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IZA DP No. 18219

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ISSN: 2365-9793

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ABSTRACT

Recession and Resilience: Labor Market Consequences of Starting College in a Bad Economy*

This study examines the impact of economic conditions at college entry on post-graduation labor market outcomes, focusing on behavioral responses related to job market preparation and career advancement. Exploiting variation in regional unemployment rates within college entry cohorts, we utilize the large and unexpected recession triggered by the Asian Financial Crisis in South Korea as a natural experiment. Using data from the Korean Labor and Income Panel Study, we find that individuals who begin their undergraduate studies under more adverse economic conditions exhibit higher employment probabilities and earnings during the first decade after graduation. Further analysis of activities during college and early career stages indicates that the improved labor market outcomes are driven by greater effort devoted to education, training, and job search aimed at enhancing employment prospects. To explain these behavioral responses, we develop a theoretical framework based on the concept of ambiguity aversion.

JEL Classification: E32, J24, I23, D81

Keywords: economic crisis, college entrants, labor market outcomes, ambiguity aversion

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* We thank Songman Kang, Jinyoung Kim, John Kim, Hitoshi Shigeoka, Jungmo Yoon, and seminar and conference participants at AASLE, Asia-Pacific Symposium on Economics and Finance, Hanyang University, KAAE, KEA, KLEA, Seoul Labor Economics Working Group–Bank of Korea Joint Seminar, and WEAI for helpful comments and discussions. Choi acknowledges financial support from Hanyang University (HY-202400000003800). All errors are our own.

1 Introduction

There is increasing concern that many economies could enter a recession in the coming years. Economic downturns pose significant challenges for young workers who are particularly vulnerable to adverse labor market conditions. A large body of research documents the lasting negative effects of recessions on young workers' careers, such as prolonged unemployment and lower earnings, as well as broader impacts on wealth accumulation and other life outcomes (see Dettling (2016) and von Wachter (2020) for an overview of this literature). However, while much of the existing research emphasizes these long-term negative consequences, relatively less attention has been given to how individuals adapt their behavior to navigate and cope with such adverse conditions.

This paper studies how economic conditions encountered during the first year of college affect post-graduation labor market outcomes, with particular attention paid to behavioral responses related to job market preparation and career advancement. Exploiting variation in regional unemployment rates within college entry cohorts, we use the large and unexpected recession triggered by the Asian Financial Crisis (AFC) in South Korea as a natural experiment. The AFC produced the country's most severe downturn since the 1950–53 Korean War, which lasted from Q4 1997 to Q1 1999. The recession was not only unprecedented in scale but also unexpected given the strong macroeconomic indicators prevailing until mid-1997. The identifying assumption is that within-cohort differences in outcomes across regions differentially affected by the recession are attributable to economic conditions at college entry, rather than other confounding factors. We conduct a range of internal validity checks that support the plausibility of this assumption.

Using data from the first 25 waves of the Korean Labor and Income Panel Study (KLIPS), we analyze a nationally representative sample of college graduates who entered two- or four-year colleges between 1989 and 2006. We find that college graduates exposed to more adverse economic conditions at entry exhibit higher employment probabilities and earnings during the first decade after graduation. The effect is sizable: a 1%p increase in the regional unemployment rate during the freshman year of college raises the employment probability by 0.9%p (1.2% relative to the mean) and increases monthly real earnings by 25,000 South Korean won (1.4% relative to the mean). The results of multiple internal validity checks indicate that these effects are not driven by positive selection into college entry or completion, nor by improvements in labor market conditions

at graