfully reproduces the temporary job trap and scar although they are not included as a target for estimation. Following Flinn et al. (2017), I also provide a structural interpretation of (a slightly modified version of) the standard Mincerian wage regression based on the estimated model. Specifically, a dummy variable indicating whether the first job is permanent or temporary is included in the regression as an additional regressor, and it is documented that the coefficient of the added variable (0.138 from the simulated data while 0.100 from the actual data) is determined by two main forces: innate versus accumulated general human capital.

After validating the estimated model in terms of its fit to the data, I use it to quantify the efficiency loss in the decentralized economy. The estimated welfare level of the *laissez-faire* economy amounts to 12.9, a number 8.9 percent lower than the level achievable by the social planner. The estimated structural model also allows me to decompose the measured inefficiency into contributions from each source of inefficiency, or contributions from each education group. The quantitative analysis indicates that the lack of training for temporary workers and the mismatched type of training for permanent workers together can explain at least 63.3 percent of the current efficiency loss, implying that the amount of the welfare loss caused by the mismatched employment contract type is relatively small. Meanwhile, since temporary and permanent jobs are typically held by the low- and high-educated, respectively (both in the model and in the data), it turns out that most (around four-fifth) of the inefficiency is attributable to these two education groups.

Counterfactual analysis The estimated structural model is employed for counterfactual analysis to develop policies for reducing the estimated welfare loss. I consider two sets of policy experiments: first of all, a 5, 25, or 50 percent reduction in training costs (through subsidies) is postulated; second, a 5, 25, or 50 percent cut in firing costs (via subsidies) is presumed. The quantitative results obtained from the first set of experiments suggest that "training-friendly" labor market can achieve welfare improvements through the "activated" human capital accumulation channel. Specifically, the reduction in training costs encourages temporary workers to invest in their human capital, thereby inducing their training participation rate to be close to the socially optimal one (45.7%). Accordingly, the implied welfare gain amounts to 3.8, 7.0, and 9.7 percent, respectively, in the 5-, 25-, and 50-percent counterfactual scenarios. Notice that these gains correspond to the elimination of 38.6, 71.7, and 99.2 percent of inefficiency arising in the decentralized economy. Meanwhile, it is documented that, as a policy option to address the inefficiency of the dualized labor market, the effect of the "shrinking-the-gap" strategy would be limited. Indeed, the expected net welfare gain amounts to at most 3.9 percent (a number obtained when 50 percent of firing costs for permanent jobs are subsidized by the government), implying the necessity for a synthesis of the "shrinking-the-gap" strategy with other policy tools designed to encourage training.

Outline The following section introduces and analyzes a benchmark model with two types of contracts. The benchmark model is extended in Section 3, where human capital accumulation on the job is incorporated to the model. Section 4 discusses the estimation strategy and results, examining the model fit to the data. Counterfactual experiments are designed and implemented in Section 5. I finally conclude in Section 6.

2 The Benchmark Model

In order to study the underlying trade-off between permanent and temporary contracts, this section develops a simple framework without human capital accumulation on the job. The model is built based on a standard random search-and-matching model (e.g. Mortensen and Pissarides, 1994). However, for the sake of transparency, I exclude productivity shocks that may reflect fluctuations in the demand for firms' products; instead, two types of employment contracts (permanent versus temporary) are introduced in the labor market, as in Berton and Garibaldi (2012), Lepage-Saucier et al. (2013), and Cahuc et al. (2016). The model presented in the current section will be extended to include on-the-job training in Section 3.

2.1 Setup

Agents One side of the labor market is constituted by infinitely lived workers, whose measure is normalized to 1. Workers differ in the level of *general* human capital $z \in \mathbb{Z}$, which is constant over the lifetime in the current setup. Let $L(\cdot)$ be the cumulative distribution function of z, and $\ell(\cdot)$ be its density. It is assumed that $L(\cdot)$ has no mass points, and $\ell(z) > 0$ for all $z \in \mathbb{Z}$. The other side of the labor market is populated by homogeneous firms. In particular, all firms are identical in terms of initial productivity (the level of specific human capital with which a worker starts a new job) and security (the exogenous separation rate). Each firm is able to employ at most one worker,[16] and each worker cannot be employed by more than one firm. Workers and firms are risk-neutral, and they have a common discount rate $r > 0$.

Search and matching Time is continuous. Only and all unemployed workers and unfilled jobs engage in search activities. Search is random, and governed by a constant return to scale (CRS) matching function $M : [0,1] \times \mathbb{R}_+ \to [0,1]$. Let U be the number of unemployed workers, and V be the number of unfilled jobs (vacancies). Using the CRS property of $M(\cdot,\cdot)$, I denote the job-finding rate of unemployed workers by $p(\theta) := M(U,V)/U$, and the worker-meeting rate of vacancies by $q(\theta) := M(U,V)/V$, where $\theta := V/U$ is the labor market tightness to be determined in equilibrium. Standard regularity conditions on $p(\cdot)$ and $q(\cdot)$ apply so that $q'(\theta) < 0 < p'(\theta)$, $\lim_{\theta\to 0} p(\theta) = \lim_{\theta\to\infty} q(\theta) = 0$, and $\lim_{\theta\to\infty} p(\theta) = \lim_{\theta\to 0} q(\theta) = 1$.[17]

Once an unemployed worker and a vacant job meet each other, they jointly decide whether to form a match or not, based on the expected surplus accruing from the match. When calculating the match surplus, they weigh two alternatives: permanent versus temporary contracts. If the permanent contract is chosen, the employment relationship persists until the arrival of the (exogenous) separation shock which follows Poisson process with rate $\delta > 0$. Once the permanent match is hit by the separation shock, the worker becomes unemployed and immediately starts searching for a new job while the job, after paying red-tape firing costs $\kappa > 0$,[18] disappears. If the temporary contract is opted for, on the other hand, it is stipulated that the employment relationship is terminated (without incurring any red-tape firing costs to the firm) when the worker's job tenure λ reaches the predetermined employment duration $\Lambda > 0$. Note that temporary matches are also subject to the separation shock, but temporary jobs are exempted from paying κ in case of its arrival.

[16] Therefore, "firm" and "job" are interchangeably used in this paper.

[17] It is also worth noting that the CRS property implies $p(\theta) = M_1(1,\theta) + \theta p'(\theta)$, which will be recalled when establishing the existence and uniqueness of stationary equilibrium in Section 2.2.

[18] As explicitly described in the text, κ is bureaucratic costs, meaning that it is not severance payments (i.e. transfers from the firm to the worker). Thus, a match surplus is affected by κ, along the same lines as Cahuc et al. (2016).

Obviously, the surplus (dis)advantage of one contract type relative to another type depends on the worker's general human capital level, and the worker-job pair chooses the contract type that maximizes the match surplus. Under both permanent and temporary contracts, wages are determined by Nash bargaining with workers' bargaining power $\beta \in (0, 1)$.[19] Therefore, maximizing the match surplus is equivalent to maximizing either the worker's or the firm's surplus, meaning that disagreement over the contract type does not arise. Finally, a match is consummated if and only if the maximized surplus is nonnegative,[20] and neither the contract type nor the wage is renegotiated.

Discussion on modeling the temporary contract Before formulating value functions based on the current environment, I briefly discuss characteristics of the temporary contract designed in the model. First, all surviving temporary contracts are terminated at Λ, meaning that the temporary-to-permanent conversion within the same firm is not allowed in the model. I abstract from such a possibility because the transition from temporary to permanent contracts within the same firm is rarely observed in the data.[21] Second, for the sake of simplicity, the renewal of temporary contracts is not considered in the model. In quantitative analysis, I lessen this gap between the model and reality by treating Λ as the policy parameter that governs not only the maximum duration of temporary contracts but also the maximum number of contract renewals, and estimating it. Lastly, if the separation shock arrives before Λ, the temporary match is immediately destroyed at no cost in the model. However, the temporary contract triggers red-tape firing costs as well in practice (albeit less burdensome relative to the permanent contract), and thus, I emphasize that κ in fact stands for the firing-cost *gap* between the two types of contracts, as in Garda (2013).

Value functions for workers For a worker of type $z \in \mathbb{Z}$, let $W_u(z)$ denote the value of unemployment, $W_p(z)$ the value of starting a permanent contract, and $W_t(z)$ the value of starting a temporary contract. Assuming that all meetings lead to matches (which will be confirmed later) allows me to write worker z's flow Bellman equation when unemployed as follows:

$$rW_u(z) = bz + p(\theta)\left[W(z) - W_u(z)\right]. \tag{1}$$

When unemployed, worker z receives $bz > 0$, instantaneous unemployment benefit depending on his general human capital level. The matching technology implies that the worker meets a firm at rate $p(\theta)$. When the search is successful, the worker starts either a permanent or a temporary job to enjoy welfare gain $W(z) - W_u(z)$, where $W(z) := \max\{W_p(z), W_t(z)\}$ is the value of employment for worker z.

In the case of worker z employed at a firm under the permanent contract, the flow Bellman equation can be written as

$$rW_p(z) = w_p(z) + \delta\left[W_u(z) - W_p(z)\right]. \tag{2}$$

If worker z is permanently employed, he receives flow wage $w_p(z)$ that depends on the worker's type and remains constant for the life of the match. The permanent job can be destroyed at rate δ. In such a case,

[19] In the benchmark model, it is assumed that temporary workers have the same bargaining power as permanent workers do, which will be relaxed in the quantitative analysis.

[20] That is, some meetings that are expected to yield a negative surplus do not result in matches, and unemployed workers and vacant jobs continue their search process. However, as discussed in detail later, all meetings in fact lead to matches in the current setup because the temporary contract ensures a positive surplus for all matches.

[21] [Empirical evidence to be added]

the worker experiences welfare loss $W_u(z) - W_p(z)$.

The flow value to worker z of starting a temporary job is determined by the following flow Bellman equation:

$$rW_t(z) = w_t(z) + \delta \left[W_u(z) - W_t(z)\right] + \mathrm{e}^{-(r+\delta)\Lambda} \left[rW_u(z) - w_t(z)\right]. \tag{3}$$

A type-z temporary worker receives wage $w_t(z)$ that depends on his type and remains the same for the duration of the contract. The temporary job is also subject to a separation shock so that it may be terminated before the specified termination date. The temporary job that has survived until Λ is inevitably destroyed, an event that occurs with probability $\mathrm{e}^{-\delta\Lambda} \in (0, 1)$. The change of the (discounted) flow value in that case is reflected in the last term on the right-hand side of (3).[22] Note that the last term converges to zero as Λ approaches infinity.

Value functions for firms Let Π denote the value of a vacant firm, $\Pi_p(z)$ the value of a firm starting a permanent contract with worker $z \in \mathbb{Z}$, and $\Pi_t(z)$ the value of a firm starting a temporary contract with worker $z \in \mathbb{Z}$. Let $u(z)$ denote the mass of unemployed type-z workers.[23] Assuming again for the moment that all meetings result in either permanent or temporary matches, I can write the flow Bellman equation describing Π as follows:

$$r\Pi = -c + \int_{z\in\mathbb{Z}} q(\theta)\frac{u(z)}{U} \left[\Pi(z) - \Pi\right] \mathrm{d}z. \tag{4}$$

A vacant firm pays an instantaneous cost $c > 0$ to maintain its vacancy. The vacant firm meets a worker of type z at rate $q(\theta)\frac{u(z)}{U}$, the product of the rate of meeting a worker of any type, $q(\theta)$, and the probability that this worker is of type z, $\frac{u(z)}{U}$. A successful search and the consequent match with worker z delivers welfare gain $\Pi(z) - \Pi$ to the firm, where $\Pi(z) := \max\{\Pi_p(z), \Pi_t(z)\}$ is the value of employing worker z. In what follows, I impose a free-entry condition, which requires the expected gain from the search to be equal to the cost of the search, namely, $\Pi = 0$.

The flow Bellman equation that determines the value of a firm starting a permanent contract with worker z reads

$$r\Pi_p(z) = yz - w_p(z) + \delta \left[\Pi - \kappa - \Pi_p(z)\right]. \tag{5}$$

A firm permanently matched with worker z earns flow profits $yz - w_p(z)$ per unit of time, where $y > 0$. Note that the arrival of a separation shock causes welfare loss $\Pi - \kappa - \Pi_p(z)$ to the firm, reflecting that the firm has to pay firing costs κ in case of match destruction.

If a firm decides to start a temporary contract with worker z, the corresponding value can be represented by the following flow Bellman equation:

$$r\Pi_t(z) = yz - w_t(z) + \delta \left[\Pi - \Pi_t(z)\right] + \mathrm{e}^{-(r+\delta)\Lambda} \left[r\Pi - yz + w_t(z)\right]. \tag{6}$$

The interpretation of (6) is straightforward (and thus, omitted), but it is worthwhile to mention that in (6) the firm temporarily employing worker z pays no firing costs under any circumstances.

[22]Readers who are interested in how to arrive at the above Bellman equations are referred to Appendix A.1.
[23]Thus, $U = \int_{z\in\mathbb{Z}} u(z)\,\mathrm{d}z$ by definition.

Surplus For a given worker $z \in \mathbb{Z}$, the surplus of starting a permanent contract, denoted by $S_p(z)$, and the surplus of starting a temporary contract, denoted by $S_t(z)$, are defined as

$$S_p(z) := W_p(z) - W_u(z) + \Pi_p(z),$$
$$S_t(z) := W_t(z) - W_u(z) + \Pi_t(z),$$

respectively.[24] Let $S(z) := \max\{S_p(z), S_t(z)\}$ be the surplus accruing from the match. Then a closed-form expression for $S(z)$ can be obtained by a simple four-step procedure. First, the assumption that wages are determined by Nash bargaining over $S(z)$ implies $W(z) - W_u(z) = \beta S(z)$, allowing me to rewrite (1) as

$$rW_u(z) = bz + p(\theta)\beta S(z). \tag{7}$$

Second, one can use (2), (3), (5), and (6) (with the definitions of $S_p(z)$ and $S_t(z)$) to arrive at

$$S_p(z) = \frac{yz - rW_u(z) - \delta\kappa}{r + \delta}, \tag{8}$$
$$S_t(z) = [1 - \mathrm{e}^{-(r+\delta)\Lambda}]\frac{yz - rW_u(z)}{r + \delta}. \tag{9}$$

Third, $rW_u(z)$ in (8) and (9) can be replaced with the right-hand side of (7), which results in

$$(r + \delta)S_p(z) = yz - bz - p(\theta)\beta S(z) - \delta\kappa, \tag{10}$$
$$(r + \delta)S_t(z) = [yz - bz - p(\theta)\beta S(z)]\,[1 - \mathrm{e}^{-(r+\delta)\Lambda}]. \tag{11}$$

Lastly, one can simultaneously solve (10) and (11) for two unknowns $S_p(z)$ and $S_t(z)$ to derive[25]

$$S(z) = \begin{cases} S_t(z) = \dfrac{[1 - \mathrm{e}^{-(r+\delta)\Lambda}](y - b)}{r + \delta + [1 - \mathrm{e}^{-(r+\delta)\Lambda}]p(\theta)\beta} z & \text{if } z < z_r, \\ S_p(z) = \dfrac{y - b}{r + \delta + p(\theta)\beta} z - \dfrac{\delta\kappa}{r + \delta + p(\theta)\beta} & \text{if } z \geq z_r, \end{cases} \tag{12}$$

where z_r denotes the marginal worker type who is indifferent between starting a permanent or temporary job (namely, $S_p(z_r) = S_t(z_r)$; see Figure 2.(a) for a numerical example), and is given by

$$z_r = \frac{r + \delta + [1 - \mathrm{e}^{-(r+\delta)\Lambda}]p(\theta)\beta}{\mathrm{e}^{-(r+\delta)\Lambda}(r + \delta)(y - b)}\delta\kappa. \tag{13}$$

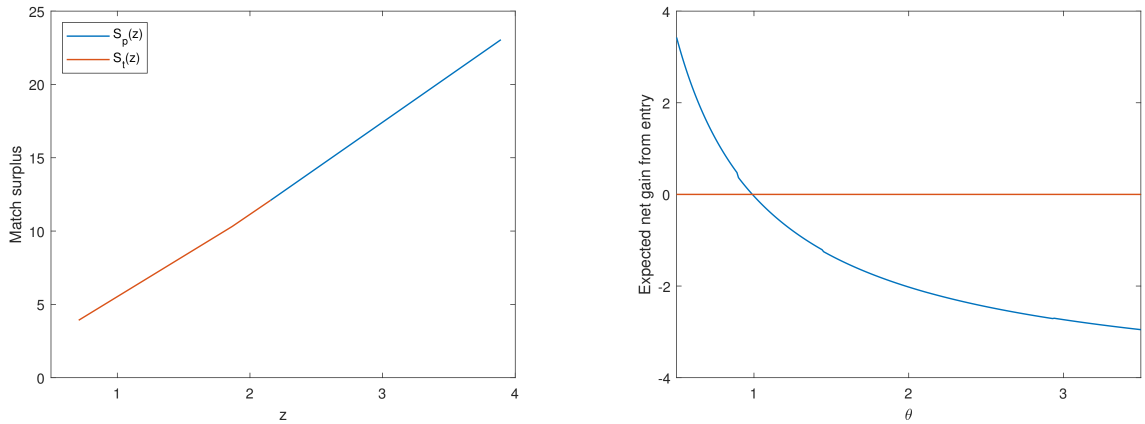
Discussion on $S(z)$ and z_r As indicated in the notation, I have derived the explicit forms of $S(z)$ and z_r by treating the labor market tightness $\theta \in (0, \infty)$ as exogenous. Before closing the model by utilizing the free-entry condition, I briefly present some properties of $S(z)$ and z_r (in the partial equilibrium environment) which are useful for later analysis. From now on, we suppose that $\mathbb{Z} = [\underline{z}, \overline{z}]$, where $\underline{z} > 0$ and $\overline{z} < \infty$.

(P1) *Positivity of $S(z)$.*

[24] Note that the free-entry condition is already embedded in the definitions of $S_p(z)$ and $S_t(z)$.
[25] Explicit expressions for $S_p(z)$ and $S_t(z)$ are presented in more detail in Appendix A.2.

Figure 2: A graphical illustration of the benchmark model

(a) Surplus functions (b) The free-entry condition



Notes: Both (a) and (b) are drawn based on the model specification described in Section 4.2 and the estimated parameter values reported in Table 2, with the modification that the values of ρ, ϕ_s, and ϕ_g are all set to zero. Under the current parameter setting, $\theta = 0.990$ uniquely satisfies the free-entry condition (19).

Provided that $y > b$ (i.e. market production is more efficient than home production), $S_t(z)$ (and thus, $S(z)$) is strictly positive for all $z \in \mathbb{Z}$. Accordingly, as long as $y > b$, all contacts between workers and firms lead to matches, as previously assumed. This is, of course, because temporary contracts incur no firing costs.

(P2) *Existence and uniqueness of* z_r.
With all parameter values fixed, z_r becomes a function of $\theta \in (0, \infty)$. Since $p'(\theta) > 0$ by assumption, $z_r(\theta)$ is increasing in θ, with its range bounded by $\lim_{\theta\to 0} z_r(\theta)$ and $\lim_{\theta\to\infty} z_r(\theta)$. In order to avoid less interesting cases where permanent and temporary contracts do not coexist in equilibrium, I assume in what follows that $\mathbb{Z}$ is chosen such that $\underline{z} < \lim_{\theta\to 0} z_r(\theta)$ and $\lim_{\theta\to\infty} z_r(\theta) < \overline{z}$. Meanwhile, both $S_p(z)$ and $S_t(z)$ are continuous piecewise linear functions in z, with a kink at $z = z_r$. As the slope of $S_p(z)$ is steeper than that of $S_t(z)$ for all $z \in \mathbb{Z}$ (see Appendix A.2), the marginal type z_r is unique as long as it exists.

(P3) *Trade-off between permanent and temporary contracts.*
From the explicit expressions for $S_p(z)$ and $S_t(z)$ (see Appendix A.2), it follows that $S_p(z) \gtreqless S_t(z)$ if and only if

$$\underbrace{\mathrm{e}^{-(r+\delta)\Lambda}\left[\frac{y-b}{r+\delta+[1-\mathrm{e}^{-(r+\delta)\Lambda}]p(\theta)\beta}\right]z}_{\text{relative costs of temporary contracts due to }\Lambda} \gtreqless \underbrace{\left(\frac{\delta}{r+\delta}\right)\kappa}_{\text{relative costs of permanent contracts due to }\kappa}. \tag{14}$$

The temporary job that has survived until Λ (an event occurring with probability $\mathrm{e}^{-\delta\Lambda}$) is unavoidably destroyed at Λ, which causes a surplus loss that amounts to $[r+\delta+(1-\mathrm{e}^{-(r+\delta)\Lambda})p(\theta)\beta]^{-1}(y-b)z$. The left-hand side of (14) exactly represents this amount of loss due to Λ, with discounting applied. On the other hand, the right-hand side of (14) stands for the discounted expected firing costs associated with permanent contracts.[26] Notice that the left-hand side is increasing in z whereas the right-hand side is independent of z, which reconfirms the uniqueness of z_r. It is also noteworthy that the trade-off between the two types of contracts diminishes as κ and Λ approach zero and infinity, respectively.

(P4) *Independence of S_r with respect to θ.*
Let S_r denote the total surplus of the match formed by worker z_r (i.e. $S_r := S(z_r)$). From (12) and (13) above, S_r is simply given by

$$S_r = \frac{1 - \mathrm{e}^{-(r+\delta)\Lambda}}{\mathrm{e}^{-(r+\delta)\Lambda}} \left(\frac{\delta}{r+\delta} \right) \kappa, \tag{15}$$

which is independent of the labor market tightness θ. An intuitive explanation is as follows. A rise in θ (and thus, $p(\theta)$) leads not only to a decrease in the slope of $S(z)$ (because of the increased opportunity costs of forming a match) but also to an increase in z_r (due to the increased value of being unemployed). However, the effect of the former is exactly offset by that of the latter, and consequently, the total surplus associated with the marginal worker type remains the same for all possible values of θ.

(P5) *Exogeneity of Λ.*
Some readers may ask whether the duration of a temporary contract can be endogenized, as in Cahuc et al. (2016). In order to inspect this possibility, one can differentiate $S_t(z)$ in (12) with respect to Λ to obtain

$$\frac{\partial S_t(z;\Lambda)}{\partial \Lambda} = \mathrm{e}^{-(r+\delta)\Lambda} \left[\frac{r+\delta}{r+\delta+[1-\mathrm{e}^{-(r+\delta)\Lambda}]p(\theta)\beta} \right]^2 (y-b)z,$$

which is strictly positive as long as $y > b$. This observation implies that any worker-firm pair who are willing to form a temporary match would choose Λ if they are allowed to choose the duration of their temporary contract from the interval $[0, \Lambda]$. Therefore, although Λ is treated as exogenous throughout the paper, it can be regarded as an optimal choice made by agents.

2.2 Stationary Equilibrium

Flow equations As the last milestone to define a stationary equilibrium and study its properties, I examine the stationary distribution of workers. In a stationary equilibrium (to be formally defined below), the outflow from unemployment must equal the inflow into unemployment for each type of worker. More precisely, the following flow equation must hold for all $z \in \mathbb{Z}$:

$$\underbrace{p(\theta)u(z)}_{\text{outflow}} = \underbrace{\delta\left[\ell(z) - u(z)\right] + \mathbb{1}_{\{z<z_r\}}\left[\mathrm{e}^{-\delta\Lambda}p(\theta)u(z)\right]}_{\text{inflow into unemployment}}, \tag{16}$$

where $\mathbb{1}_{\{z<z_r\}}$ is an indicator function that takes the value one if $z < z_r$ and zero otherwise. As search is random, the flow of matches formed by job seekers of type z is simply given by $p(\theta)u(z)$. Meanwhile, the mass of employed type-z workers is $\ell(z) - u(z)$, and their jobs are destroyed with flow probability δ, as represented by the first term on the right-hand side of (16). The second term corresponds to the case where

[26] Indeed, recall that the separation occurrence follows the Poisson process to see $\int_0^\infty (\mathrm{e}^{-rt}\kappa)\delta\mathrm{e}^{-\delta t}\,\mathrm{d}t = \delta\kappa/(r+\delta)$.

temporary workers whose tenure reaches Λ go back to unemployment due to the nature of the temporary contract.[27]

Letting $u_t := \frac{\delta}{(1-\mathrm{e}^{-\delta\Lambda})p(\theta)+\delta}$ and $u_p := \frac{\delta}{p(\theta)+\delta}$, (16) can be equivalently rearranged as follows:

$$u(z) = \begin{cases} u_t \ell(z) & \text{if } z < z_r, \\ u_p \ell(z) & \text{if } z \geq z_r, \end{cases} \tag{17}$$

in which $u_t > u_p$, reflecting lower job security of temporary workers (relative to their permanent counterparts). As $\int_{z\in\mathbb{Z}} \ell(z)\,\mathrm{d}z = 1$ by assumption, integrating the both sides of (17) over $\mathbb{Z}$ yields the steady state unemployment rate, namely,

$$U = u_t L_r + u_p\left(1 - L_r\right), \tag{18}$$

where $L_r := \int_{z<z_r} \ell(z)\,\mathrm{d}z$ is the total mass of workers of type $z < z_r$.

Stationary equilibrium A stationary equilibrium for this economy is defined in a standard fashion. An equilibrium is a labor market tightness θ that satisfies (4), with the free-entry condition imposed, as formally stated in the following definition.[28]

Definition 1 (Equilibrium in the benchmark model)**.** A *stationary equilibrium* is a labor market tightness $\theta \in (0, \infty)$ satisfying the following free-entry condition:

$$c = \int_{z\in\mathbb{Z}} q(\theta)\frac{u(z;\theta)}{U(\theta)}(1-\beta)S(z;\theta)\,\mathrm{d}z, \tag{19}$$

where $S(z;\theta)$, $u(z;\theta)$, and $U(\theta)$ are given by (12), (17), and (18), respectively.

See Figure 2.(b) for a numerical example of the equilibrium.

Armed with this definition, the next goal is to establish the existence and uniqueness of the equilibrium. For this purpose, I introduce mild assumptions on the model parameters. First, along with $b < y$ which is motivated by (P1), a sufficient condition ensuring that the cost of posting a vacancy is small enough so that each vacancy can expect a positive net gain from searching when search frictions for unfilled jobs are absent (that is, when $q(\theta) = 1$) is imposed to achieve the existence. Second, in order to prove the uniqueness result, I lay down two additional sufficient conditions, under which the cost of posting a vacancy is sufficiently large (compared to the firm's share of the surplus from a match associated with the marginal worker type), and the matching rate for a vacancy is always more elastic (with respect to θ) than the matching rate for a worker so that, consequently, the decreasing monotonicity of the firm's expected net benefit from creating a vacancy (as a function of θ) is guaranteed.

Proposition 1 (Existence and uniqueness of the equilibrium)**.**

(a) *A stationary equilibrium exists under the following conditions:*

(E1) $b < y$,

[27]Notice that only a fraction $\mathrm{e}^{-\delta\Lambda}$ of newly-formed temporary matches, the flow of which is $p(\theta)u(z)$, will survive until Λ.

[28]From now on, for the sake of clarity, I indicate whether an expression depends on θ or not by adding θ to the notation when the expression is affected by it: e.g. $S(z;\theta)$, $u(z;\theta)$, $U(\theta)$, etc.

(E2) $c < \int_{z\in\mathbb{Z}} \ell(z)(1-\beta)S(z;0)\,\mathrm{d}z$, *with* $S(z;0) := \lim_{\theta\to 0} S(z;\theta)$.

(b) *Furthermore, the stationary equilibrium is unique if, in addition to* (E1) *and* (E2)*, the following additional conditions are satisfied:*

(U1) $(1-\beta)S_r \leq c$, *where* S_r *is given by (15),*

(U2) $\left|\frac{\theta p'(\theta)}{p(\theta)}\right| \leq \left|\frac{\theta q'(\theta)}{q(\theta)}\right|$ *for all* $\theta \in (0,\infty)$.

Proof. See Appendix A.3. □

Two remarks on the conditions appearing in Proposition 1 are in order. First, (U1) and (E2) provide lower and upper bounds, respectively, for the cost of posting a vacancy, and one may ask whether these two conditions are compatible with each other, namely, whether the following inequality holds in general:

$$(1-\beta)S_r < \int_{z\in\mathbb{Z}} \ell(z)(1-\beta)S(z;0)\,\mathrm{d}z. \tag{20}$$

Since it cannot be shown that (20) holds true without any restrictions on $\mathbb{Z}$ and $\ell(\cdot)$, I demonstrate the compatibility by presenting a simple example that requires only minimal assumptions on $\mathbb{Z}$ and $\ell(\cdot)$ in Appendix A.4. Second, (U2) is not too restrictive for the purpose of quantitative analysis. For instance, one may employ a Cobb-Douglas matching function of the form $M(U,V) = U^{1-\eta}V^{\eta}$ with $\eta \in (0,1)$ to have

$$\left|\frac{\theta p'(\theta)}{p(\theta)}\right| = \eta,$$
$$\left|\frac{\theta q'(\theta)}{q(\theta)}\right| = 1-\eta,$$

meaning that (U2) is satisfied as long as $\eta \leq 0.5$.[29] With this observation in hand, it is worth mentioning that an elasticity of 0.5 ($\eta = 0.5$) is commonly used in the literature (see Petrongolo and Pissarides, 2001).[30]

Comparative statics Based on the existence and uniqueness results above, I study how the stationary equilibrium responds to a variation in two policy parameters κ and Λ.[31] First, a rise in the firing costs associated with permanent contracts affects the right-hand side of (19), the firm's expected benefit from creating a vacancy, in three distinct ways:

(K1) A *negative* effect of a decrease in the surplus of forming a permanent match;

(K2) A *positive* effect of an increase in the unemployment rate for marginal workers who were previously indifferent but now, due to (K1), prefer temporary to permanent contracts;

(K3) A *negative* effect of an increase in the aggregate unemployment rate, which is induced by the increase in the unemployment rate for marginal workers in (K2).

[29] Notice that, as implied by this example, (U2) has two equivalent variants: $\left|\frac{\theta p'(\theta)}{p(\theta)}\right| \leq 0.5$, or alternatively, $\left|\frac{\theta q'(\theta)}{q(\theta)}\right| \geq 0.5$ for all $\theta \in (0,\infty)$.

[30] The value of 0.5 is also utilized in the quantitative part of this study; see the discussion contained in Section 4.

[31] Only an informal discussion is presented here; Appendix A.5 is devoted to provide technical details, including a formal statement (Proposition 3) and its proof.

Note that (U1) is enough to make (K2) overwhelmed by (K3), leading to a conclusion that a rise in κ drives the labor market tightness down.

Second, the response of the labor market tightness to an extension of the maximum duration of temporary contracts can be decomposed into four components:[32]

(L1) A *positive* effect of an increase in the surplus of forming a temporary match;

(L2) A *positive* effect of an increase in the unemployment rate for marginal workers who were previously indifferent but now, due to (L1), prefer temporary to permanent contracts;

(L3) A *negative* effect of a decrease in the unemployment rate for existing temporary workers;

(L4) An *ambiguous* effect of a change in the aggregate unemployment rate, which is jointly caused by the increase in the unemployment rate for marginal workers in (L2) and the decrease in the unemployment rate for existing temporary workers in (L3).

As witnessed in (L1)–(L4), one cannot sign the effect of a longer Λ in general. Accordingly, in Appendix A.5, I propose two sufficient conditions, one making (L1) outweigh (L3) and the other ensuring the positivity of (L4), to establish the overall positive effect of a longer Λ on the labor market tightness.

Welfare properties The last question addressed in this section is whether the stationary equilibrium in the decentralized economy can achieve the social planner's allocation.[33] The objective of the social planner is to choose the labor market tightness $\theta \in (0, \infty)$ and the marginal worker type $z_r \in [\underline{z}, \overline{z}]$ to maximize aggregate output (including home production) net of the firing costs (incurred by permanent contracts) and the vacancy costs subject to constraints associated with labor market configurations (such as the search frictions and the fixed duration of temporary contracts), namely,

$$\begin{aligned} \max_{\theta,\, z_r} \int_{\underline{z}}^{z_r} & \left[\{\ell(z) - u(z,\theta)\}\, yz + u(z,\theta) bz - \theta u(z,\theta) c \right] \mathrm{d}z \\ & + \int_{z_r}^{\overline{z}} \left[\{\ell(z) - u(z,\theta)\} (yz - \delta\kappa) + u(z,\theta) bz - \theta u(z,\theta) c \right] \mathrm{d}z \end{aligned} \tag{21}$$

subject to, recalling that $u_t(\theta) = \frac{\delta}{(1-\mathrm{e}^{-\delta\Lambda})p(\theta)+\delta}$ and $u_p(\theta) = \frac{\delta}{p(\theta)+\delta}$,

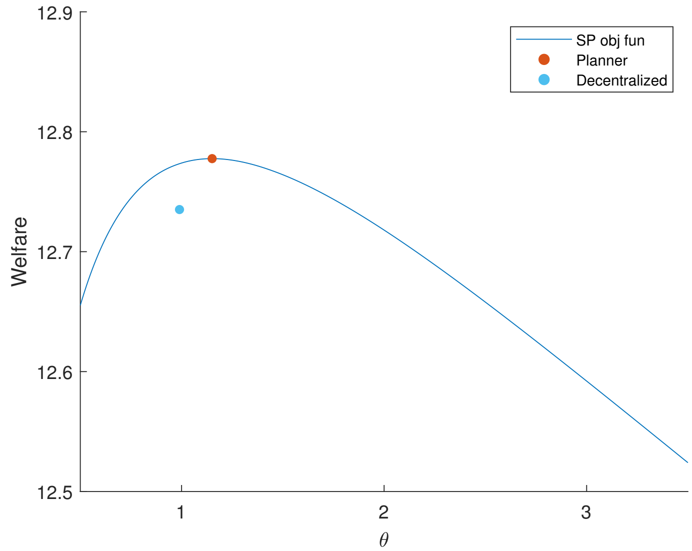
$$u(z,\theta) = \begin{cases} u_t(\theta)\ell(z) & \text{if } z < z_r, \\ u_p(\theta)\ell(z) & \text{if } z \geq z_r. \end{cases}$$

Let θ^P and z_r^P denote the labor market tightness and the marginal worker type, respectively, chosen by the planner, as opposed to θ^* and z_r^*, the corresponding objects in the decentralized economy. As apparently observed in (21), the planner has no interest in how to divide the surplus of a match between a worker and a firm, implying that both θ^P and z_r^P are independent of the exogenous bargaining power parameter β. Accordingly, the question of efficiency boils down to whether there exists a value of $\beta \in (0,1)$ that ensures $\theta^* = \theta^P$ and $z_r^* = z_r^P$. Appendix A.6 is devoted to unraveling this question, thereby establishing the following proposition.

[32] Contrary to the previous case, $u(z;\theta)$ in (17) is directly affected by a change in Λ, making the analysis more complicated.

[33] For the sake of simplicity, time discounting is ignored (that is, $r = 0$) in the following discussion.

Figure 3: A graphical illustration of the social planner's objective function in the benchmark model



Notes: The figure is drawn using the estimated parameter values reported in Table 2, with the values of ρ, ϕ_s, and ϕ_g all set to zero. Although it has no significant economic meaning, it is instructive to observe that the level of welfare implementable by the planner amounts to 12.78, a number 0.33 percent greater than that of the decentralized economy.

Proposition 2 (Inefficiency of the decentralized economy)**.** *Suppose that the social planner's objective function (21) is uniquely maximized at* $(\theta, z_r) = (\theta^P, z_r^P)$. *Then there is no value of* $\beta \in (0, 1)$ *which guarantees* $\theta^* = \theta^P$ *and* $z_r^* = z_r^P$ *in general. In other words, the stationary equilibrium is not efficient.*

Proof. See Appendix A.6. □

The intuition behind Proposition 2 is as follows (see Figure 3 for a numerical illustration). Since the planner's optimal choice (θ^P, z_r^P) uniquely maximizes the objective function (21), the stationary equilibrium is efficient if and only if $\theta^* = \theta^P$ and $z_r^* = z_r^P$. However, in general, the value of β which is implied by $\theta^* = \theta^P$ does not coincide with the value of β which is pinned down by $z_r^* = z_r^P$. This is simply because $\theta^* = \theta^P$ and $z_r^* = z_r^P$ are two distinct objectives which are generally incompatible with each other: the former is required for an efficient total supply of jobs, whereas the latter is necessary for an efficient choice of the contract type. In a word, there is a "fundamental tension," as in Davis (2001) and Ljungqvist and Sargent (2012, Chapter 28), which prevents the decentralized economy to be efficient.[34]

3 The Extended Model

The benchmark model developed and explored in Section 2 describes well the landscape of the dualized labor market, including the considerable share of temporary jobs, and the strong link between low education and

[34] An alternative argument for Proposition 2 can be made based on the Hosios (1990) condition. Specifically, as the benchmark model belongs to the family of undirected search models, the standard Hosios condition $\beta = 1-\eta(\theta^P)$ (where $\eta(\theta) = \theta p'(\theta)/p(\theta)$ so that $1 - \eta(\theta) = -\theta q'(\theta)/q(\theta)$) can be regarded as a necessary condition for efficiency. However, in general, $\beta = 1 - \eta(\theta^P)$ conflicts with $\beta = 1 - c[q(\theta^P)S_r]^{-1}$ that is required for $z_r^* = z_r^P$, leading to a failure of efficiency. See Appendix A.6 for detailed arguments.

temporary employment. However, much the same as models previously studied in the literature, this simple framework lacks a channel for human capital accumulation on the job. As a result, the role of training as an accelerator for the temporary-to-permanent conversion cannot be investigated within the benchmark model, calling for an extension of the model to incorporate human capital accumulation on the job—a main objective of this section. I extend the benchmark model by introducing two types of human capital: "general" and "specific" (Becker, 1964).[35] The main ingredients for the extension are largely borrowed from Flinn et al. (2017), and the key distinctions between the following extended model and theirs are drawn in Section 3.1. Section 3.2 redefines the stationary equilibrium in the new environment to study its welfare properties.

3.1 Setup

Agents The measure of workers is normalized to 1, as in the benchmark model. Each worker is born with a certain level of general human capital $z_0 \in \mathbb{Z}$, which is drawn from the cumulative distribution function $L(\cdot)$. Over their lifetimes, workers can increase the level of general human capital through on-the-job training when employed. To distinguish the current level of general human capital from its initial (innate) level, I denote the former by $z \in \mathbb{Z}$, where $\mathbb{Z}$ is assumed to be an evenly-spaced discrete set of N points (spaced by $\iota_z > 0$), namely, $\mathbb{Z} = \{z_1, \ldots, z_N\}$. Notice that depreciation of human capital is not modeled, and thus, $z = z_j$ is always greater than or equal to $z_0 = z_i$ for a given worker.[36] All workers are subject to a "retirement" (death) shock,[37] which arrives at Poisson rate $\rho > 0$. Each retired worker is replaced with an unemployed entrant who possesses the same *initial* level of general human capital.

Search and matching Unemployed workers and vacant jobs are brought together by a matching function $M(\cdot, \cdot)$. A match between a worker and a job is formed if and only if the expected joint match surplus is nonnegative. The expected joint match surplus is determined by their decision on the type of contract and the type of training. As before, there are two types of contracts (permanent and temporary contracts) available to a worker-firm pair. For each contract type chosen, it can be also decided whether to invest in training or not. If they agree to invest in training, the type of training (either specific or general training, but not both) can be chosen as well. To sum up, the choice set for a worker-firm pair consists of six options,[38] among which the best one (i.e. an option that yields the maximum expected joint match surplus) is chosen by the pair. As in the benchmark model, wages are determined by Nash bargaining over the match surplus, with $\beta \in (0, 1)$ being the bargaining power of workers.

On-the-job training I assume that every worker starts a new job (which can be either permanent or temporary) with the same level of specific human capital, denoted by y_0. It is further assumed that the production function has the form of yz (the product of the specific human capital level and the general human capital level), meaning that the flow output of a match associated with a worker whose specific

[35] General human capital is defined as a type of human capital that is equally productive in all jobs. Specific human capital, on the other hand, is defined as a type of human capital that is productive in a given job but not in the other jobs.

[36] In other words, $j \in \{i, i+1, \ldots, N-1, N\}$ for a given $i \in \{1, \ldots, N\}$. Note that I use "z_j" and "z_i" throughout the paper to represent a typical value of z and z_0, respectively.

[37] The value of retirement is simply set to zero.

[38] For notational convenience, let p and t denote permanent and temporary contracts, respectively. Furthermore, let n, s, and g denote *no training, specific training,* and *general training,* respectively. Then the choice set for a worker-firm pair can be concisely described as $\{(p, n), (p, s), (p, g), (t, n), (t, s), (t, g)\}$.

human capital level equals y_0 and general one equals z is given by $y_0 z$ when all amount of time of a given moment (which is normalized to unity) is devoted to production.

If a permanent or temporary contract which stipulates specific training of a worker with general human capital z starts, an amount of time $\tau_s(z)$ is allocated for specific training at every moment of time until the training is complete. The completion of training follows a Poisson process with arrival rate ϕ_s. If the training is complete, then the level of specific human capital increases to $y_1 > y_0$. Endogenous job separation after the training completion is not allowed, but a new wage is negotiated via Nash bargaining over the match surplus that has been changed due to the increase in y. I assume that, once the training is complete, no further training is available until the match is exogenously separated.[39] In case of general training, everything is the same as the specific case, except that $\tau_g(z)$ and $\phi_g(z)$ replace $\tau_s(z)$ and ϕ_s, respectively, and that the completion of general training leads to an increase in the general human capital level from z to $z' = z + \iota_z$. In what follows, I suppose that $\tau_g(z) = \phi_g(z) = 0$ for $z = z_N$ (with $\phi_g(z) = \phi_g$ for $z < z_N$) so that a worker with $z = z_N$ cannot "break through the ceiling" through general training.

Surplus As in the benchmark model, one can formulate value functions for workers and firms under the extended environment. Relegating a detailed discussion on it to Appendix A.7, I delve into surplus functions in what follows.

For a worker of type $z \in \mathbb{Z}$, the surplus of a permanent contract that does not stipulate any type of training is denoted by $S_{p,n}(z)$. Following a similar procedure described in Section 2.1 (see (8), in particular), one can obtain

$$(r + \rho + \delta)S_{p,n}(z) = y_0 z - (r + \rho)W_u(z) - \delta\kappa, \tag{22}$$

where $W_u(z)$ is the value of unemployment so that it satisfies the extended counterpart of (7), namely,

$$(r + \rho)W_u(z) = bz + p(\theta)\beta S(z), \tag{23}$$

in which $S(z)$ represents the expected joint surplus accruing from the match (to be formally defined later).

Let $S_{p,s}(z)$ denote the surplus of a permanent contract that stipulates specific training of a worker with general human capital z. Then $S_{p,s}(z)$ satisfies the following equation:

$$(r + \rho + \delta)S_{p,s}(z) = [1 - \tau_s(z)]\, y_0 z + \phi_s \left[S_{p,s}^{p,s}(z) - S_{p,s}(z)\right] - (r + \rho)W_u(z) - \delta\kappa, \tag{24}$$

where $S_{p,s}^{p,s}(z)$ stands for the surplus that can be enjoyed after the completion of specific training, and it is formally described as[40]

$$(r + \rho + \delta)S_{p,s}^{p,s}(z) = y_1 z - (r + \rho)W_u(z) - \delta\kappa. \tag{25}$$

If the worker-firm pair decides to invest in specific human capital, an amount of time $1 - \tau_s(z)$ is allocated to production while the remainder $\tau_s(z)$ is devoted to specific training. The investment in specific human capital becomes successful at rate ϕ_s, in which case the surplus is changed to $S_{p,s}^{p,s}(z)$. The third term on

[39] This assumption is consistent with the finding of previous studies (e.g. Flinn et al., 2017) that workers receive training, typically, during the early period of employment.

[40] It is worthwhile noting that the outside option of the worker does not change even after the completion of specific training (because the specific human capital accumulated on the job is supposed to be fully depreciated upon destruction of the match), as reflected in (25).

the right-hand side of (24) is related to the outside option of the worker. The last term appears since the permanent contract is currently under consideration.

The surplus delivered by a combination of the permanent contract and the general training for a worker with $z < z_N$ is denoted by $S_{p,g}(z)$. A similar argument as the case of $S_{p,s}(z)$ allows me to write

$$(r+\rho+\delta)S_{p,g}(z) = [1-\tau_g(z)]\, y_0 z + \phi_g \left[S_{p,g}^{p,g}(z') - S_{p,g}(z) + W_u(z') - W_u(z)\right] - (r+\rho)W_u(z) - \delta\kappa, \quad (26)$$

where $S_{p,g}^{p,g}(z')$ corresponds to the surplus that is updated after the completion of general training, whose formal definition is implied by

$$(r+\rho+\delta)S_{p,g}^{p,g}(z') = y_0 z' - (r+\rho)W_u(z') - \delta\kappa. \quad (27)$$

If a type-z worker receives general training, only an amount of time $1-\tau_g(z)$ is used for production. The general training for the worker is completed at rate ϕ_g, which results in an "upgrade" of general human capital from z to $z' = z + \iota_z$. The growth of general human capital induces an adjustment not only in the match surplus but also in the worker's outside option (because the general human capital accumulated through training will not be destroyed upon separation of the match), as indicated in the second term on the right-hand side of (26). The last two terms show up for the same reason as before.

In order to calculate $S_{t,n}(z)$, the surplus of a temporary contract that does not stipulate any type of training for a worker with z, one can refer to the discussion in Section 2.1 (especially, (9)) to arrive at

$$(r+\rho+\delta)S_{t,n}(z) = [1-\mathrm{e}^{-(r+\rho+\delta)\Lambda}]\,[y_0 z - (r+\rho)W_u(z)]\,. \quad (28)$$

Recall that the temporary job that has survived until Λ must be destroyed without any exception, which occurs with probability $\mathrm{e}^{-(\rho+\delta)\Lambda} \in (0,1)$. For later purposes, let $\sigma_n := 1-\mathrm{e}^{-(r+\rho+\delta)\Lambda}$ denote the "suppression" coefficient needed to calculate the "effective" surplus under (t,n).

If a worker z and a firm on a temporary contract agree to invest in specific human capital, the expected surplus, denoted by $S_{t,s}(z)$, has to satisfy

$$\begin{aligned}(r+\rho+\delta)S_{t,s}(z) = {} & [1-\mathrm{e}^{-R_s\Lambda}]\,[(1-\tau_s(z))y_0 z - (r+\rho)W_u(z)] \\ & + \phi_s\left[\int_0^{\Lambda} R_s \mathrm{e}^{-R_s\eta} S_{t,s}^{t,s}(z,\eta)\,\mathrm{d}\eta - S_{t,s}(z)\right], \end{aligned} \quad (29)$$

where $R_s := r+\rho+\delta+\phi_s$ is the effective discount rate, and $S_{t,s}^{t,s}(z,\eta)$ stands for the surplus that can be achieved if the specific training is completed at the moment that the worker's job tenure reaches $\eta \in [0,\Lambda]$, which is implicitly defined as

$$(r+\rho+\delta)S_{t,s}^{t,s}(z,\eta) = [1-\mathrm{e}^{-(r+\rho+\delta)(\Lambda-\eta)}]\,[y_1 z - (r+\rho)W_u(z)]\,. \quad (30)$$

When a temporary worker with z receives specific training, an amount of time $\tau_s(z)$ is invested in it, and thus, the match produces a flow of output $(1-\tau_s(z))y_0 z$ per unit of time. The term $(r+\rho)W_u(z)$ shown in the first line on the right-hand side of (29) represents the worker's outside option as before, while the term $1-\mathrm{e}^{-R_s\Lambda}$ in the first line is included to take into account the fact that the temporary job "surviving" until

Λ (which is realized with probability $\mathrm{e}^{-(\rho+\delta+\phi_s)\Lambda}$) is inevitably destroyed at Λ. The second line of (29) is the counterpart of $\phi_s[S_{p,s}^{p,s}(z) - S_{p,s}(z)]$ in (24), indicating a surplus change initiated by the completion of specific training. For future purposes, it is convenient to define $\sigma_s := 1 - \mathrm{e}^{-R_s\Lambda}$, the suppression coefficient required to obtain the effective surplus under (t, s), and

$$\tilde{\sigma}_s := \int_0^\Lambda R_s \mathrm{e}^{-R_s\eta} \left[1 - \mathrm{e}^{-(r+\rho+\delta)(\Lambda-\eta)}\right] \mathrm{d}\eta,$$

the expected suppression coefficient necessary to calculate the effective after-specific-training-completion surplus under the temporary contract.[41]

Let $S_{t,g}(z)$ denote the surplus of a temporary contract that stipulates general training of a worker with general human capital $z < z_N$. In a similar fashion as above, one can derive

$$\begin{aligned}(r+\rho+\delta)S_{t,g}(z) &= [1-\mathrm{e}^{-R_g\Lambda}]\,[(1-\tau_g(z))y_0 z - (r+\rho)W_u(z)] \\ &\quad + \phi_g\left[\int_0^\Lambda R_g \mathrm{e}^{-R_g\eta} S_{t,g}^{t,g}(z',\eta)\,\mathrm{d}\eta - S_{t,g}(z)\right] + \phi_g[1-\mathrm{e}^{-R_g\Lambda}]\,[W_u(z') - W_u(z)]\,, \end{aligned} \tag{31}$$

where $R_g := r + \rho + \delta + \phi_g$ is the effective discount rate, and $S_{t,g}^{t,g}(z', \eta)$ represents the surplus which is recalculated if the general training is completed at the moment that the worker's tenure on the job reaches $\eta \in [0, \Lambda]$, namely,

$$(r+\rho+\delta)S_{t,g}^{t,g}(z',\eta) = [1-\mathrm{e}^{-(r+\rho+\delta)(\Lambda-\eta)}]\,[y_0 z' - (r+\rho)W_u(z')]\,. \tag{32}$$

The first line of (31) has the same interpretation as that of (29), and the second line can be regarded as the counterpart of $\phi_g[S_{p,g}^{p,g}(z') - S_{p,g}(z) + W_u(z') - W_u(z)]$ in (26). Note again that the general human capital accumulated via training will not be shattered upon termination of the contract. Therefore, both the match surplus and the worker's outside option need to be reevaluated in response to the increase in general human capital, as reflected in the last two terms of (31). Under the current context, σ_g and $\tilde{\sigma}_g$ can be similarly defined (and interpreted) as in the case of (t, s), namely, $\sigma_g := 1 - \mathrm{e}^{-R_g\Lambda}$, and

$$\tilde{\sigma}_g := \int_0^\Lambda R_g \mathrm{e}^{-R_g\eta} \left[1 - \mathrm{e}^{-(r+\rho+\delta)(\Lambda-\eta)}\right] \mathrm{d}\eta.$$

Lastly, given a worker with general human capital z, the expected joint surplus accruing from the match, $S(z)$, is formally defined as

$$S(z) := \max\{S_{p,n}(z), S_{p,s}(z), S_{p,g}(z), S_{t,n}(z), S_{t,s}(z), S_{t,g}(z)\}\,. \tag{33}$$

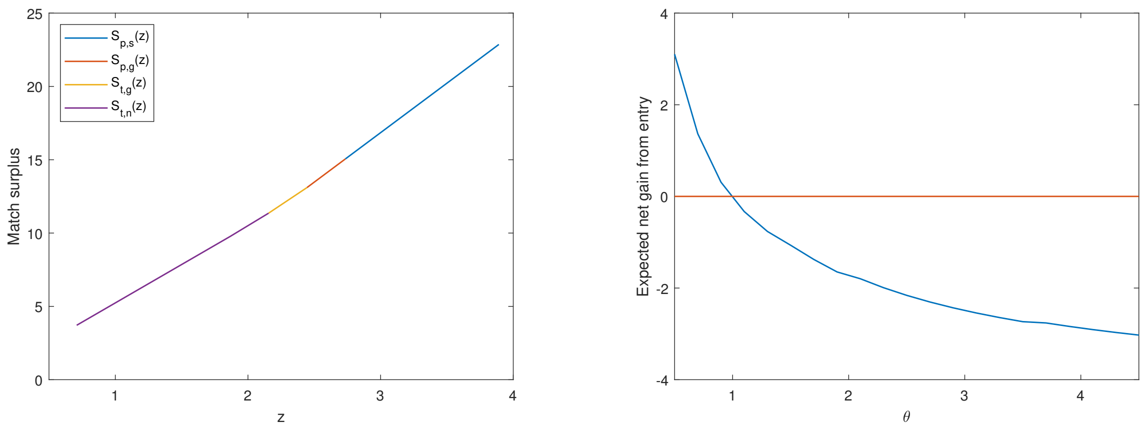
See Figure 4.(a) for a numerical example of $S(\cdot)$.

Discussion on $S(z)$

[41] It will be useful later to observe that $\tilde{\sigma}_s$ can be equivalently expressed as $\sigma_s - \frac{R_s}{\phi_s}[\mathrm{e}^{-(r+\rho+\delta)\Lambda} - \mathrm{e}^{-R_s\Lambda}] = \sigma_s - \frac{R_s}{\phi_s}[\sigma_s - \sigma_n]$, and that it converges to 1 as Λ tends to infinity.

Figure 4: A graphical illustration of the extended model

(a) Surplus functions (b) The free-entry condition



Notes: Both figures are drawn based on the model specification described in Section 4.2 and the estimated parameter values reported in Table 2. The labor market tightness is normalized to one for estimation so that, given the estimated parameter values, $\theta = 1$ is the unique value that satisfies the free-entry condition (37).

(Q1) *Labor market imperfections and investment in human capital.*
[To be added]

(Q2) *Labor market dualism and investment in human capital.*
In the extended model, holding a temporary contract diminishes the incentive to invest in both types of human capital, which is consistent with the stylized fact discussed in Section 1.[42] This implication from the model is intuitive: *ceteris paribus*, the period during which the temporary worker-firm match can gain the benefits from successful training is relatively short due to the predetermined duration of the temporary contract, thereby forcing them to hesitate on investing in any type of training. In what follows, I formally establish this implication for the case of specific human capital; the discussion will be completed in Appendix A.8 in which the general human capital case is addressed.

In order to show that temporary employment results in a lower incentive to invest in specific training, I first study under what conditions a permanent worker-firm match invests in specific training, that is, $S_{p,n}(z) < S_{p,s}(z)$ for a given $z \in \mathbb{Z}$. For this purpose, I replace $(r+\rho)W_u(z)$ in (22) and (24) with the right-hand side of (23) to arrive at[43]

$$[r+\rho+\delta+p(\theta)\beta]\, S_{p,n}(z) = (y_0 - b)z - \delta\kappa,$$
$$[r+\rho+\delta+p(\theta)\beta]\, S_{p,s}(z) = (y_0 - b)z - \delta\kappa - \tau_s(z) y_0 z + \phi_s \left[S^{p,s}_{p,s}(z) - S_{p,s}(z)\right],$$

from which it follows that $S_{p,n}(z) < S_{p,s}(z)$ if and only if the costs of specific training are less than its

[42] In the case of specific human capital, Berton and Garibaldi (2012) and Cabrales et al. (2017) have arrived at the same conclusion. To the best of my knowledge, however, there has been no studies that analytically investigate the impact of temporary employment on the incentive to invest in general human capital.

[43] To obtain the following expressions, permanent deviations are considered so that $S_{p,n}(z)$ or $S_{p,s}(z)$ is substituted for $S(z)$ when $(r+\rho)W_u(z)$ is replaced with $bz + p(\theta)\beta S(z)$.

expected benefits, namely,

$$\tau_s(z)y_0z < \phi_s\left[S_{p,s}^{p,s}(z) - S_{p,s}(z)\right].$$

Then one can use the fact that $R_s\left[S_{p,s}^{p,s}(z) - S_{p,s}(z)\right] = y_1z - [1-\tau_s(z)]\,y_0z$ to conclude that, under the permanent contract associated with a type-z worker, investment in specific human capital occurs if and only if

$$(r+\rho+\delta)\tau_s(z)y_0 < \phi_s(y_1 - y_0). \tag{34}$$

Notice that, provided $\tau_s'(z) < 0$ for all $z \in \mathbb{Z}$,[44] the left-hand side of (34) is decreasing in z whereas the right-hand side is constant, implying that, if (34) holds for some $z \in \mathbb{Z}$, it is satisfied for all $z' > z$.

A condition under which a temporary worker-firm match invests in specific training can be derived in a similar way. More precisely, one can use (23) to rewrite (28) and (29) as follows:

$$\begin{aligned}
&[r+\rho+\delta+\sigma_n p(\theta)\beta]\,S_{t,n}(z) = \sigma_n(y_0-b)z,\\
&[r+\rho+\delta+\sigma_n p(\theta)\beta]\,S_{t,s}(z) = \sigma_n(y_0-b)z - \sigma_n\tau_s(z)y_0z + \frac{\phi_s}{R_s}\tilde{\sigma}_sY_s(z),
\end{aligned}$$

where $Y_s(z) := y_1z - [1-\tau_s(z)]\,y_0z$ represents the change in flow output thanks to the completion of specific training. Therefore, $S_{t,n}(z) < S_{t,s}(z)$ if and only if $\sigma_n\tau_s(z)y_0z < \frac{\phi_s}{R_s}\tilde{\sigma}_sY_s(z)$, or equivalently,

$$\sigma_s(r+\rho+\delta)\tau_s(z)y_0 < \tilde{\sigma}_s\phi_s(y_1-y_0). \tag{35}$$

Again, the left-hand side of (35) is decreasing in z as long as $\tau_s'(z) < 0$ for all $z \in \mathbb{Z}$, suggesting that $S_{t,n}(\cdot)$ and $S_{t,s}(\cdot)$ cross at most once over $\mathbb{Z}$. Furthermore, since $\sigma_s > \tilde{\sigma}_s$, by comparing (35) with (34), one can easily reach the conclusion that temporary employment leads to a lower incentive for investment in specific human capital, as desired.

(Q3) *Cutoff human capital levels.*
The endogenous accumulation of general human capital makes it complicated to characterize the contract type choice and the training investment decision without specific parameter values. However, two simplifying assumptions (namely, no depreciation of general human capital and no availability of general training for those with $z = z_N$) substantially facilitate the analysis. Specifically, under these two assumptions, one can first study the problem faced by type-z_N workers and their potential employers, and then, based on the inspection result for them, one can tackle the problem associated with type z_{N-1}, and so on. Nevertheless, a complete analysis is still demanding, and thus, not pursued in this paper. Instead, guided by estimation results to be discussed below (see Section 4.3), I focus only on the case where (p,s), (p,g), (t,g), and (t,n) are selected by groups of workers with "high," "high-medium," "low-medium," and "low" levels of human capital, respectively.[45]

Before proceeding further, it is convenient to introduce the following notation. Let $z_{p,g}^{p,s}$ be the largest

[44] Here it is implicitly assumed that $\tau_s(\cdot)$ is differentiable on its entire domain (which is supposed to be a superset of $[z_1, z_N]$). Consistent with this assumption, I restrict the function $\tau_s(\cdot)$ to have the form $\tau_s(z) = \tau/z$ with τ fixed as 1 when estimating the model; see Section 4.2.

[45] Accordingly, it is assumed that $S(z) \neq \max\{S_{p,n}(z), S_{t,s}(z)\}$ for any $z \in \mathbb{Z}$. Furthermore, it is also assumed that $|\mathbb{Z}| = N \geq 4$ in the following analysis.

$z_j \in \mathbb{Z} \setminus \{z_N\}$ such that $S(z_j) = S_{p,g}(z_j)$ and $S(z'_j) = S_{p,s}(z'_j)$ for all $z'_j \in \{z_{j+1}, \ldots, z_N\}$. Similarly, for a given $z^{p,s}_{p,g} \in \mathbb{Z}$, let $z^{p,g}_{t,g}$ be the largest $z_j \in \mathbb{Z} \setminus \{z^{p,s}_{p,g}, \ldots, z_N\}$ such that $S(z_j) = S_{t,g}(z_j)$ and $S(z'_j) = S_{p,g}(z'_j)$ for all $z'_j \in \{z_{j+1}, \ldots, z^{p,s}_{p,g}\}$. Lastly, for a given $(z^{p,s}_{p,g}, z^{p,g}_{t,g}) \in \mathbb{Z}^2$, let $z^{t,g}_{t,n}$ be the largest $z_j \in \mathbb{Z} \setminus \{z^{p,g}_{t,g}, \ldots, z_N\}$ such that $S(z_j) = S_{t,n}(z_j)$ and $S(z'_j) = S_{t,g}(z'_j)$ for all $z'_j \in \{z_{j+1}, \ldots, z^{p,g}_{t,g}\}$.[46] I am now ready to study how $z^{p,s}_{p,g}$, $z^{p,g}_{t,g}$, and $z^{t,g}_{t,n}$ are determined.[47] Notice that, in order to facilitate the algebra, I specify the training cost functions $\tau_s(\cdot)$ and $\tau_g(\cdot)$ as $\tau_s(z) = \tau_g(z) = z^{-1}$, a functional form employed for the quantitative analysis later in the paper.

i. $S_{p,s}(z)$ *versus* $S_{p,g}(z)$.
Let $Y_g := y_0 z' - [1 - \tau_g(z)]\, y_0 z = y_0 \iota_z + y_0$ be the change in flow output owing to the completion of general training, and let $P(\theta) := \frac{p(\theta)\beta}{r+\delta+p(\theta)\beta}$ be the "effective job-finding rate" (for a given θ).

Suppose that workers with $z = z_N$ and their employers choose (p, s), that is, $S(z_N) = S_{p,s}(z_N)$. Then, assuming that all other options are dominated by (p, s) or (p, g) (to be confirmed later), one can find $z^{p,s}_{p,g}$ by successively (starting from z_{N-1} and potentially ending with z_1) checking whether $S_{p,s}(z) < S_{p,g}(z)$ is satisfied by a candidate $z = z_j$. In other words, $z^{p,s}_{p,g}$ is determined by the largest $z_j \in \mathbb{Z} \setminus \{z_N\}$ satisfying

$$\underbrace{r\left[\frac{\phi_s}{R_s} Y_s(z_j) - \frac{\phi_g}{R_g} Y_g\right]}_{\substack{\text{expected gains from } (p,s) \text{ relative to } (p,g) \\ \text{enjoyable at the current job}}} < \underbrace{\frac{\phi_g}{R_g}\delta\left[P(\theta)\left\{\frac{\phi_s}{R_s} y_1 + \frac{r+\delta}{R_s} y_0\right\} + (1 - P(\theta))b\right]\iota_z}_{\text{expected gains from } (p,g) \text{ enjoyable in the future}}, \tag{36}$$

where the left-hand side represents the expected gains from specific training that are enjoyable at the current job (relative to general training), whereas the right-hand side corresponds to the expected gains from general training enjoyable in the future (when the current match is destroyed).[48] Notice that the left-hand side is increasing in z_j while the right-hand side is independent of it, which verifies that $S(z'_j) = S_{p,s}(z'_j)$ for all $z'_j \in \{z^{p,s}_{p,g} + \iota_z, \ldots, z_N\}$.

ii. $S_{p,g}(z)$ *versus* $S_{t,g}(z)$.
[To be added]

iii. $S_{t,g}(z)$ *versus* $S_{t,n}(z)$.
[To be added]

(Q4) *Relation to $S(z)$ in the benchmark model.*
[To be added]

[46] For notational simplicity, both the dependence of $z^{p,g}_{t,g}$ on $z^{p,s}_{p,g}$ and the dependence of $z^{t,g}_{t,n}$ on $(z^{p,s}_{p,g}, z^{p,g}_{t,g})$ are suppressed. That is, I express $z^{p,g}_{t,g}(z^{p,s}_{p,g})$ and $z^{t,g}_{t,n}(z^{p,s}_{p,g}, z^{p,g}_{t,g}(z^{p,s}_{p,g}))$ simply as $z^{p,g}_{t,g}$ and $z^{t,g}_{t,n}$, respectively, unless any confusion arises. Meanwhile, it has to be remembered that $z^{p,s}_{p,g}$, $z^{p,g}_{t,g}$, and $z^{t,g}_{t,n}$ all depend on θ although notationally suppressed.

[47] The following discussion only outlines the results; see Appendix A.9 for a detailed analysis.

[48] Indeed, the right-hand side of (36) describes all possible cases that may occur to the worker when his current job is destroyed at rate δ after his general human capital level increases by ι_z at rate ϕ_g. When unemployed, the worker either does find a new job with "probability" $P(\theta)$, or does not with "probability" $1 - P(\theta)$. If he finds a new job, his specific human capital level could be either y_1 or y_0, depending on whether specific training is successfully completed with "probability" ϕ_s/R_s or not with "probability" $(r + \delta)/R_s$. If he fails to find a new job, the worker simply receives unemployment benefits b.

3.2 Stationary Equilibrium

Flow equations Analytically deriving the stationary transition equations in the current environment is a complicated task simply due to the endogenous dynamics of human capital accumulation. Consequently, for a thorough discussion, I refer readers to Appendix A.10 which includes an instructive example for the case of $N = 4$ (see Figure 12 therein). However, I introduce the related notation here for the following discussion.

For a given labor market tightness θ, let $\ell_i^j(\theta)$ denote the mass of workers whose initial general human capital level is $z_i \in \mathbb{Z}$ and current general human capital level is $z_j \geq z_i$.[49] Similarly, let $u_i^j(\theta)$ denote the mass of unemployed workers with $(z_0, z) = (z_i, z_j)$ with $i \leq j$. Meanwhile, I denote by $g_i^j(\theta)$ the mass of employed workers who were initially born with $z_0 = z_i$, and have completed the general training with the current employer so that his general human capital has increased from z_{j-1} to z_j. Lastly, I denote by $s_i^j(\theta)$ the mass of employed workers whose (z_0, z) equals (z_i, z_j) with $i \leq j$, and specific human capital is y_1 thanks to the completion of specific training on the current job.

Stationary equilibrium I slightly modify Definition 1 in Section 2.2 to define the stationary equilibrium of the extended model as follows (see Figure 4.(b) for a numerical example of the equilibrium).[50]

Definition 2 (Equilibrium in the extended model)**.** A *stationary equilibrium* is a labor market tightness $\theta \in (0, \infty)$ satisfying the following free-entry condition:

$$c = \sum_{z_j \in \mathbb{Z}} q(\theta) \frac{u(z_j; \theta)}{U(\theta)} (1 - \beta) S(z_j; \theta), \tag{37}$$

where $S(z_j; \theta)$ is given by (33), $u(z_j; \theta) = \sum_{1 \leq i \leq N} u_i^j(\theta)$, and $U(\theta) = \sum_{1 \leq j \leq N} u(z_j; \theta)$.

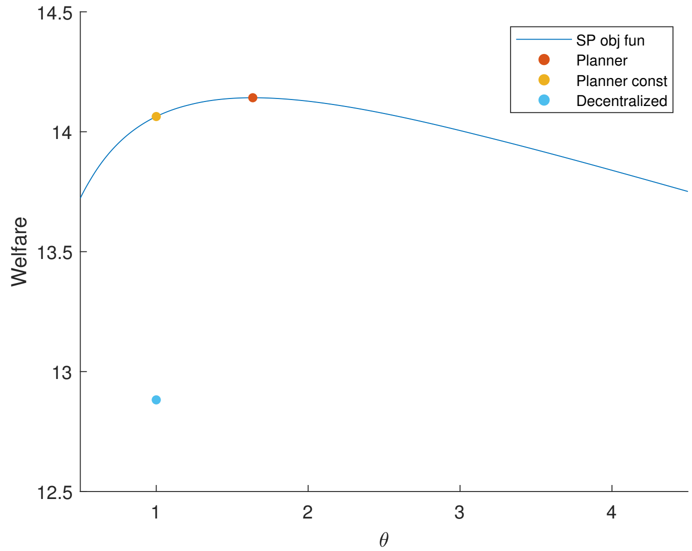
Welfare properties The objective function of the social planner can be constructed in a similar manner to the benchmark case. The planner chooses the labor market tightness $\theta \in (0, \infty)$ and the set of options $\{(c(z_0), h(z_0))\}_{z_0 \in \mathbb{Z}} \in \{(p, n), (p, s), (p, g), (t, n), (t, s), (t, g)\}^N$ to maximize aggregate output (including home production), net of the training costs, the firing costs (incurred by permanent contracts), and the vacancy costs, subject to constraints associated with labor market configurations (such as the search frictions and the fixed duration of temporary contracts).[51] Since a formal definition and analysis of the planner's objective function requires some more notation, I relegate further details to Appendix A.11, and discuss welfare implications in an informal way (see Figure 5 for a numerical illustration). [To be added]

[49] By definition, $\ell(z_i) = \sum_{j \geq i} \ell_i^j(\theta)$ for all $z_i \in \mathbb{Z}$, and $\sum_i \sum_{j \geq i} \ell_i^j(\theta) = \sum_i \ell(z_i) = 1$.

[50] Technically speaking, the stationary equilibrium of the extended model is not well-defined when relying on Definition 2 because of the discreteness of $\mathbb{Z}$. In fact, it must be defined as the value of $\theta \in (0, \infty)$ that minimizes the difference between the left-hand side and the right-hand side of (37). However, in order to emphasize the relation between the benchmark and extended models, I stick with Definition 2 for the rest of the paper.

[51] To understand notation such as (p, s), see Footnote 38.

Figure 5: A graphical illustration of the social planner's objective function in the extended model



Notes: The figure is drawn based on the estimated parameter values reported in Table 2, along with the model specification described in Section 4.2. The constrained planner has the same objective function as the unconstrained planner, but he can only choose the set of options $\{(c(z_0), h(z_0))\}_{z_0 \in \mathbb{Z}} \in \{(p, n), (p, s), (p, g), (t, n), (t, s), (t, g)\}^N$, taking the labor market tightness determined in the decentralized equilibrium as given. The social welfare achieved by the unconstrained (constrained) planner amounts to 14.14 (14.06), a number 9.78 (9.16, respectively) percent higher than that of the decentralized equilibrium.

4 Estimation

4.1 Data

For the quantitative analysis, I utilize the 2002 to 2016 waves of the Korean Labor and Income Panel Study (KLIPS).[52] The KLIPS is an annually conducted panel survey on a sample of 5,000 Korean households and their members (aged 15 or over) designed to represent the nationwide population. Along with standard individual characteristics (such as gender, age, and education), the data provide information on employment and labor market outcomes (such as wage, training participation—both at the extensive and intensive margins, and contract type). Accordingly, the data allow me not only to trace each individual's wage and training participation history, but also to observe contract type transitions occurring in the labor market (e.g. the transition rate from temporary to permanent contracts).

To estimate the model, I construct a subsample consisting of female respondents aged 30 to 65 in 2006 (the baseline year for computing data moments later). [To be added]

[52] The year 2002 corresponds to the fifth wave of the KLIPS. I have opted to drop the first four waves because there were adjustments to the questionnaire between wave 4 (2001) and wave 5 (2002).

4.2 Estimation Strategy and Identification

Model specification To specify the distribution of innate abilities $L(\cdot)$, I choose the gamma distribution, which is parameterized by two additional parameters μ_z and σ_z.[53] The functional form of the matching function is borrowed from the literature (e.g. Petrongolo and Pissarides, 2001) so that $M(U,V) = hU^{1-\eta}V^{\eta}$, where h is estimated whereas η is fixed as 0.5. Meanwhile, I use $\tau_s(z) = \tau_g(z) = \tau/z$, where τ is fixed as 1 in the estimation stage.[54] Finally, the values of $(r, \rho, \beta, b, y_0, N)$ are set to be $(0.04, 0.04, 0.5, 3, 6, 12)$, respectively. [To be added]

Estimation method To estimate the model, I use the simulated method of moments (SMM), a widely-used structural estimation technique (McFadden, 1989; Pakes and Pollard, 1989). Loosely speaking, the SMM finds the set of parameter values that minimizes the weighted difference between the actual data moments and the simulated data moments. [To be added]

Identification Since a rigorous analysis of identification is beyond the scope of this paper, here I present an identification argument in a heuristic way. To be specific, I discuss, among all moments to be used in the estimation, which one is (ones are) expected to be sensitive to a particular parameter. Then I support my choice of moments by reporting the elasticity of each moment with respect to each parameter (see Table 10 in Appendix B.3). [To be added]

[53] Given a shape parameter $\mu_z > 0$ and a scale parameter $\sigma_z > 0$, the mean and variance of the gamma distribution are $\mu_z\sigma_z$ and $\mu_z\sigma_z^2$, respectively. For the purpose of estimation, the gamma distribution is truncated on the interval ranging from two standard deviations below its mean to one standard deviation above. In the end, such a restriction leads to $\iota_z = 0.284$, corresponding to a roughly 38.6 (7.9, respectively) percent increase in general human capital after successful general training for workers with z equal to z_1 (z_{N-1}).

[54] In Section 5, τ is postulated to decrease (by 0.5, 1, or 2 percent) for the counterfactual analysis.

Table 2: Moments and estimates

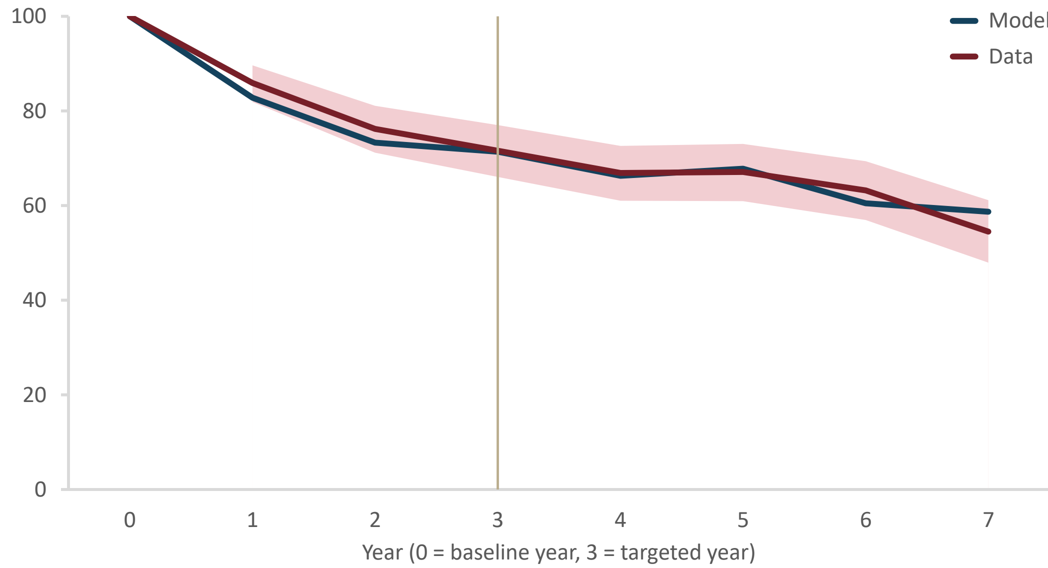
Moment	Model	Data	Parameter	Estimate
S1. share of p on training	0.166	0.174 (.018)	rate of increase in y	$\phi_s = 0.940$
S2. share of t on training	0.058	0.055 (.017)	rate of increase in z	$\phi_g = 0.322$
S3. share of t in the labor force	0.286	0.290 (.018)	firing costs for p	$\kappa = 6.087$
S4. share of t caught in the trap	0.714	0.716 (.033)		
S5. share of p who were t on training	0.002	0.002 (.002)		
J1. job-finding rate	0.789	0.815 (.075)	matching efficiency	$h = 0.640$
J2. job tenure of p	6.481	6.453 (.310)	job separation rate	$\delta = 0.117$
J3. job tenure of t	2.956	2.939 (.174)	cap on t tenure	$\Lambda = 7.660$
A1. avg log wage of p	2.738	2.739 (.026)	avg innate abilities	$\mu_z = 7.120$
A2. avg log wage of t	2.123	2.121 (.038)	var innate abilities	$\sigma_z = 0.398$
A3. avg log wage of new t relative to p	0.657	0.661 (.058)	productivity after ϕ_s	$y_1 = 6.592$

Notes: The eleven moments are used to estimate the nine parameters. Moments S4, S5, and J1 are calculated over the 3-year interval. I use the bootstrap to compute the variance of each data moment, whose square root is reported in parentheses. All rate parameters are expressed at an annual frequency. Standard errors of the estimated parameters are not reported since they have not been obtained.

4.3 Estimation Results

Estimation results The estimation results are summarized in Table 2, where moments and parameters are partitioned (by dashed lines) into three groups according to the identification strategy although all parameters have been jointly estimated. Notice that the labor market tightness θ has been normalized to one for estimation (Shimer, 2005), which allows me to back out the vacancy cost ($c = 4.465$) using the free-entry condition (37). [To be added]

Figure 6: Model fit—Share of temporary workers caught in the temporary job trap



Notes: The figure shows the share of temporary workers in $year \in \{0, 1, 2, 3, 4, 5, 6, 7\}$ among those who were temporary workers in $year = 0$. While $year = 3$ was targeted in the estimation (Moment S4 in Table 2), the other years were not. The shaded area indicates a point-wise 90% confidence interval of the data moments.

Model fit Overall, the prominent features of the data are well captured by the model. Especially, the model successfully reproduces the temporary job trap although they are not included as a target for estimation (see Figure 6). Meanwhile, readers interested in the model fit in terms of the distribution of wages are referred to Figure 15 in Appendix B.3.[55] [To be added]

[55] Appendix B.3 also provides the estimated distribution of general human capital; see Figure 14 therein.

Table 3: Mincer regressions: data (top) versus model (bottom)

	Const	High sch	College	Yrs in LF	1st cont
Log wage	2.027	0.337	0.724	0.002	0.100
	(.028)	(.021)	(.024)	(.001)	(.024)
Log wage	2.085	0.366	0.640	0.001	0.138
(a) z inborn	0.445	0.321	0.586	0.000	0.183
(b) z accumulated	-0.007	0.192	0.142	0.000	-0.142
(c) y initial	1.792	-	-	-	-
(d) y accumulated	-0.008	0.035	0.049	0.000	0.028
(e) hours worked	-0.018	-0.156	-0.119	0.001	0.056
(f) residual	-0.118	-0.025	-0.019	0.000	0.012

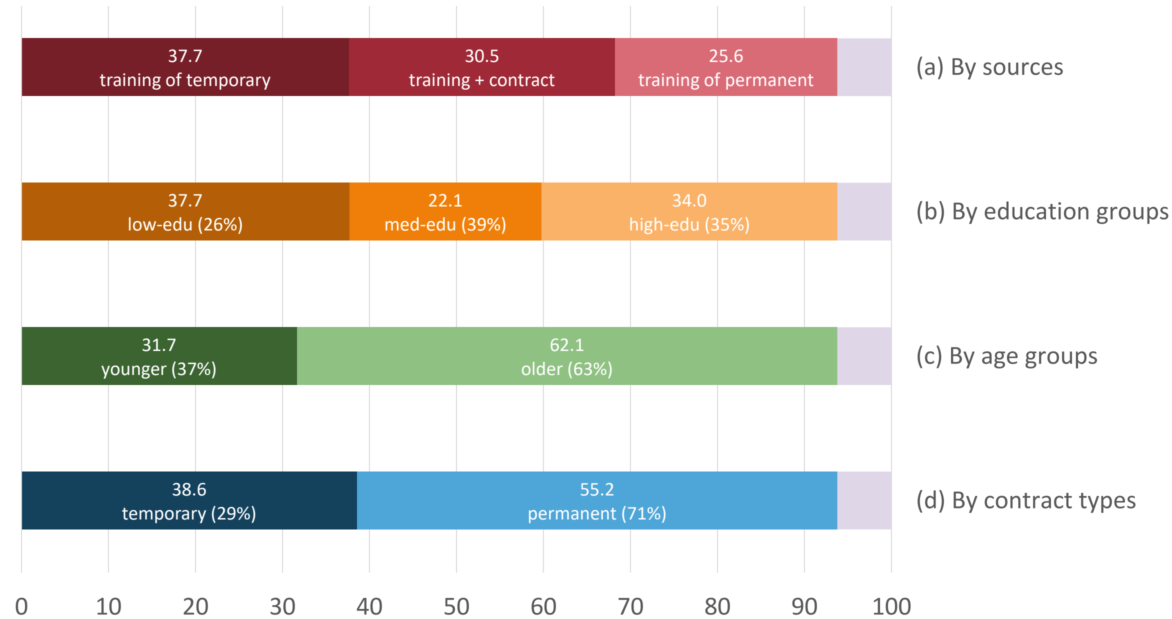
Notes: When running the regression using the actual data, I drop the top one, bottom five, and top ten percent of outliers for the low, medium, and high educated groups, respectively. See Table 11 in Appendix B.3 for additional details, including sample selection and robustness checks. When running the regression using the simulated data in the bottom panel, I assign the education level of each individual based on his level of z_0. Meanwhile, for each covariate appearing in the first row, the regression coefficients from (a)-(f) must sum up to the coefficient for the regression using the log wage; see (38) for the decomposition of log wages in the model.

Mincer regressions Let $Y := zy(1-\tau) = z_0 z_\tau y_0 y_\tau (1-\tau)$ to obtain

$$\log(wage) = \underbrace{\log z_0}_{(a)} + \underbrace{\log z_\tau}_{(b)} + \underbrace{\log y_0}_{(c)} + \underbrace{\log y_\tau}_{(d)} + \underbrace{\log(1-\tau)}_{(e)} + \underbrace{\log(wage/Y)}_{(f)}, \tag{38}$$

which allows me to provide a structural interpretation of (a slightly modified version of) the standard Mincerian wage regression based on the estimated model, as in Flinn et al. (2017). Specifically, a dummy variable indicating whether the first job is permanent or temporary is included in the regression as an additional regressor, and it is documented that the coefficient of the added variable (0.138 from the simulated data while 0.100 from the actual data; see Table 3) is determined by two main forces: innate versus accumulated general human capital. [To be added]

Figure 7: Decomposition of inefficiency



Notes: The total estimated welfare loss is normalized to 100 for easy comparison. The unlabelled light purple segment that is commonly included in all parts represents the efficiency loss associated with labor market tightness, accounting for 6.2% of the total estimated loss. The three elements {training of temporary, training + contract, training of permanent} in (a) correspond to the gap between the green and light blue dots, between the purple and green dots, and between the orange and purple dots, respectively, in Figure 16.(a) in Appendix B.3. A similar relationship can be established for (b)–(d), in which the percentage of each group in the total population is reported in parentheses. In (c), individuals who have been in the labor market for less than 13.5 years belong to the younger group while the others belong to the older group.

Decomposition of inefficiency As illustrated in Figure 5, the estimated welfare level of the *laissez-faire* economy amounts to 12.9, a number 8.9 percent lower than the level achievable by the social planner. The estimated model can be used to decompose this measured welfare loss into contributions from each source of inefficiency (Figure 7.(a)), or contributions from each education group (Figure 7.(b)). The quantitative analysis indicates that the lack of training for temporary workers and the mismatched type of training for permanent workers together can explain at least 63.3 percent of the current efficiency loss, implying that the amount of the welfare loss caused by the mismatched employment contract type is relatively small. Meanwhile, since temporary and permanent jobs are typically held by the low- and high-educated, respectively (both in the model and in the data), it turns out that most (around four-fifth) of the inefficiency is attributable to these two education groups. [To be added]

Table 4: Counterfactaul analysis 1 (Reduction in training costs)

	(1) *Laissez-faire*	(2) 5% cut in τ	(3) 25% cut in τ	(4) 50% cut in τ	(5) Planner
Welfare					
After subtracting costs	100.00	103.77	107.01	109.69	109.78
Before subtracting costs	-	104.19	109.63	116.09	-
Labor market composition					
Tightness, %	100.00	109.36	122.00	138.44	163.54
Moment S1	0.166	0.172	0.213	0.236	0.202
Moment S2	0.058	0.457	0.457	0.457	0.457
Moment S3	0.286	0.193	0.283	0.490	0.592
Moment S4					
− over 3 yrs	0.714	0.660	0.677	0.720	0.704
− over 5 yrs	0.678	0.542	0.566	0.639	0.658
− over 7 yrs	0.587	0.460	0.500	0.609	0.644
Moment S5					
− over 3 yrs	0.002	0.001	0.001	0.000	0.003
− over 5 yrs	0.003	0.007	0.007	0.015	0.018
− over 7 yrs	0.006	0.016	0.019	0.032	0.033
Wage					
Moment A2 over A1	0.775	0.662	0.748	0.804	0.766

Notes: Columns (1)–(5) correspond to the light blue, green, purple, orange, and red dots, respectively, in Figure 8.(a) below. The welfare of the decentralized equilibrium has been normalized to 100 for easy comparison.

5 Counterfactual Analysis

The estimated structural model is employed for counterfactual analysis to develop policies for reducing the estimated welfare loss. I consider two sets of policy experiments: first of all, a 5, 25, or 50 percent reduction in training costs (through subsidies) is postulated (see Table 4 and Figure 8); second, a 5, 25, or 50 percent cut in firing costs (via subsidies) is presumed (see Table 5 and Figure 9). The quantitative results obtained from the first set of experiments suggest that "training-friendly" labor market can achieve welfare improvements through the "activated" human capital accumulation channel. Specifically, the reduction in training costs encourages temporary workers to invest in their human capital, thereby inducing their training participation rate to be close to the socially optimal one (45.7%). Accordingly, the implied welfare gain amounts to 3.8, 7.0, and 9.7 percent, respectively, in the 5-, 25-, and 50-percent counterfactual scenarios. Notice that these gains correspond to the elimination of 38.6, 71.7, and 99.2 percent of inefficiency arising in the decentralized economy. Meanwhile, it is documented that, as a policy option to address the inefficiency of the dualized labor market, the effect of the "shrinking-the-gap" strategy would be limited. Indeed, the expected net welfare gain amounts to at most 3.9 percent (a number obtained when 50 percent of firing costs for permanent jobs are subsidized by the government), implying the necessity for a synthesis of the "shrinking-the-gap" strategy with other policy tools designed to encourage training.

Table 5: Counterfactaul analysis 2 (Reduction in firing costs)

	(1) *Laissez-faire*	(2) 5% cut in κ	(3) 25% cut in κ	(4) 50% cut in κ	(5) Planner
Welfare					
After subtracting costs	100.00	100.01	102.64	103.86	109.78
Before subtracting costs	-	100.13	103.46	105.57	-
Labor market composition					
Tightness, %	100.00	100.32	108.46	114.83	163.54
Moment S1	0.166	0.166	0.196	0.207	0.202
Moment S2	0.058	0.058	0.111	0.246	0.457
Moment S3	0.286	0.286	0.092	0.011	0.592
Moment S4					
− over 3 yrs	0.714	0.716	0.709	0.484	0.704
− over 5 yrs	0.678	0.667	0.653	0.310	0.658
− over 7 yrs	0.587	0.587	0.527	0.321	0.644
Moment S5					
− over 3 yrs	0.002	0.002	0.000	0.000	0.003
− over 5 yrs	0.003	0.004	0.000	0.000	0.018
− over 7 yrs	0.006	0.006	0.002	0.002	0.033
Wage					
Moment A2 over A1	0.775	0.774	0.692	0.410	0.766

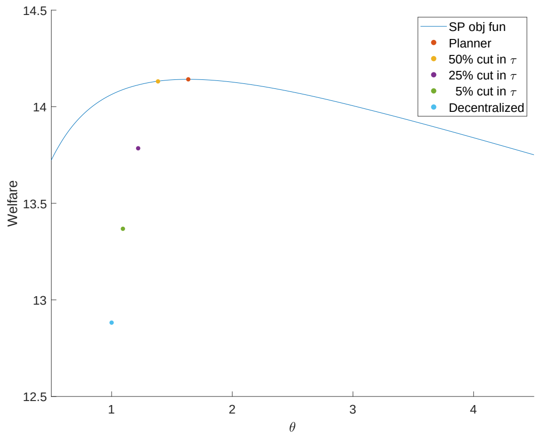
Notes: Columns (1)–(5) correspond to the light blue, green, purple, orange, and red dots, respectively, in Figure 9.(a) below. The welfare of the decentralized equilibrium has been normalized to 100 for easy comparison.

6 Conclusion

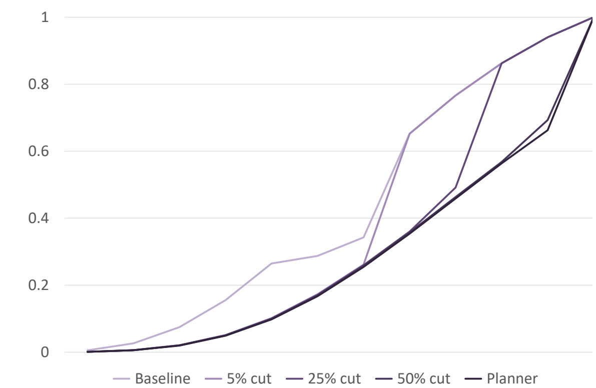
To the best of my knowledge, this paper is the first study that establishes and investigates the underlying link between the dualized labor market and human capital accumulation in order to understand strong persistence in temporary employment and its implications for social welfare. Consequently, the developed model here (or its modified versions) can be a stepping stone to further research on emerging issues, including whether there is any substitutive or complementary relationship between the two main channels of human capital accumulation (namely, education and training) in the context of dualism. [To be added]

Figure 8: Counterfactaul analysis 1 (Reduction in training costs)

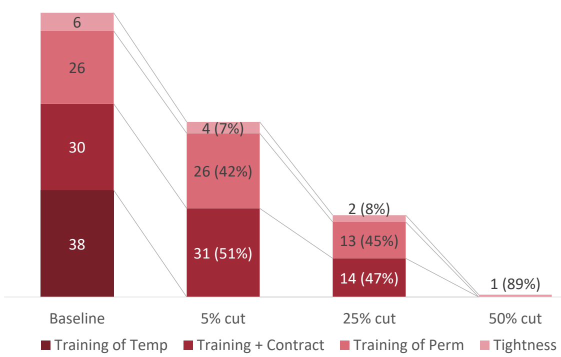
(a) Counterfactual scenarios on the Pareto set



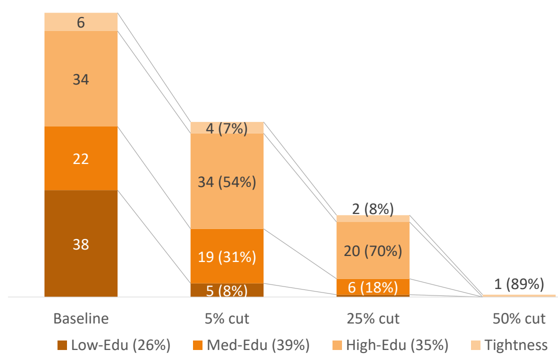
(b) Distribution of general human capital



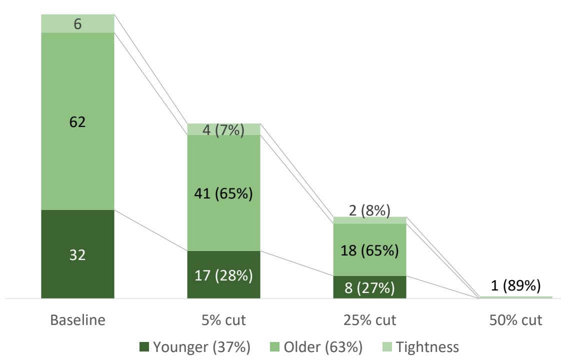
(c) Anatomy of inefficiency by sources



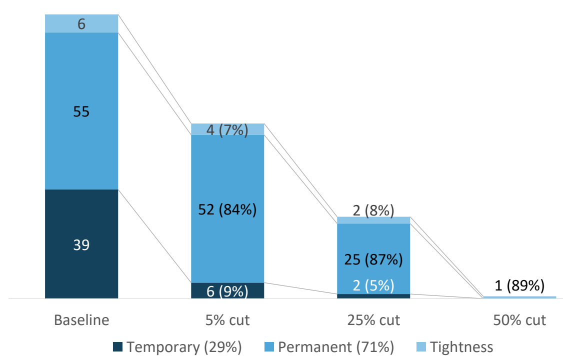
(d) Anatomy of inefficiency by education groups



(e) Anatomy of inefficiency by age groups

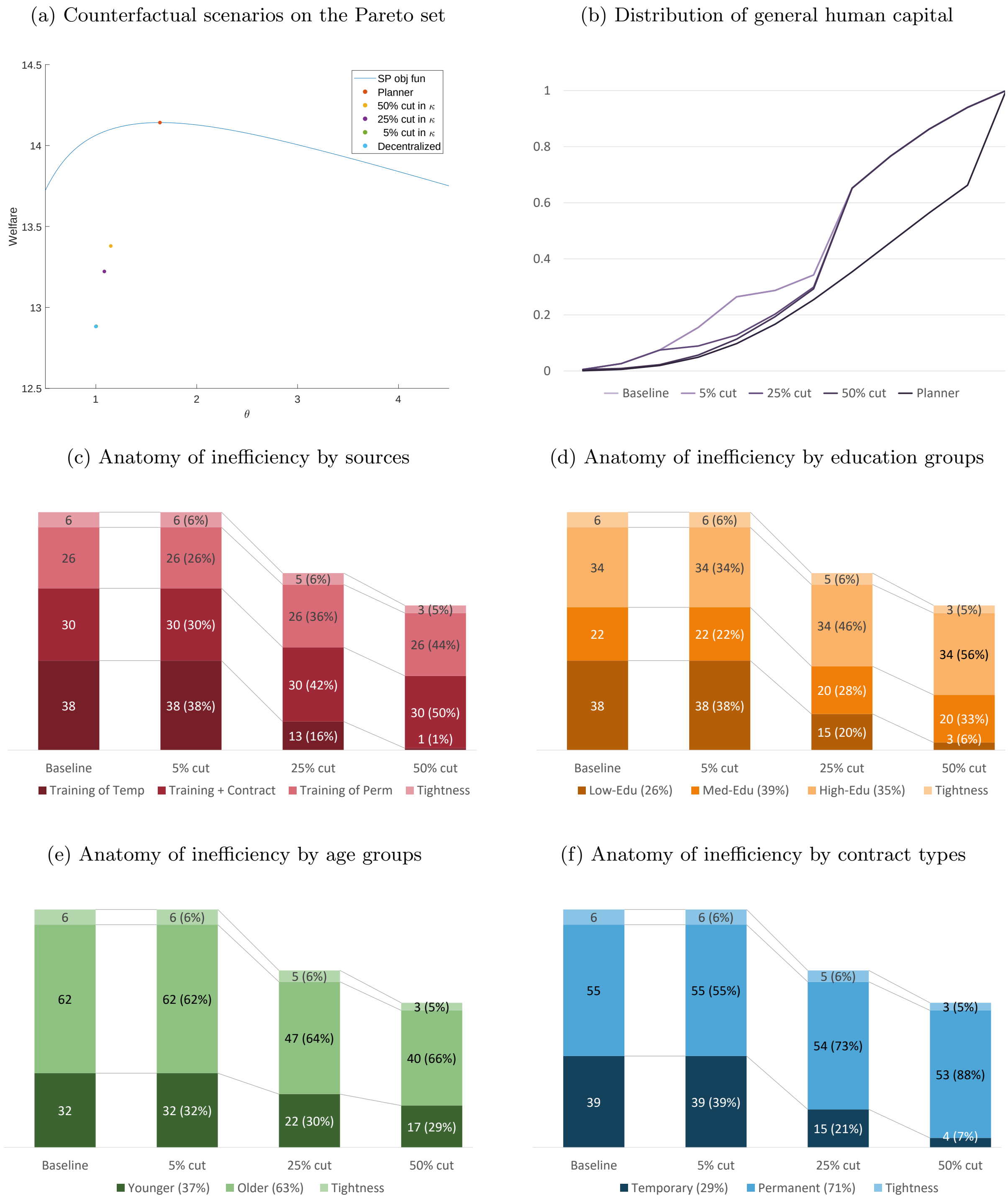


(f) Anatomy of inefficiency by contract types



Notes: (a) The light blue, green, purple, orange, and red dots correspond to columns (1)–(5), respectively, in Table 4 above. (b) The area between each curve and the darkest (the most-right) one represents inefficient human capital accumulation in the corresponding scenario. (c)–(f) The total welfare loss estimated for the baseline case is normalized to 100 so that the number on each segment denotes the rescaled amount of welfare loss. For a given counterfactual scenario, the percentage of welfare loss attributable to each segment is reported in parentheses.

Figure 9: Counterfactaul analysis 2 (Reduction in firing costs)



Notes: (a) The light blue, green, purple, orange, and red dots correspond to columns (1)–(5), respectively, in Table 5 above. The green dot is hardly seen because it is overlaid with the light blue dot. (b) The area between each curve and the darkest (the most-right) one represents inefficient human capital accumulation in the corresponding scenario. (c)–(f) The total welfare loss estimated for the baseline case is normalized to 100 so that the number on each segment denotes the rescaled amount of welfare loss. For a given counterfactual scenario, the percentage of welfare loss attributable to each segment is reported in parentheses.

References

Acemoglu, D. and J.-S. Pischke (1999). Beyond Becker: Training in imperfect labour markets. *The Economic Journal 109*(453), F112–F142.

Auer, W. and N. Danzer (2015). Uncertainty in the labour market: How does fixed-term employment affect fertility and mental health of the young generation? *IBS Working Papers 06/2015*.

Autor, D. H. and S. N. Houseman (2010). Do temporary-help jobs improve labor market outcomes for low-skilled workers? Evidence from "Work First". *American Economic Journal: Applied Economics 2*(3), 96–128.

Becker, G. (1964). *Human Capital*. Chicago, IL: The University of Chicago Press.

Berton, F., F. Devicienti, and L. Pacelli (2011). Are temporary jobs a port of entry into permanent employment? Evidence from matched employer-employee. *International Journal of Manpower 32*(8), 879–899.

Berton, F., F. Devicienti, and L. Pacelli (2016). Human capital mix and temporary contracts: Implications for productivity and inequality. *Politica Economica 32*(1), 27–46.

Berton, F. and P. Garibaldi (2012). Workers and firms sorting into temporary jobs. *The Economic Journal 122*(562), F125–F154.

Bureau of Labor Statistics (2005). Contingent and alternative employment arrangements – February 2005. `https://www.bls.gov/news.release/archives/conemp_07272005.pdf` (visited on 09/18/2018).

Bureau of Labor Statistics (2018). Contingent and alternative employment arrangements – May 2017. `https://www.bls.gov/news.release/archives/conemp_06072018.pdf` (visited on 09/18/2018).

Cabrales, A., J. J. Dolado, and R. Mora (2017). Dual employment protection and (lack of) on-the-job training: PIAAC evidence for Spain and other European countries. *SERIEs 8*(4), 345–371.

Cahuc, P. (2012). For a unified contract. *European Labour Law Journal 3*(3), 191–206.

Cahuc, P., S. Carcillo, and A. Zylberberg (2014). *Labor Economics, Second edition*. Cambridge, MA: The MIT Press.

Cahuc, P., O. Charlot, and F. Malherbet (2016). Explaining the spread of temporary jobs and its impact on labor turnover. *International Economic Review 57*(2), 533–572.

Charlot, O. and F. Malherbet (2013). Education and employment protection. *Labour Economics 20*, 3–23.

Dao, M., D. Furceri, J. Hwang, M. Kim, and T.-J. Kim (2014). Strategies for reforming Korea's labor market to foster growth. *IMF Working Paper 14/137*.

Daruich, D., S. Di Addario, and R. Saggio (2017). The effects of partial employment protection reforms: Evidence from Italy.

Davis, S. J. (2001). The quality distribution of jobs and the structure of wages in search equilibrium. *NBER Working Paper No.8434*.

Dolado, J. J., E. Lalé, and N. Siassi (2018). From dual to unified employment protection: Transition and steady state.

Dolado, J. J., S. Ortigueira, and R. Stucchi (2016). Does dual employment protection affect TFP? Evidence from Spanish manufacturing firms. *SERIEs 7*(4), 421–459.

European Commission (2004). *Employment in Europe 2004: Recent Trends and Prospects.* Luxembourg: Office for Official Publications of the European Communities.

Flinn, C., A. Gemici, and S. Laufer (2017). Search, matching and training. *Review of Economic Dynamics 25*, 260–297.

García-Pérez, J. I. and F. Muñoz-Bullón (2011). Transitions into permanent employment in Spain: An empirical analysis for young workers. *British Journal of Industrial Relations 49*(1), 103–143.

Garda, P. (2013). Wage losses after displacement in dual labor markets: The role of firm specific human capital. *Essays on the Macroeconomics of Labor Markets, PhD diss.*, Universitat Pompeu Fabra.

Hosios, A. J. (1990). On the efficiency of matching and related models of search and unemployment. *The Review of Economic Studies 57*(2), 279–298.

Houseman, S. N. (2014). Temporary agency work. *IZA World of Labor 2014: 27*, doi. http://dx.doi.org/10.15185/izawol.27.

ILO (2015). *World Employment and Social Outlook 2015: The Changing Nature of Jobs.* Geneva: International Labour Office.

Jones, R. S. and K. Fukawa (2016). Labour market reforms in Korea to promote inclusive growth. *OECD Economics Department Working Papers No.1325*, doi. http://dx.doi.org/10.1787/5jlr3cvdf35k-en.

Kahn, L. M. (2018). Permanent jobs, employment protection, and job content. *Industrial Relations: A Journal of Economy and Society 57*(3), 469–538.

Lepage-Saucier, N., J. Schleich, and E. Wasmer (2013). Moving towards a single labour contract: Pros, cons and mixed feelings. *OECD Economics Department Working Papers No.1026*, doi. http://dx.doi.org/10.1787/5k4c0vvc4zxv-en.

Ljungqvist, L. and T. J. Sargent (2012). *Recursive Macroeconomic Theory, Third edition.* Cambridge, MA: The MIT Press.

McFadden, D. (1989). A method of simulated moments for estimation of discrete response models without numerical integration. *Econometrica 57*(5), 995–1026.

Mortensen, D. T. and C. A. Pissarides (1994). Job creation and job destruction in the theory of unemployment. *The Review of Economic Studies 61*(3), 397–415.

OECD (2014). *OECD Employment Outlook 2014.* Paris: OECD Publishing.

OECD (2018). *OECD Employment Outlook 2018.* Paris: OECD Publishing.

Pakes, A. and D. Pollard (1989). Simulation and the asymptotics of optimization estimators. *Econometrica 57*(5), 1027–1057.

Petrongolo, B. and C. A. Pissarides (2001). Looking into the black box: A survey of the matching function. *Journal of Economic Literature 39*(2), 390–431.

Schauer, J. (2018). Labor market duality in Korea. *IMF Working Paper 18/126.*

Shimer, R. (2005). The cyclical behavior of equilibrium unemployment and vacancies. *American Economic Review 95*(1), 25–49.

Wasmer, E. (2006). General versus specific skills in labor markets with search frictions and firing costs. *American Economic Review 96*(3), 811–831.

Appendices

A Additional Material - Theoretical Part

A.1 Formulating Bellman equations in the benchmark model

I focus only on the worker's problem since the firm's problem can be formulated in a similar way. Let $W_t(z, \lambda)$ be the value to worker $z \in \mathbb{Z}$ with tenure $\lambda \in [0, \Lambda]$ of holding a temporary contract.[56] Let $\mathrm{d}\lambda$ be a small interval of time. Standard dynamic programming arguments for continuous-time models (e.g. Cahuc et al., 2014, Appendix D) imply

$$W_u(z) = \frac{1}{1 + r\,\mathrm{d}\lambda}\left[bz\,\mathrm{d}\lambda + (1 - p(\theta)\,\mathrm{d}\lambda)\,W_u(z) + p(\theta)\,\mathrm{d}\lambda W(z)\right], \tag{A.1}$$

$$W_p(z) = \frac{1}{1 + r\,\mathrm{d}\lambda}\left[w_p(z)\,\mathrm{d}\lambda + (1 - \delta\,\mathrm{d}\lambda)\,W_p(z) + \delta\,\mathrm{d}\lambda W_u(z)\right], \tag{A.2}$$

$$W_t(z, \lambda) = \frac{1}{1 + r\,\mathrm{d}\lambda}\left[w_t(z)\,\mathrm{d}\lambda + (1 - \delta\,\mathrm{d}\lambda)\,W_t(z, \lambda + \mathrm{d}\lambda) + \delta\,\mathrm{d}\lambda W_u(z)\right], \tag{A.3}$$

for all $(z, \lambda) \in \mathbb{Z} \times [0, \Lambda)$. Rearranging terms in (A.1) and (A.2) directly yields (1) and (2), respectively. Manipulating (A.3) and then letting $\mathrm{d}\lambda \to 0$ results in

$$rW_t(z, \lambda) = w_t(z) + \delta\left[W_u(z) - W_t(z, \lambda)\right] + \frac{\partial W_t(z, \lambda)}{\partial \lambda}, \tag{A.4}$$

where $\frac{\partial W_t(z,\lambda)}{\partial \lambda} := \lim_{\mathrm{d}\lambda \to 0} \frac{W_t(z,\lambda+\mathrm{d}\lambda) - W_t(z,\lambda)}{\mathrm{d}\lambda}$. One can use the terminal condition $W_t(z, \Lambda) = W_u(z)$ to obtain the following solution to the differential equation (A.4):

$$rW_t(z, \lambda) = w_t(z) + \delta\left[W_u(z) - W_t(z, \lambda)\right] + \mathrm{e}^{-(r+\delta)(\Lambda-\lambda)}\left[rW_u(z) - w_t(z)\right],$$

for all $(z, \lambda) \in \mathbb{Z} \times [0, \Lambda]$.[57] Note that (3) is a special case obtained by setting $\lambda = 0$.

One can arrive at (3) in a different manner. Following the arguments in Cahuc et al. (2016), the value to worker z of starting a temporary job, $W_t(z)$, can be written as

$$W_t(z) = \underbrace{\int_0^{\Lambda}\left[\int_0^{\overline{\lambda}} \mathrm{e}^{-r\lambda} w_t(z)\,\mathrm{d}\lambda + \mathrm{e}^{-r\overline{\lambda}} W_u(z)\right]\delta \mathrm{e}^{-\delta\overline{\lambda}}\,\mathrm{d}\overline{\lambda}}_{\text{in case of a separation shock arriving before } \Lambda} + \underbrace{\left[\int_0^{\Lambda} \mathrm{e}^{-r\lambda} w_t(z)\,\mathrm{d}\lambda + \mathrm{e}^{-r\Lambda} W_u(z)\right]\mathrm{e}^{-\delta\Lambda}}_{\text{in case of a separation shock arriving after } \Lambda}. \tag{A.5}$$

Once the temporary job is started, a separation shock can arrive either before or after Λ. In the former case, the worker receives wage $w_t(z)$ until $\overline{\lambda} \le \Lambda$, a random moment of time when the separation occurs so that the worker enters the pool of searchers with value $W_u(z)$. Recall that the separation occurrence follows the Poisson process whose density is $\delta \mathrm{e}^{-\delta\overline{\lambda}}$. In the latter case occurring with probability $\mathrm{e}^{-\delta\Lambda}$, the worker receives wage $w_t(z)$ until Λ, and then he goes back to unemployment. It is straightforward (albeit tedious) to verify that (A.5) is simplified to (3).

[56] Thus, $W_t(z, 0) = W_t(z)$ for all $z \in \mathbb{Z}$ by definition.

[57] The detailed procedure of deriving the solution is omitted for the sake of brevity, but one can easily verify the solution by substituting it into (A.4).

A.2 Surplus functions in the benchmark model

(10) and (11) constitute a system of two equations and two unknowns $S_p(z)$ and $S_t(z)$. Assuming that $z_r \in \mathbb{Z}$ as in the main text, one can solve the system for $S_p(z)$ and $S_t(z)$ as follows:

$$S_p(z) = \begin{cases} \dfrac{y-b}{r+\delta+[1-\mathrm{e}^{-(r+\delta)\Lambda}]p(\theta)\beta} z - \dfrac{\delta\kappa}{r+\delta} & \text{if } z < z_r, \\ \dfrac{y-b}{r+\delta+p(\theta)\beta} z - \dfrac{\delta\kappa}{r+\delta+p(\theta)\beta} & \text{if } z \geq z_r, \end{cases}$$

and

$$S_t(z) = \begin{cases} \dfrac{[1-\mathrm{e}^{-(r+\delta)\Lambda}](y-b)}{r+\delta+[1-\mathrm{e}^{-(r+\delta)\Lambda}]p(\theta)\beta} z & \text{if } z < z_r, \\ \dfrac{[1-\mathrm{e}^{-(r+\delta)\Lambda}](y-b)}{r+\delta+p(\theta)\beta} z + \dfrac{[1-\mathrm{e}^{-(r+\delta)\Lambda}]p(\theta)\beta}{(r+\delta)[r+\delta+p(\theta)\beta]}\delta\kappa & \text{if } z \geq z_r, \end{cases}$$

where it is worth mentioning that the slope of $S_p(z)$ is always steeper than that of $S_t(z)$. I can arrive at (12) by recalling that $S(z) = \max\{S_p(z), S_t(z)\}$.

A.3 Proof of Proposition 1

Part (a) Let $F(\theta)$ be the firm's expected net benefit from creating a vacancy as a function of the labor market tightness $\theta \in (0, \infty)$, namely,

$$F(\theta) := \int_{z\in\mathbb{Z}} q(\theta)\frac{u(z;\theta)}{U(\theta)}(1-\beta)S(z;\theta)\,\mathrm{d}z - c. \tag{A.6}$$

In order to prove the existence of $\theta^* \in (0, \infty)$ such that $F(\theta^*) = 0$, it is enough to show that

$$\underbrace{\left[\lim_{\theta\to 0} F(\theta)\right]}_{>0} \times \underbrace{\left[\lim_{\theta\to\infty} F(\theta)\right]}_{<0} < 0.$$

First, $\lim_{\theta\to 0} q(\theta) = \lim_{\theta\to 0} U(\theta) = 1$ and $\lim_{\theta\to 0} u(z;\theta) = \ell(z)$ jointly implies that

$$\lim_{\theta\to 0} F(\theta) = \int_{z\in\mathbb{Z}} \ell(z)(1-\beta)S(z;0)\,\mathrm{d}z - c,$$

which is strictly positive by (E2). Second, from the assumption $\lim_{\theta\to\infty} q(\theta) = 0$, it immediately follows that $\lim_{\theta\to\infty} F(\theta) = -c < 0$. Then the existence result is obtained by applying the intermediate value theorem with the fact that $F(\cdot)$ is continuous.

Part (b) I prove the uniqueness by showing that $F(\theta)$ is strictly monotone in θ.[58] Recalling (17), one can decompose $F(\theta)$ into three parts, $F(\theta) = F_t(\theta) + F_p(\theta) - c$, where

$$F_t(\theta) := \int_{\underline{z}}^{z_r(\theta)} \frac{q(\theta)u_t(\theta)}{U(\theta)} \ell(z)(1-\beta)S_t(z;\theta)\,\mathrm{d}z,$$
$$F_p(\theta) := \int_{z_r(\theta)}^{\overline{z}} \frac{q(\theta)u_p(\theta)}{U(\theta)} \ell(z)(1-\beta)S_p(z;\theta)\,\mathrm{d}z.$$

Let $\varepsilon[f(x)] := f'(x)/f(x)$ be the semi-elasticity of a continuously differentiable function $f(\cdot)$ at point x.[59] Using the Leibniz integral rule, I differentiate $F(\theta)$ with respect to θ, which yields

$$\begin{aligned} F'(\theta) = F_r'(\theta) &+ \varepsilon\left[\frac{q(\theta)u_t(\theta)}{U(\theta)}\right] F_t(\theta) + \varepsilon\left[\frac{q(\theta)u_p(\theta)}{U(\theta)}\right] F_p(\theta) \\ &+ \underbrace{\frac{q(\theta)u_t(\theta)}{U(\theta)} \int_{\underline{z}}^{z_r(\theta)} \ell(z)(1-\beta)\frac{\partial S_t(z;\theta)}{\partial\theta}\,\mathrm{d}z}_{<0} + \underbrace{\frac{q(\theta)u_p(\theta)}{U(\theta)} \int_{z_r(\theta)}^{\overline{z}} \ell(z)(1-\beta)\frac{\partial S_p(z;\theta)}{\partial\theta}\,\mathrm{d}z}_{<0}, \end{aligned}$$

where, letting $\ell_r(\theta) := \ell(z_r(\theta))$,

$$F_r'(\theta) := \frac{q(\theta)}{U(\theta)}\left[u_t(\theta) - u_p(\theta)\right] z_r'(\theta)\ell_r(\theta)(1-\beta)S_r. \tag{A.7}$$

Then, as $\frac{\partial S_t(z;\theta)}{\partial\theta} < 0$ and $\frac{\partial S_p(z;\theta)}{\partial\theta} < 0$, a sufficient condition for the negativity of $F'(\theta)$ is

$$F_r'(\theta) + \varepsilon\left[\frac{q(\theta)u_t(\theta)}{U(\theta)}\right] F_t(\theta) + \varepsilon\left[\frac{q(\theta)u_p(\theta)}{U(\theta)}\right] F_p(\theta) \leq 0. \tag{A.8}$$

Noting that $U'(\theta)$ can be decomposed into two parts, $U'(\theta) = U_u'(\theta) + U_r'(\theta)$, where

$$U_u'(\theta) := u_t'(\theta)L_r(\theta) + u_p'(\theta)\left[1 - L_r(\theta)\right],$$
$$U_r'(\theta) := \left[u_t(\theta) - u_p(\theta)\right] z_r'(\theta)\ell_r(\theta),$$

one can rewrite (A.8) as

$$\underbrace{\underbrace{F_r'(\theta)}_{>0} - \underbrace{\frac{U_r'(\theta)}{U(\theta)}}_{>0}\underbrace{[F_t(\theta)+F_p(\theta)]}_{>0}}_{\leq 0\ \forall\theta=\theta^*\text{ s.t. }F(\theta^*)=0\text{ by (U1)}} + \left[\underbrace{\underbrace{\varepsilon[q(\theta)]}_{<0} - \underbrace{\frac{U_u'(\theta)}{U(\theta)}}_{<0}}_{\leq 0\text{ by (U2)}}\right]\underbrace{[F_t(\theta)+F_p(\theta)]}_{>0} + \underbrace{\sum_{i\in\{t,p\}} \varepsilon[u_i(\theta)]F_i(\theta)}_{<0} \leq 0. \tag{A.9}$$

Therefore, (A.8) or (A.9) holds true, provided that the following two conditions are satisfied:

(Ua) $F_r'(\theta) - \frac{U_r'(\theta)}{U(\theta)}\left[F_t(\theta) + F_p(\theta)\right] \leq 0,$

(Ub) $\varepsilon[q(\theta)] - \frac{U_u'(\theta)}{U(\theta)} \leq 0.$

[58] Technically speaking, I show that $F(\theta)$ is strictly decreasing at any $\theta = \theta^*$ such that $F(\theta^*) = 0$.

[59] It is worth noting that $\varepsilon\left[\frac{f(x)g(x)}{h(x)}\right] = \varepsilon[f(x)] + \varepsilon[g(x)] - \varepsilon[h(x)]$ for continuously differentiable functions $f(\cdot)$, $g(\cdot)$, and $h(\cdot)$.

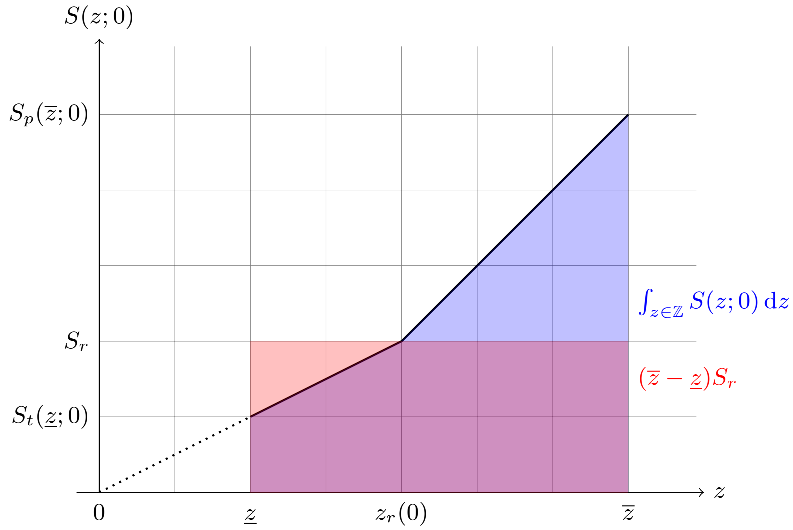
Now, to complete the proof, I show that (Ua) and (Ub) are implied by (U1) and (U2), respectively.

i. (U1) *implies* (Ua).
Since (A.7) can be simplified to $F_r'(\theta) = q(\theta)\frac{U_r'(\theta)}{U(\theta)}(1-\beta)S_r$, the left-hand side of (Ua) can be rewritten as
$$F_r'(\theta) - \frac{U_r'(\theta)}{U(\theta)}\left[F_t(\theta) + F_p(\theta)\right] = \frac{U_r'(\theta)}{U(\theta)}\left[q(\theta)(1-\beta)S_r - F_t(\theta) - F_p(\theta)\right],$$
which is negative as long as the following inequality holds:
$$q(\theta)(1-\beta)S_r \leq F_t(\theta) + F_p(\theta). \tag{A.10}$$
Suppose that there exists $\theta^* \in (0,\infty)$ such that $F(\theta^*) = 0$.[60] Then I need to check whether (A.10) holds at $\theta = \theta^*$. Recalling $F(\theta) = F_t(\theta) + F_p(\theta) - c$, one can see that
$$q(\theta^*)(1-\beta)S_r \leq (1-\beta)S_r \leq c = c + F(\theta^*) = F_t(\theta^*) + F_p(\theta^*),$$
where the first inequality holds since $q(\theta^*) \leq 1$, and the second inequality follows from (U1).

ii. (U2) *implies* (Ub).
It is straightforward to verify
$$\frac{u_p'(\theta)}{u_p(\theta)} = -\frac{p'(\theta)}{p(\theta)+\delta} < -\frac{(1-\mathrm{e}^{-\delta\Lambda})p'(\theta)}{(1-\mathrm{e}^{-\delta\Lambda})p(\theta)+\delta} = \frac{u_t'(\theta)}{u_t(\theta)},$$
which can be used to derive
$$\frac{u_p'(\theta)}{u_p(\theta)} < \frac{u_t'(\theta)L_r(\theta) + u_p'(\theta)\left[1-L_r(\theta)\right]}{u_t(\theta)L_r(\theta) + u_p(\theta)\left[1-L_r(\theta)\right]} = \frac{U_u'(\theta)}{U(\theta)}, \tag{A.11}$$
where the inequality is obtained by applying the mediant inequality. Then the desired result directly follows from
$$\varepsilon[q(\theta)] \leq -\varepsilon[p(\theta)] = -\frac{p'(\theta)}{p(\theta)} < -\frac{p'(\theta)}{p(\theta)+\delta} = \frac{u_p'(\theta)}{u_p(\theta)} < \frac{U_u'(\theta)}{U(\theta)},$$
where the first inequality is due to (U2), while the last inequality holds true by (A.11).

[60] Note that the existence of θ^* is guaranteed by (E1) and (E2).

Figure 10: A graphical illustration of the compatibility between (U1) and (E2)



Notes: The red area corresponds to the left-hand side of (A.12) while the blue area represents the right-hand side. It is clearly depicted in the figure that the former is smaller than the latter, with $z_r(0)$ being less than $(\underline{z}+\overline{z})/2$. The parameter values used to produce the figure are arbitrarily chosen only for the purpose of illustration.

A.4 Compatibility between (U1) and (E2)

Suppose that z is uniformly distributed over $[\underline{z},\overline{z}]$, with $(\underline{z}+\overline{z})/2 > z_r(0)$.[61] Then (20) is equivalent to

$$(\overline{z}-\underline{z})S_r < \int_{z\in\mathbb{Z}} S(z;0)\,\mathrm{d}z, \tag{A.12}$$

where the right-hand side can be rewritten as

$$\begin{aligned}\int_{z\in\mathbb{Z}} S(z;0)\,\mathrm{d}z &= \int_{\underline{z}}^{z_r(0)} S_t(z;0)\,\mathrm{d}z + \int_{z_r(0)}^{\overline{z}} S_p(z;0)\,\mathrm{d}z \\ &= \frac{1}{2}\left[z_r(0)-\underline{z}\right]\left[S_t(\underline{z};0)+S_r\right] + \frac{1}{2}\left[\overline{z}-z_r(0)\right]\left[S_r+S_p(\overline{z};0)\right].\end{aligned}$$

Therefore, (A.12) can be rearranged as $(\overline{z}-\underline{z})S_r < [z_r(0)-\underline{z}]\,S_t(\underline{z};0)+[\overline{z}-z_r(0)]\,S_p(\overline{z};0)$, or equivalently,

$$\left[z_r(0)-\underline{z}\right]\left[S_r-S_t(\underline{z};0)\right] < \left[\overline{z}-z_r(0)\right]\left[S_p(\overline{z};0)-S_r\right],$$

which holds true since $z_r(0)-\underline{z} < \overline{z}-z_r(0)$ by assumption, and $S_r - S_t(\underline{z};0) < S_p(\overline{z};0) - S_r$.[62] A graphical illustration is provided in Figure 10, in which the left-hand side of (A.12) is highlighted in red whereas the right-hand side is in blue.

[61] In other words, it is assumed that the mean (or median) worker type is greater than the marginal worker type determined when search frictions for unfilled jobs are absent.

[62] To see $S_r - S_t(\underline{z};0) < S_p(\overline{z};0) - S_r$, recall that the slope of $S_p(\cdot)$ is steeper than that of $S_t(\cdot)$, as illustrated in Figure 10.

A.5 Comparative statics for the benchmark model

In order to precisely state the comparative statics results for the benchmark model, I indicate whether an expression depends on κ or Λ by adding them to the notation as needed: e.g. $S_p(z;\theta,\kappa)$, $S_t(z;\theta,\Lambda)$, $F(\theta,\kappa)$, $F(\theta,\Lambda)$, etc. In addition, let $\varepsilon_{x_i}[f(x)] := [\partial f(x)/\partial x_i]/f(x)$ be the semi-elasticity of a multivariate continuously differentiable function $f:\mathbb{R}^n \to \mathbb{R}$ with respect to its i-th argument at point $x = (x_1,\ldots,x_i,\ldots,x_n)$.

Proposition 3 (Comparative statics)**.**

(a) *Given the other model parameters satisfying* (E1) *and* (U2)*, let* $\mathbb{K}$ *be the open interval containing all values of* κ *that (together with the other parameters) satisfy* (E2) *and* (U1)*. Let* $\theta^*(\kappa_0) \in (0,\infty)$ *be the unique stationary equilibrium for some* $\kappa_0 \in \mathbb{K}$ *so that* $F(\theta^*(\kappa_0),\kappa_0) = 0$*. If* $F_\theta(\theta^*(\kappa_0),\kappa_0) \neq 0$*, then the slope of the level curve of* $F(\cdot,\cdot)$ *for the value* $F(\theta^*(\kappa_0),\kappa_0)$ *at the point* $(\theta^*(\kappa_0),\kappa_0)$*,* $\frac{\mathrm{d}\theta^*(\kappa)}{\mathrm{d}\kappa}\Big|_{\kappa=\kappa_0}$*, is strictly negative, namely,*

$$\frac{\mathrm{d}\theta^*(\kappa)}{\mathrm{d}\kappa}\bigg|_{\kappa=\kappa_0} = -\frac{F_\kappa(\theta^*(\kappa_0),\kappa_0)}{F_\theta(\theta^*(\kappa_0),\kappa_0)} < 0.$$

(b) *Given the other model parameters satisfying* (E1) *and* (U2)*, let* $\mathbb{L}$ *be the open interval containing all values of* Λ *that (together with the other parameters) satisfy* (E2) *and* (U1)*. Let* $\theta^*(\Lambda_0) \in (0,\infty)$ *be the unique stationary equilibrium for some* $\Lambda_0 \in \mathbb{L}$ *so that* $F(\theta^*(\Lambda_0),\Lambda_0) = 0$*. If* $F_\theta(\theta^*(\Lambda_0),\Lambda_0) \neq 0$*, then the slope of the level curve of* $F(\cdot,\cdot)$ *for the value* $F(\theta^*(\Lambda_0),\Lambda_0)$ *at the point* $(\theta^*(\Lambda_0),\Lambda_0)$*,* $\frac{\mathrm{d}\theta^*(\Lambda)}{\mathrm{d}\Lambda}\Big|_{\Lambda=\Lambda_0}$*, is strictly positive, namely,*

$$\frac{\mathrm{d}\theta^*(\Lambda)}{\mathrm{d}\Lambda}\bigg|_{\Lambda=\Lambda_0} = -\frac{F_\Lambda(\theta^*(\Lambda_0),\Lambda_0)}{F_\theta(\theta^*(\Lambda_0),\Lambda_0)} > 0,$$

provided that

(C1) $\varepsilon_\Lambda[S_t(z;\theta^*(\Lambda_0),\Lambda_0)] + \varepsilon_\Lambda[u_t(\theta^*(\Lambda_0),\Lambda_0)] \geq 0$,

(C2) $\varepsilon_\Lambda[U(\theta^*(\Lambda_0),\Lambda_0)] \leq 0$.

Before proving the above proposition, I provide concise interpretations of (C1) and (C2).[63] First, because $\partial S_t(z;\theta,\Lambda)/\partial\Lambda > 0$ for all $(z,\theta,\Lambda) \in \mathbb{Z}\times(0,\infty)\times\mathbb{L}$ (the longer is Λ, the higher is the surplus from a temporary match) and $\partial u_t(\theta,\Lambda)/\partial\Lambda < 0$ for all $(\theta,\Lambda) \in (0,\infty)\times\mathbb{L}$ (the longer is Λ, the lower is the unemployment rate for temporary workers), (C1) requires that $S_t(z;\theta,\Lambda)$ must be more elastic (with respect to Λ) than $u_t(\theta,\Lambda)$ at a given equilibrium $\theta^*(\Lambda_0)$.[64] Second, $\varepsilon_\Lambda[U(\theta,\Lambda)]$ can be decomposed into two parts, namely,

$$\varepsilon_\Lambda[U(\theta,\Lambda)] = \underbrace{[u_t(\theta,\Lambda) - u_p(\theta)]\frac{\partial z_r(\theta,\Lambda)}{\partial\Lambda}\ell_r(\theta,\Lambda)}_{>0} + \underbrace{\frac{\partial u_t(\theta,\Lambda)}{\partial\Lambda}L_r(\theta,\Lambda)}_{<0},$$

where the first part corresponds to an increase in the unemployment rate (caused by marginal workers who choose a temporary contract, instead of a permanent one, in response to a longer Λ), while the second part stands for a decrease in the unemployment rate (resulting from a reduced unemployment rate for existing temporary workers). Therefore, (C2) requires that, at a given equilibrium $\theta^*(\Lambda_0)$, the latter must outweigh the former in order for the net effect of a longer Λ on the aggregate unemployment rate to be negative.

[63] As will be clear in what follows, (C1) is introduced to ensure that (L1) is not overshadowed by (L3), while (C2) is imposed to guarantee the positivity of (L4).

[64] Note that $\varepsilon_\Lambda[S_t(z;\theta,\Lambda)]$ is independent of z, as seen in the proof below.

Proof. Since (E1)–(E2) and (U1)–(U2) are assumed, it immediately follows that $F_\theta(\theta^*(\kappa_0), \kappa_0) < 0$ and $F_\theta(\theta^*(\Lambda_0), \Lambda_0) < 0$ (see Appendix A.3). Therefore, by the implicit function theorem, it is enough to show that $F_\kappa(\theta^*(\kappa_0), \kappa_0) < 0$ and $F_\Lambda(\theta^*(\Lambda_0), \Lambda_0) > 0$ for parts (a) and (b), respectively.

Part (a) Recalling (A.6), one can differentiate $F(\theta, \kappa)$ with respect to κ, which yields

$$F_\kappa(\theta, \kappa) = \frac{\partial}{\partial \kappa}\left[\int_{\underline{z}}^{z_r(\theta,\kappa)} \frac{q(\theta)u_t(\theta)}{U(\theta,\kappa)}\ell(z)(1-\beta)S_t(z;\theta)\,\mathrm{d}z\right] + \frac{\partial}{\partial \kappa}\left[\int_{z_r(\theta,\kappa)}^{\overline{z}} \frac{q(\theta)u_p(\theta)}{U(\theta,\kappa)}\ell(z)(1-\beta)S_p(z;\theta,\kappa)\,\mathrm{d}z\right].$$

Using the fact that $\frac{\partial S_t(z;\theta)}{\partial \kappa} = 0$, I apply the Leibniz integral rule to obtain

$$\begin{aligned} F_\kappa(\theta, \kappa) = {} & \frac{q(\theta)}{U(\theta,\kappa)}\left[u_t(\theta) - u_p(\theta)\right]\frac{\partial z_r(\theta,\kappa)}{\partial \kappa}\ell_r(\theta,\kappa)(1-\beta)S_r(\kappa) + \varepsilon_\kappa\left[\frac{1}{U(\theta,\kappa)}\right]\left[F_t(\theta,\kappa) + F_p(\theta,\kappa)\right] \\ & + \underbrace{\int_{z_r(\theta,\kappa)}^{\overline{z}} \frac{q(\theta)u_p(\theta)}{U(\theta,\kappa)}\ell(z)(1-\beta)\frac{\partial S_p(z;\theta,\kappa)}{\partial \kappa}\,\mathrm{d}z,}_{=(\mathrm{K1})<0} \end{aligned}$$

where the last term is less than zero as $\frac{\partial S_p(z;\theta,\kappa)}{\partial \kappa} < 0$. Consequently, a sufficient condition for $F_\kappa(\theta^*(\kappa_0), \kappa_0)$ to be negative is that

$$\underbrace{\frac{q(\theta)}{U(\theta,\kappa)}\left[u_t(\theta) - u_p(\theta)\right]\frac{\partial z_r(\theta,\kappa)}{\partial \kappa}\ell_r(\theta,\kappa)(1-\beta)S_r(\kappa)}_{=(\mathrm{K2})>0}\;\underbrace{-\,\varepsilon_\kappa\left[U(\theta,\kappa)\right]\left[F_t(\theta,\kappa) + F_p(\theta,\kappa)\right]}_{=(\mathrm{K3})<0} \leq 0 \tag{A.13}$$

holds for $(\theta, \kappa) = (\theta^*(\kappa_0), \kappa_0)$. Note that $\frac{\partial U(\theta,\kappa)}{\partial \kappa} = \left[u_t(\theta) - u_p(\theta)\right]\frac{\partial z_r(\theta,\kappa)}{\partial \kappa}\ell_r(\theta,\kappa)$ can be used to derive

$$\varepsilon_\kappa\left[U(\theta,\kappa)\right] = \frac{1}{U(\theta,\kappa)}\left[u_t(\theta) - u_p(\theta)\right]\frac{\partial z_r(\theta,\kappa)}{\partial \kappa}\ell_r(\theta,\kappa),$$

which simplifies (A.13) to

$$q(\theta)(1-\beta)S_r(\kappa) - \left[F_t(\theta,\kappa) + F_p(\theta,\kappa)\right] \leq 0. \tag{A.14}$$

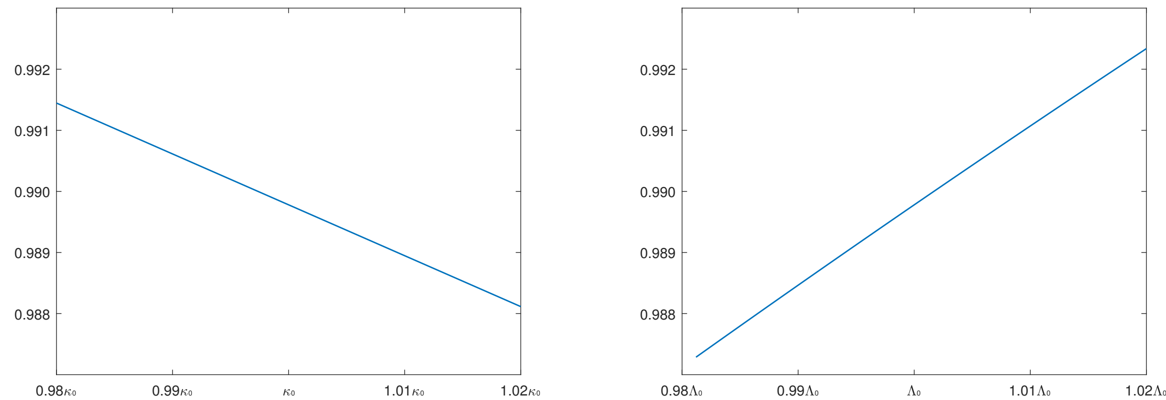
Then, since $F_t(\theta^*(\kappa_0), \kappa_0) + F_p(\theta^*(\kappa_0), \kappa_0) = c$, it is straightforward to verify that (U1) ensures (A.14) when $(\theta, \kappa) = (\theta^*(\kappa_0), \kappa_0)$, completing the proof.

Part (b) Noting that $\frac{\partial S_p(z;\theta)}{\partial \Lambda} = 0$, one can apply the Leibniz integral rule to obtain

$$\begin{aligned} F_\Lambda(\theta, \Lambda) = {} & \int_{\underline{z}}^{z_r(\theta,\Lambda)} \frac{q(\theta)u_t(\theta,\Lambda)}{U(\theta,\Lambda)}\ell(z)(1-\beta)\frac{\partial}{\partial \Lambda}S_t(z;\theta,\Lambda)\,\mathrm{d}z \\ & + \varepsilon_\Lambda\left[u_t(\theta,\Lambda)\right]F_t(\theta,\Lambda) + \varepsilon_\Lambda\left[\frac{1}{U(\theta,\Lambda)}\right]\left[F_t(\theta,\Lambda) + F_p(\theta,\Lambda)\right] \\ & + \underbrace{\frac{q(\theta)}{U(\theta,\Lambda)}\left[u_t(\theta,\Lambda) - u_p(\theta)\right]\frac{\partial z_r(\theta,\Lambda)}{\partial \Lambda}\ell_r(\theta,\Lambda)(1-\beta)S_r(\Lambda),}_{=(\mathrm{L2})>0} \end{aligned}$$

Figure 11: An illustration of comparative statics for the benchmark model

(a) Labor market tightness as a function of κ (b) Labor market tightness as a function of Λ



Notes: (a) and (b) show how labor market tightness responds to small changes (up to $\pm 2\%$) in κ and Λ, respectively, in the benchmark case (where $\rho = \phi_s = \phi_g = 0$). The values of κ and Λ are initially set to $\kappa_0 = 6.087$ and $\Lambda_0 = 7.660$, respectively (the numbers reported in Table 2), yielding a unique stationary equilibrium $\theta^*(\kappa_0) = \theta^*(\Lambda_0) = 0.990$. The function $\theta^*(\kappa)$ is decreasing on the interval $(0.98\kappa_0, 1.02\kappa_0)$ in (a) whereas the function $\theta^*(\Lambda)$ is increasing on the interval $(0.98\Lambda_0, 1.02\Lambda_0)$ in (b), as established in Proposition 3.

where the last term is greater than zero as $\frac{\partial z_r(\theta,\Lambda)}{\partial \Lambda} > 0$. Now, it is useful to observe that $\varepsilon_\Lambda[S_t(z;\theta,\Lambda)]$ does not depend on z, as shown in

$$\varepsilon_\Lambda[S_t(z;\theta,\Lambda)] = \frac{(r+\delta)^2[\mathrm{e}^{(r+\delta)\Lambda} - 1]^{-1}}{r + \delta + [1 - \mathrm{e}^{-(r+\delta)\Lambda}]p(\theta)\beta},$$

suggesting a sufficient condition for $F_\Lambda(\theta^*(\Lambda_0);\Lambda_0)$ to be positive:

$$\underbrace{\varepsilon_\Lambda[S_t(z;\theta,\Lambda)]F_t(\theta,\Lambda)}_{=\,(\mathrm{L1})\,>\,0} \underbrace{+\varepsilon_\Lambda\left[u_t(\theta,\Lambda)\right]F_t(\theta,\Lambda)}_{=\,(\mathrm{L3})\,<\,0} \underbrace{-\varepsilon_\Lambda\left[U(\theta,\Lambda)\right]\left[F_t(\theta,\Lambda) + F_p(\theta,\Lambda)\right]}_{=\,(\mathrm{L4}),\text{ whose sign is ambiguous}} \geq 0,$$

or equivalently,

$$\Big[\underbrace{\varepsilon_\Lambda\left[S_t(z;\theta,\Lambda)\right] + \varepsilon_\Lambda\left[u_t(\theta,\Lambda)\right]}_{\geq\, 0 \text{ at } (\theta,\Lambda) = (\theta^*(\Lambda_0),\Lambda_0) \text{ by (C1)}}\Big] F_t(\theta,\Lambda) \geq \underbrace{\varepsilon_\Lambda\left[U(\theta,\Lambda)\right]}_{\leq\, 0 \text{ by (C2)}}\left[F_t(\theta,\Lambda) + F_p(\theta,\Lambda)\right] \tag{A.15}$$

holds for $(\theta,\Lambda) = (\theta^*(\Lambda_0),\Lambda_0)$. Note that, when evaluated at $(\theta,\Lambda) = (\theta^*(\Lambda_0),\Lambda_0)$, the left-hand side of (A.15) is positive by (C1) whereas the right-hand side is negative by (C2), completing the proof. $\square$

A.6 Proof of Proposition 2

[To be added]

A.7 Formulating Bellman equations in the extended model

[To be added]

A.8 (Q2) details: Temporary employment and general training

[To be added]

A.9 (Q3) details: Deriving cutoff human capital levels

$S_{p,s}(z)$ **versus** $S_{p,g}(z)$ [To be added]

$S_{p,g}(z)$ **versus** $S_{t,g}(z)$ [To be added]

$S_{t,g}(z)$ **versus** $S_{t,n}(z)$ [To be added]

A.10 Deriving the stationary distribution of workers in the extended model

The objective of this subsection is to analytically derive the steady state distribution of the current level of general human capital $z_j \in \mathbb{Z}$ among the unemployed, $\{u(z_j;\theta)\}_{z_j\in\mathbb{Z}}$, which appears in the definition of the stationary equilibrium (37). As previously pointed out, this is a complicated task because of the endogenous dynamics of human capital accumulation. In fact, determining $\{u(z_j;\theta)\}_{z_j\in\mathbb{Z}}$ requires solving for $\{\ell_i^j(\theta), u_i^j(\theta), g_i^j(\theta), s_i^j(\theta)\}_{1\le i\le N}^{i\le j\le N}$ using the stationary transition equations.[65] Nevertheless, the problem is tractable mainly due to the simplifying assumptions on the dynamics of general human capital.[66] Accordingly, in what follows, I present the transition equations which have to be satisfied in the stationary equilibrium. Since each retired worker is substituted by an unemployed entrant with the same initial level of general human capital, the distribution of initial general human capital across workers is constant over time. Therefore, I describe the stationary transition equations on the basis of an initial level of general human capital $z_0 \in \mathbb{Z}$, rather than its current level $z \in \mathbb{Z}$. Furthermore, $\{u(z_j)\}_{z_j\in\mathbb{Z}}$ must be well-defined out of equilibrium as well as at equilibrium. For this reason, when deriving the stationary transition equations, I consider all possible options[67] that may be chosen by each $z_0 \in \mathbb{Z}$. [To be added]

(H1) *Solving for* $\{\ell_i^j(\theta), u_i^j(\theta), g_i^j(\theta), s_i^j(\theta)\}_{1\le i\le N}^{j=i}$.

I first pin down the values of $\ell_i^j(\theta)$, $u_i^j(\theta)$, $g_i^j(\theta)$, and $s_i^j(\theta)$ for the bottom rung of the human capital ladder, which will facilitate the next step associated with the upper rungs of the human capital ladder. Notice that by definition $g_i^i(\theta) = 0$ for all scenarios considered below.

i. *When* $S(z_j) = S_{p,n}(z_j)$.

For a worker with $z_0 = z_i$, both types of human capital do not evolve under the current option.

[65] See Section 3.2 for the definitions of $\ell_i^j(\theta)$, $u_i^j(\theta)$, $g_i^j(\theta)$, and $s_i^j(\theta)$.

[66] Recall that there is no depreciation of general human capital, and that only one-level upgrade of human capital is allowed during the employment relationship with the current employer.

[67] Namely, $\{(p,n),(p,s),(p,g),(t,n),(t,s),(t,g)\}$, as listed and explored below.

Thus, the argument made for the benchmark model (see Section 2.2) can be borrowed for the current purpose, implying that $\ell_i^i(\theta) = \ell(z_i)$ and $s_i^i(\theta) = 0$. Furthermore, (16) is extended to

$$[p(\theta) + \rho]\, u_i^i(\theta) = \delta \left[\ell(z_i) - u_i^i(\theta)\right] + \rho\ell(z_i),$$

where the left-hand side is the outflow from unemployment whereas the right-hand side is the inflow into unemployment. Rearranging terms yields the extended counterpart of (17), namely,

$$u_i^i(\theta) = \frac{\delta + \rho}{p(\theta) + \delta + \rho}\ell(z_i). \tag{A.16}$$

ii. *When* $S(z_j) = S_{p,s}(z_j)$.
The level of general human capital does not change under the current option so that $\ell_i^i(\theta) = \ell(z_i)$. Meanwhile, job separation and retirement are not affected by the specific human capital level, and thus, $u_i^i(\theta)$ is determined by (A.16). Lastly, in a stationary equilibrium, the outflow from and inflow into $s_i^i(\theta)$ must balance each other, namely,

$$(\delta + \rho)\, s_i^i(\theta) = \phi_s \left[\ell(z_i) - u_i^i(\theta) - s_i^i(\theta)\right],$$

from which one can arrive at

$$s_i^i(\theta) = \frac{\phi_s}{\delta + \rho + \phi_s}\left[\ell(z_i) - u_i^i(\theta)\right]. \tag{A.17}$$

iii. *When* $S(z_j) = S_{p,g}(z_j)$.
[To be added]

iv. *When* $S(z_j) = S_{t,n}(z_j)$.
As in the case of $S(z_j) = S_{p,n}(z_j)$, one can recall the argument in the benchmark model to obtain $\ell_i^i(\theta) = \ell(z_i)$, $s_i^i(\theta) = 0$, and

$$u_i^i(\theta) = \frac{\delta + \rho}{[1 - \mathrm{e}^{-(\delta+\rho)\Lambda}]p(\theta) + \delta + \rho}\ell(z_i). \tag{A.18}$$

v. *When* $S(z_j) = S_{t,s}(z_j)$.
Applying a similar argument to the case of $S(z_j) = S_{p,s}(z_j)$, one can conclude that $\ell_i^i(\theta) = \ell(z_i)$, $u_i^i(\theta)$ is given by (A.18), and

$$s_i^i(\theta) = \frac{\phi_s}{\delta + \rho + \phi_s}\left[\ell(z_i) - u_i^i(\theta)\right] - \frac{\mathrm{e}^{-(\delta+\rho)\Lambda}(1 - \mathrm{e}^{-\phi_s\Lambda})}{\delta + \rho + \phi_s}p(\theta)u_i^i(\theta). \tag{A.19}$$

Notice that (A.19) is obtained from the following balance equation:

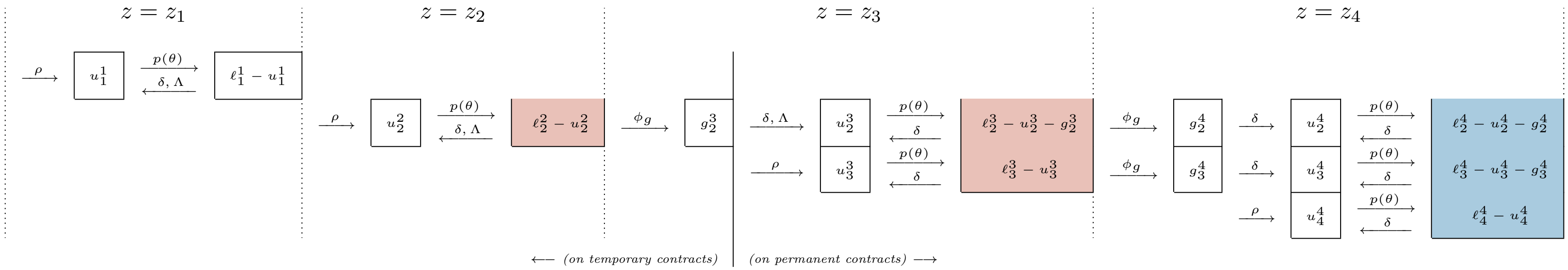
$$(\delta + \rho)\, s_i^i(\theta) + \mathrm{e}^{-(\delta+\rho)\Lambda}(1 - \mathrm{e}^{-\phi_s\Lambda})p(\theta)u_i^i(\theta) = \phi_s \left[\ell(z_i) - u_i^i(\theta) - s_i^i(\theta)\right],$$

where the left-hand and right-hand sides represent the outflow from and inflow into $s_i^i(\theta)$, respectively. In particular, the second term in the left-hand side stands for the outflow from $s_i^i(\theta)$ due to the presence of Λ : Among newly-formed (t, s) matches whose flow is equal to $p(\theta)u_i^i(\theta)$, only a fraction $\mathrm{e}^{-(\delta+\rho)\Lambda}(1-\mathrm{e}^{-\phi_s\Lambda})$ survives until Λ and completes specific training before Λ; however, they are forced to go back to unemployment when their tenure reaches Λ.

vi. *When* $S(z_j) = S_{t,g}(z_j)$.
[To be added]

(H2) *Solving for* $\{\ell_i^j(\theta), u_i^j(\theta), g_i^j(\theta), s_i^j(\theta)\}_{1\leq i<N}^{i<j\leq N}$.
[To be added]

Figure 12: A graphical illustration of the unemployment inflows and outflows when $\mathbb{Z} = \{z_1, z_2, z_3, z_4\}$



Notes: The diagram is drawn for the case where $(z_1, z_2, z_3, z_4) = (z_{t,n}^{t,g}, z_{t,g}^{p,g}, z_{p,g}^{p,s}, z_N)$ and $S(z_N) = S_{p,s}(z_N)$. Workers who are on the red areas receive general training, while those on the blue areas receive specific training. The inflows and outflows related to (s_2^4, s_3^4, s_4^4) are omitted for graphical simplicity.

A.11 Welfare properties of the extended model

In this subsection, I formulate the social planner's problem in the extended model. In the environment of the extended model, the planner chooses the labor market tightness $\theta \in (0, \theta)$ to maximize

$$\sum_{z_i \in \mathbb{Z}} \max \left\{ S^*_{p,n}(z_i,\theta), S^*_{p,s}(z_i,\theta), S^*_{p,g}(z_i,\theta), S^*_{t,n}(z_i,\theta), S^*_{t,s}(z_i,\theta), S^*_{t,g}(z_i,\theta) \right\},$$

where

$$\begin{aligned}
S^*_{p,n}(z_i,\theta) &= \left\{ \ell_i^i(\theta) - u_i^i(\theta) \right\} \{ y_0 z_i - \delta\kappa \} + u_i^i(\theta) b z_i - \theta u_i^i(\theta) c, \\
S^*_{p,s}(z_i,\theta) &= \left\{ \ell_i^i(\theta) - u_i^i(\theta) - s_i^i(\theta) \right\} \{ y_0 z_i - \delta\kappa - \tau_s(z_i) y_0 z_i \} + s_i^i(\theta) \left(y_1 z_i - \delta\kappa \right) + u_i^i(\theta) b z_i - \theta u_i^i(\theta) c, \\
S^*_{p,g}(z_i,\theta) &= \left\{ \ell_i^i(\theta) - u_i^i(\theta) \right\} \{ y_0 z_i - \delta\kappa - \tau_g(z_i) y_0 z_i \} + u_i^i(\theta) b z_i - \theta u_i^i(\theta) c + \mathbb{1}_{\{i < |\mathbb{Z}|\}} \times \\
&\left[g_i^{i+1}(\theta) \left(y_0 z_{i+1} - \delta\kappa \right) + \left\{ \sum_{k \geq i+1} \ell_{i+1}^k(\theta) \right\}^{-1} \left\{ \sum_{k \geq i} \ell_i^k(\theta) - \ell_i^i(\theta) - g_i^{i+1}(\theta) \right\} S^*(z_{i+1},\theta) \right], \\
S^*_{t,n}(z_i,\theta) &= \left\{ \ell_i^i(\theta) - u_i^i(\theta) \right\} y_0 z_i + u_i^i(\theta) b z_i - \theta u_i^i(\theta) c, \\
S^*_{t,s}(z_i,\theta) &= \left\{ \ell_i^i(\theta) - u_i^i(\theta) - s_i^i(\theta) \right\} \{ y_0 z_i - \tau_s(z_i) y_0 z_i \} + s_i^i(\theta) y_1 z_i + u_i^i(\theta) b z_i - \theta u_i^i(\theta) c, \\
S^*_{t,g}(z_i,\theta) &= \left\{ \ell_i^i(\theta) - u_i^i(\theta) \right\} \{ y_0 z_i - \tau_g(z_i) y_0 z_i \} + u_i^i(\theta) b z_i - \theta u_i^i(\theta) c + \mathbb{1}_{\{i < |\mathbb{Z}|\}} \times \\
&\left[g_i^{i+1}(\theta) y_0 z_{i+1} + \left\{ \sum_{k \geq i+1} \ell_{i+1}^k(\theta) \right\}^{-1} \left\{ \sum_{k \geq i} \ell_i^k(\theta) - \ell_i^i(\theta) - g_i^{i+1}(\theta) \right\} S^*(z_{i+1},\theta) \right],
\end{aligned}$$

subject to the stationary transition equations described in Appendix A.10. [To be added]

B Additional Material - Quantitative Part

B.1 Descriptive statistics for the KLIPS

Table 6: Descriptive statistics for the KLIPS-9

	(1) All employees	(2) Permanent	(3) Temporary
Highest level of education			
Primary	609 (18.0)	384 (11.4)	225 (6.7)
Secondary	1,357 (40.2)	1,072 (31.7)	285 (8.4)
Tertiary	1,411 (41.8)	1,311 (38.8)	100 (3.0)
Age			
16 to 29	819 (24.3)	686 (20.3)	133 (3.9)
30 to 55	2,325 (68.9)	1,926 (57.0)	399 (11.8)
56 to 65	233 (6.9)	155 (4.6)	78 (2.3)
Gender			
Male	2,070 (61.3)	1,746 (51.7)	324 (9.6)
Female	1,307 (38.7)	1,021 (30.2)	286 (8.5)
Marital status			
Married	2,195 (65.0)	1,796 (53.2)	399 (11.8)
Not married	1,182 (35.0)	971 (28.8)	211 (6.3)
On-the-job training			
Received	524 (15.5)	478 (14.2)	46 (1.4)
Not received	2,853 (84.5)	2,289 (67.8)	564 (16.7)
Presence of labor union			
Present	681 (20.2)	622 (18.4)	59 (1.8)
Not present	2,696 (79.8)	2,145 (63.5)	551 (16.3)
The total number of employees			
1 to 9	1,004 (29.7)	706 (20.9)	298 (8.8)
10 to 99	1,101 (32.6)	934 (27.7)	167 (5.0)
100 or above	1,272 (37.7)	1,127 (33.4)	145 (4.3)
Occupation			
Managers and professionals	836 (24.8)	776 (23.0)	60 (1.8)
Clerks	745 (22.1)	685 (20.3)	60 (1.8)
Service or sales workers	449 (13.3)	314 (9.3)	135 (4.0)
Elementary occupations	359 (10.6)	206 (6.1)	153 (4.5)
All other occupations	988 (29.3)	786 (23.3)	202 (6.0)
Industry			
Agriculture/forestry/fishing and construction	337 (10.0)	183 (5.4)	154 (4.6)
Extractive and manufacturing	984 (29.1)	884 (26.2)	100 (3.0)
Electricity/gas/water supply	18 (0.5)	17 (0.5)	1 (0.0)
Trade, hotels, and restaurants	633 (18.7)	467 (13.8)	166 (4.9)
Transportation and communication	228 (6.8)	206 (6.1)	22 (0.7)
Financial/insurance/real estate activities	245 (7.3)	219 (6.5)	26 (0.8)
Public service activities	932 (27.6)	791 (23.4)	141 (4.2)

Notes: The table reports the number of employees by personal and job characteristics (with percentages in parentheses), using the 9th wave of KLIPS (KLIPS-9, corresponding to the 2006 survey). The sample size is 3,377, 18.1% (81.9%) of which are classified as temporary (permanent, respectively) employees. Column (1) includes all employees; only permanent and temporary employees are counted in columns (2) and (3), respectively. *On-the-job training* is recorded as "Received" if the individual has received on-the-job training at least once during the past twelve months and "Not received" otherwise. *Occupation* and *Industry* are categorized according to the 5th Korean Standard Classification of Occupations (KSCO) and the 8th Korean Standard Industrial Classification (KSIC), respectively.

B.2 Reduced-form analysis

Table 7: Determinants of temporary employment, 2006 (KLIPS)

	(1)	(2)	(3)	(4)	(5)
Constant	−0.337***	−0.430***	−0.182**	0.089	0.840***
	(0.051)	(0.080)	(0.086)	(0.104)	(0.130)
Highest level of education					
Secondary education	−0.488***	−0.472***	−0.436***	−0.305***	−0.293***
	(0.063)	(0.068)	(0.069)	(0.072)	(0.075)
Tertiary education	−1.133***	−1.126***	−1.019***	−0.686***	−0.734***
	(0.071)	(0.078)	(0.080)	(0.092)	(0.096)
Age					
16 to 29		0.138*	0.139*	0.211***	0.227***
		(0.076)	(0.077)	(0.079)	(0.081)
56 to 65		0.195**	0.226**	0.127	0.088
		(0.094)	(0.095)	(0.097)	(0.103)
Gender					
Female		0.159***	0.119**	0.138**	0.291***
		(0.053)	(0.054)	(0.059)	(0.063)
Marital status					
Married		−0.047	−0.019	0.019	0.011
		(0.065)	(0.066)	(0.067)	(0.070)
Presence of labor union					
Present			−0.294***	−0.218**	−0.069
			(0.089)	(0.091)	(0.096)
The total number of employees					
10 to 99			−0.431***	−0.394***	−0.326***
			(0.064)	(0.066)	(0.069)
100 or above			−0.365***	−0.345***	−0.223***
			(0.074)	(0.076)	(0.079)
Occupation					
Managers and professionals				−0.839***	−0.877***
				(0.106)	(0.112)
Clerks				−0.838***	−0.877***
				(0.106)	(0.110)
Service or sales workers				−0.310***	−0.344***
				(0.097)	(0.104)
All other occupations				−0.453***	−0.428***
				(0.084)	(0.095)
Industry					
Extractive and manufacturing					−1.286***
					(0.097)
Electricity/gas/water supply					−0.897**
					(0.448)
Trade, hotels, and restaurants					−0.838***
					(0.112)
Transportation and communication					−1.287***
					(0.148)
Financial/insurance/real estate activities					−1.093***
					(0.141)
Public service activities					−0.832***
					(0.101)
No. obs.	3,484	3,484	3,484	3,484	3,484
Pseudo-R^2	0.084	0.091	0.116	0.143	0.203

Notes: The table reports estimation results from a probit model whose dependent variable (*Temporary*) is equal to one if the individual holds a temporary contract and zero otherwise. Among all 3,484 dependent workers surveyed in 2006 (corresponding to the 9th wave of KLIPS), 625 workers (17.9%) are classified as temporary employees. All the independent variables used are dummies. The dummies for *Occupation* are relative to "Elementary occupations" while the baseline dummy for *Industry* is "Agriculture/forestry/fishing and construction." The *Occupation* and *Industry* categories are constructed according to the 5th KSCO and the 8th KSIC, respectively. Standard errors are reported in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 8: Determinants of receiving on-the-job training, 2006 (KLIPS)

	(1)	(2)	(3)	(4)	(5)
Constant	−0.943***	−1.351***	−1.509***	−1.699***	−2.090***
	(0.028)	(0.080)	(0.107)	(0.075)	(0.133)
Contract type					
Temporary contract	−0.494***	−0.330***	−0.295***	−0.250***	−0.126
	(0.080)	(0.084)	(0.084)	(0.086)	(0.090)
Highest level of education					
Secondary education		0.264***	0.258***		0.188*
		(0.089)	(0.094)		(0.101)
Tertiary education		0.596***	0.603***		0.421***
		(0.088)	(0.094)		(0.102)
Age					
16 to 29			0.044		0.101
			(0.078)		(0.084)
56 to 65			−0.114		−0.097
			(0.127)		(0.133)
Gender					
Female			−0.185***		−0.092
			(0.059)		(0.062)
Marital status					
Married			0.316***		0.240***
			(0.070)		(0.075)
Presence of labor union					
Present				0.217***	0.202***
				(0.074)	(0.075)
The total number of employees					
10 to 99				0.305***	0.281***
				(0.087)	(0.089)
100 or above				0.903***	0.844***
				(0.087)	(0.088)
Sector by ownership					
Public sector				0.289**	0.254**
				(0.117)	(0.118)
Job tenure					
(continuous, in years)				0.019***	0.018***
				(0.005)	(0.005)
No. obs.	3,375	3,375	3,375	3,375	3,375
Pseudo-R^2	0.014	0.036	0.050	0.129	0.143

Notes: The table reports estimation results from a probit model whose dependent variable (*On-the-job training*) takes the value of one if the individual has received on-the-job training at least once during the previous twelve months and zero otherwise. Among all 3,375 dependent workers surveyed in 2006 (corresponding to the 9th wave of KLIPS), 524 workers (15.5%) are classified as those with *On-the-job training* = 1 while 610 workers (18.1%) as temporary employees. All the independent variables are dummies, except for *Job tenure* that is a continuous variable expressed in years. Standard errors are reported in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

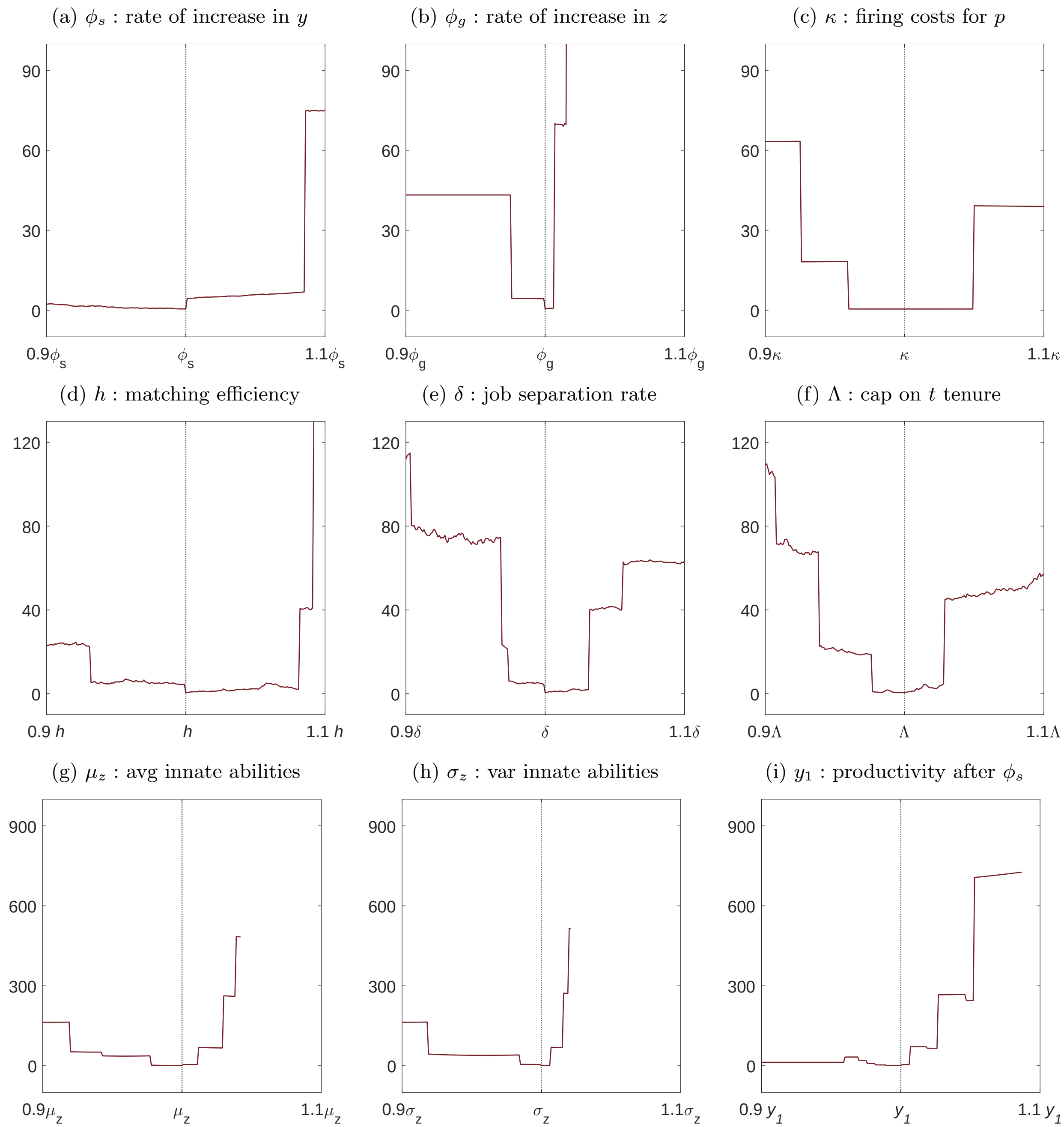
Table 9: Determinants of conversion from temporary to permanent employment, 2006-2016 (KLIPS)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	−1.238***	−0.928***	−0.783***	−0.712***	−0.700***	−0.556***	−0.432***	−0.328**
	(0.092)	(0.086)	(0.089)	(0.096)	(0.106)	(0.116)	(0.136)	(0.161)
Training experience								
(extensive margin)	0.038	0.056	0.055	0.189**	0.255**	0.255**	0.190	0.117
	(0.087)	(0.083)	(0.087)	(0.092)	(0.101)	(0.112)	(0.132)	(0.153)
Highest level of education								
Secondary education	0.249***	0.236***	0.242***	0.234***	0.267***	0.266***	0.266***	0.271**
	(0.068)	(0.062)	(0.064)	(0.069)	(0.075)	(0.084)	(0.099)	(0.115)
Tertiary education	0.353***	0.321***	0.335***	0.500***	0.549***	0.582***	0.787***	0.918***
	(0.093)	(0.089)	(0.094)	(0.101)	(0.114)	(0.129)	(0.154)	(0.185)
Age								
16 to 29	0.235**	0.293***	0.409***	0.397***	0.636***	0.527***	0.471***	0.583***
	(0.100)	(0.098)	(0.106)	(0.119)	(0.138)	(0.156)	(0.178)	(0.220)
56 to 65	−0.316***	−0.347***	−0.401***	−0.452***	−0.536***	−0.589***	−0.711***	−0.865***
	(0.078)	(0.072)	(0.078)	(0.087)	(0.101)	(0.119)	(0.150)	(0.195)
Marital status								
Married	−0.073	−0.096	−0.094	−0.173**	−0.164**	−0.208**	−0.171	−0.248**
	(0.063)	(0.060)	(0.064)	(0.069)	(0.077)	(0.088)	(0.105)	(0.124)
Presence of labor union								
Present	0.073	0.109	0.214**	0.260**	0.303**	0.359**	0.470***	0.495***
	(0.113)	(0.106)	(0.108)	(0.118)	(0.127)	(0.146)	(0.164)	(0.189)
Occupation								
Managers and professionals	0.079	0.216**	0.279**	0.350***	0.383***	0.356**	0.122	0.374
	(0.104)	(0.101)	(0.108)	(0.121)	(0.138)	(0.157)	(0.191)	(0.239)
Clerks	−0.003	0.139	0.218*	0.265**	0.373***	0.357**	0.447**	0.603***
	(0.115)	(0.110)	(0.115)	(0.126)	(0.142)	(0.160)	(0.183)	(0.219)
Service or sales workers	−0.019	0.044	0.066	0.178**	0.267***	0.175	0.074	0.018
	(0.078)	(0.075)	(0.079)	(0.087)	(0.097)	(0.110)	(0.131)	(0.153)
All other occupations	0.036	0.106	0.072	0.190**	0.226***	0.143	0.035	0.108
	(0.072)	(0.068)	(0.071)	(0.077)	(0.085)	(0.094)	(0.107)	(0.125)
Job tenure								
(continuous, in years)	−0.043***	−0.041***	−0.038***	−0.041***	−0.042***	−0.041***	−0.054***	−0.062***
	(0.007)	(0.006)	(0.006)	(0.007)	(0.008)	(0.009)	(0.011)	(0.014)
No. obs.	4,539	3,739	3,069	2,464	1,965	1,505	1,105	821
Pseudo-R^2	0.058	0.065	0.079	0.099	0.125	0.124	0.147	0.189
Pr(*Temp to perm* = 1)	0.096	0.167	0.215	0.250	0.280	0.298	0.311	0.335
Pr(*Training experience* = 1)	0.098	0.099	0.101	0.105	0.106	0.116	0.119	0.126

Notes: The table reports estimation results from a probit model whose dependent variable (*Temp to perm*) equals one if the temporary worker in the baseline year (2006 to $2017 - y$, corresponding to the 9th to $(20 - y)$-th waves of KLIPS) achieves permanent employment status y years later, with y being equal to 1 in column (1), 2 in column (2), and so on, and zero otherwise. The variable *Training experience* takes the value of one if the temporary worker has received on-the-job training at least once during the previous three years and zero otherwise. The *Occupation* categories are constructed according to the 5th KSCO, and "Elementary occupations" is used as the baseline dummy. All the independent variables are dummies except for *Job tenure,* a continuous variable expressed in years. Standard errors are reported in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

B.3 Additional tables and figures

Figure 13: One-dimensional slices of the objective function for the simulated method of moments



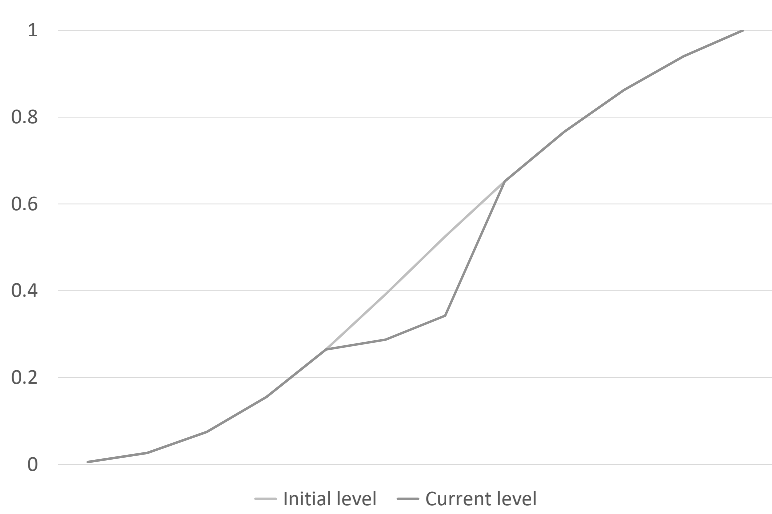
Notes: In each figure, the objective function for estimation (see Section 4.2 for its definition) is evaluated over a range from 10% below to 10% above the estimated value of the parameter of interest, with all the other parameters fixed as estimated. The plot is incomplete in (g)–(i) because the objective function cannot be evaluated on the corresponding interval. The dashed vertical line in the plots indicates where the objective function is minimized; obviously, the line crosses the x-axis at each parameter estimate. The minimized value of the objective function is 0.439.

Table 10: Elasticity of moments with respect to parameters

	ϕ_s	ϕ_g	κ	h	δ	Λ	μ_z	σ_z	y_1
S1.	−0.69	1.83	−1.44	0.82	0.95	−1.44	1.83	1.83	−5.17
S2.	0.00	13.33	−5.05	13.33	−4.93	−5.32	3.57	13.33	0.00
S3.	0.00	−4.04	5.12	1.77	5.14	5.23	−5.96	−4.04	0.00
S4.	0.02	−0.20	0.12	−0.27	−0.15	0.26	−0.05	−0.20	0.10
S5.	−0.17	13.33	1.87	13.33	−21.12	1.86	−3.10	13.33	−0.41
J1.	0.09	0.10	0.19	0.87	0.32	0.11	0.21	0.10	0.58
J2.	0.13	−0.10	−0.01	0.08	−0.84	0.01	0.14	−0.10	0.14
J3.	0.00	0.04	0.04	−0.19	−0.07	0.90	0.03	0.04	−0.07
A1.	0.01	−0.12	0.27	0.23	0.30	0.30	0.12	0.30	−0.05
A2.	0.00	−0.64	0.97	0.03	0.87	1.14	−0.03	−0.15	0.01
A3.	0.05	−1.60	1.52	−1.58	1.09	1.33	−0.78	−1.97	0.64

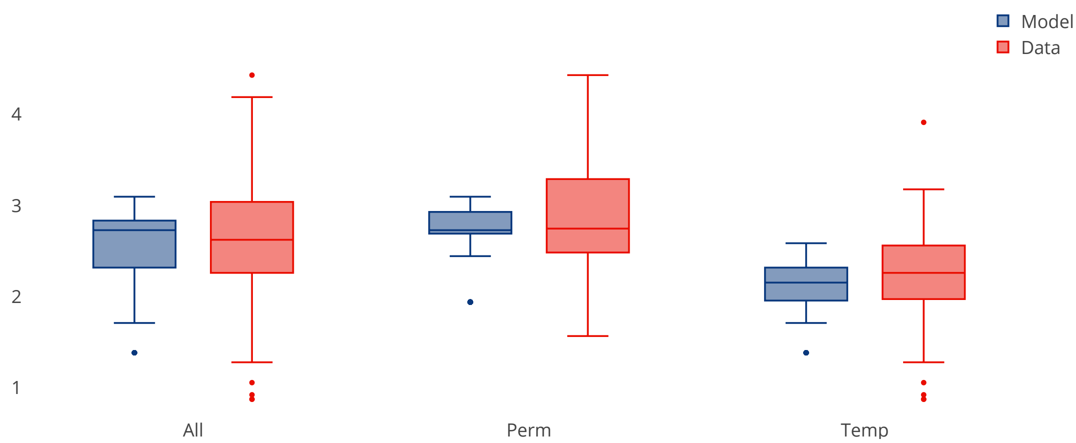
Notes: To obtain the table, a 7.5 percent decrease in the estimated parameter values is postulated. A positive (negative) sign means that a moment moves in the same (opposite) direction as the parameter of interest, that is, the moment decreases (increases) as the parameter of interest decreases. The shaded areas correspond to the heuristic identification argument made in Section 4.2. See Table 2 for descriptions of each moment and each parameter.

Figure 14: Estimated cumulative distribution of general human capital



Notes: The light grey curve represents the estimated cumulative distribution of z_0; the dark grey curve stands for that of z. The area between these two curves indicates that there are some workers who have “upgraded” their general human capital through general training.

Figure 15: Distribution of log wages by contract type



Notes: The mean and variance of log wages for all workers are 2.565 and 0.140, respectively, in the simulated data while 2.560 and 0.364 in the actual data. The variances of log wages for permanent and temporary workers are 0.064 and 0.063, respectively, according to the estimated extended model while their data counterparts are 0.292 and 0.271.

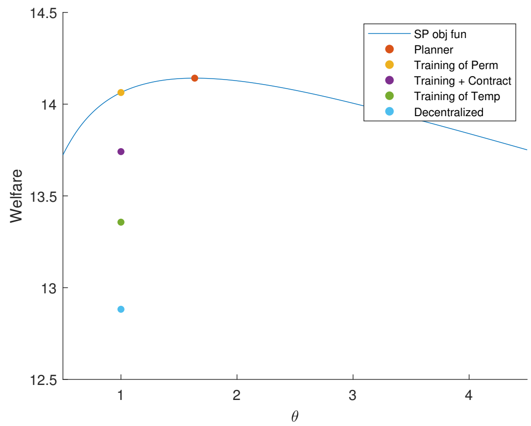
Table 11: Mincer regressions, 2002-2009 (KLIPS)

	(1)	(2)	(3)	(4)	(5)
Constant	2.061***	2.027***	1.914***	1.972***	1.933***
	(0.023)	(0.028)	(0.022)	(0.023)	(0.026)
Highest level of education					
Secondary education	0.335***	0.337***	0.336***	0.346***	0.335***
	(0.021)	(0.021)	(0.019)	(0.019)	(0.019)
Tertiary education	0.711***	0.724***	0.589***	0.592***	0.581***
	(0.023)	(0.024)	(0.021)	(0.022)	(0.022)
Contract type of the first job					
Permanent contract	0.114***	0.100***	0.069***		0.077***
	(0.023)	(0.024)	(0.021)		(0.022)
Years in the labor force					
(continuous, in years)		0.002**		−0.000	−0.001
		(0.001)		(0.001)	(0.001)
Job tenure					
(continuous, in years)			0.043***	0.044***	0.044***
			(0.002)	(0.002)	(0.002)
No. obs.	3,477	3,477	3,477	3,477	3,477
Adjusted R^2	0.228	0.229	0.371	0.369	0.371

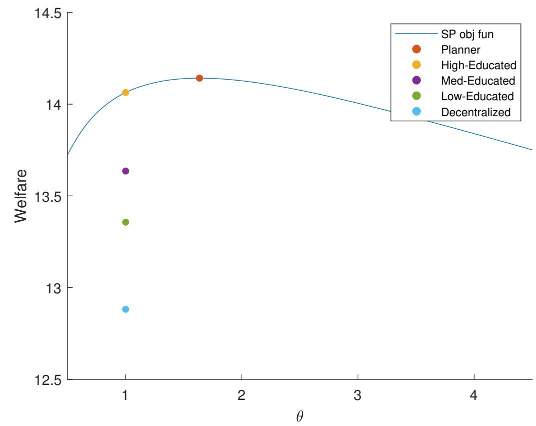
Notes: The sample consists of 3,477 female workers who were aged between 30 and 65 in 2006 (corresponding to the 9th wave of KLIPS). Their log wages observed from 2002 to 2009, with the outliers (the top one, bottom five, and top ten percent for the low, medium, and high educated groups, respectively) removed, are regressed on a set of explanatory variables. The variables *Highest level of education* and *Contract type of the first job* are dummies whereas *Years in the labor force* and *Job tenure* are continuous variables expressed in years. Column (2) is the model presented in the top panel of Table 3. Standard errors are reported in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Figure 16: Decomposition of inefficiency on the Pareto set

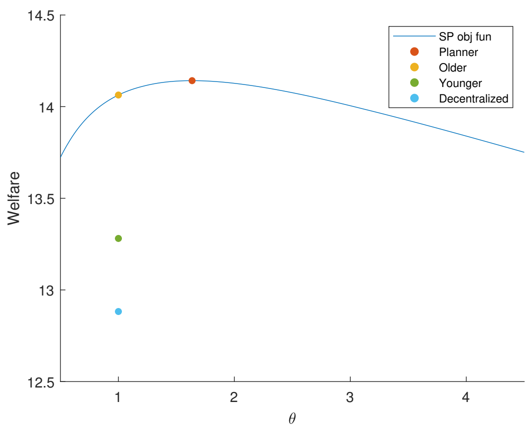
(a) Decomposition by sources



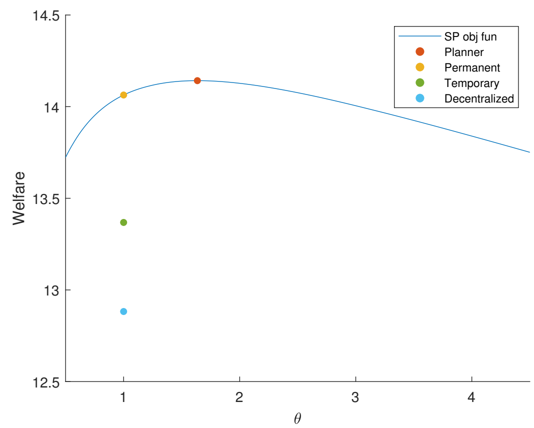
(b) Decomposition by education groups



(c) Decomposition by age groups



(d) Decomposition by contract types



Notes: In all figures, the red, orange, and light blue dots, respectively, correspond to those in Figure 5. The gaps between the green and light blue dots, between the purple and green dots, and between the orange and purple dots correspond to "training of temporary," "training + contract," and "training of permanent," respectively, in Figure 7.(a). A similar relationship can be established for (b)–(d). For the proportion of inefficiency that is explained by each source, education group, age group, and contract type, see the numbers in Figure 7.

Table 12: Mincer regressions for counterfactual analysis 1

	Const	High sch	College	Yrs in LF	1st cont
A. *Laissez-faire*					
Log wage	2.085	0.366	0.640	0.001	0.138
(a) z inborn	0.445	0.321	0.586	0.000	0.183
(b) z accumulated	-0.007	0.192	0.142	0.000	-0.142
(c) y initial	1.792	-	-	-	-
(d) y accumulated	-0.008	0.035	0.049	0.000	0.028
(e) hours worked	-0.018	-0.156	-0.119	0.001	0.056
(f) residual	-0.118	-0.025	-0.019	0.000	0.012
B. 5% cut in τ					
Log wage	2.043	0.332	0.609	0.004	0.135
(a) z inborn	0.442	0.324	0.590	0.000	0.182
(b) z accumulated	0.301	-0.156	-0.205	0.001	-0.139
(c) y initial	1.792	-	-	-	-
(d) y accumulated	0.003	0.018	0.032	0.000	0.027
(e) hours worked	-0.327	0.126	0.164	0.002	0.053
(f) residual	-0.167	0.019	0.027	0.000	0.012
C. 25% cut in τ					
Log wage	2.095	0.356	0.529	0.005	0.147
(a) z inborn	0.439	0.390	0.599	0.000	0.174
(b) z accumulated	0.314	-0.166	-0.280	0.003	-0.088
(c) y initial	1.792	-	-	-	-
(d) y accumulated	-0.012	0.010	0.048	0.001	0.014
(e) hours worked	-0.251	0.091	0.122	0.001	0.038
(f) residual	-0.186	0.031	0.040	0.000	0.010
D. 50% cut in τ					
Log wage	2.158	0.385	0.563	0.006	0.114
(a) z inborn	0.434	0.451	0.667	0.000	0.161
(b) z accumulated	0.289	-0.162	-0.241	0.004	-0.099
(c) y initial	1.792	-	-	-	-
(d) y accumulated	-0.016	0.007	0.020	0.001	0.026
(e) hours worked	-0.161	0.058	0.080	0.001	0.019
(f) residual	-0.181	0.031	0.037	0.000	0.007
E. Planner					
Log wage	1.950	0.464	0.703	0.008	0.144
(a) z inborn	0.442	0.444	0.706	0.000	0.164
(b) z accumulated	0.285	-0.158	-0.256	0.004	-0.120
(c) y initial	1.792	-	-	-	-
(d) y accumulated	-0.017	0.009	0.026	0.001	0.032
(e) hours worked	-0.394	0.148	0.202	0.002	0.057
(f) residual	-0.158	0.020	0.025	0.000	0.012

Notes: Panels A to E above correspond to columns (1) to (5) in Table 4, respectively. Panel A, which is identical to the bottom panel of Table 3, is included for easier comparison across all scenarios.

Table 13: Mincer regressions for counterfactual analysis 2

	Const	High sch	College	Yrs in LF	1st cont
A. *Laissez-faire*					
Log wage	2.085	0.366	0.640	0.001	0.138
(a) z inborn	0.445	0.321	0.586	0.000	0.183
(b) z accumulated	−0.007	0.192	0.142	0.000	−0.142
(c) y initial	1.792	-	-	-	-
(d) y accumulated	−0.008	0.035	0.049	0.000	0.028
(e) hours worked	−0.018	−0.156	−0.119	0.001	0.056
(f) residual	−0.118	−0.025	−0.019	0.000	0.012
B. 5% cut in κ					
Log wage	2.087	0.367	0.639	0.001	0.138
(a) z inborn	0.446	0.319	0.585	0.000	0.183
(b) z accumulated	−0.007	0.192	0.143	0.000	−0.142
(c) y initial	1.792	-	-	-	-
(d) y accumulated	−0.008	0.035	0.049	0.000	0.028
(e) hours worked	−0.018	−0.156	−0.119	0.001	0.056
(f) residual	−0.118	−0.024	−0.018	0.000	0.013
C. 25% cut in κ					
Log wage	1.918	0.193	0.522	0.003	0.384
(a) z inborn	0.313	0.266	0.592	0.000	0.310
(b) z accumulated	0.158	−0.162	−0.253	0.001	0.066
(c) y initial	1.792	-	-	-	-
(d) y accumulated	−0.005	0.033	0.058	0.000	0.012
(e) hours worked	−0.189	0.032	0.089	0.001	0.003
(f) residual	−0.151	0.025	0.036	0.000	−0.006
D. 50% cut in κ					
Log wage	1.597	0.361	0.687	0.003	0.529
(a) z inborn	−0.086	0.398	0.725	0.000	0.574
(b) z accumulated	0.352	−0.204	−0.294	0.001	−0.098
(c) y initial	1.792	-	-	-	-
(d) y accumulated	−0.011	0.037	0.062	0.000	0.012
(e) hours worked	−0.262	0.087	0.144	0.001	0.014
(f) residual	−0.189	0.043	0.050	0.000	0.026
E. Planner					
Log wage	1.950	0.464	0.703	0.008	0.144
(a) z inborn	0.442	0.444	0.706	0.000	0.164
(b) z accumulated	0.285	−0.158	−0.256	0.004	−0.120
(c) y initial	1.792	-	-	-	-
(d) y accumulated	−0.017	0.009	0.026	0.001	0.032
(e) hours worked	−0.394	0.148	0.202	0.002	0.057
(f) residual	−0.158	0.020	0.025	0.000	0.012

Notes: Panels A to E above correspond to columns (1) to (5) in Table 5, respectively. Panel A, which is identical to the bottom panel of Table 3, is included for easier comparison across all scenarios.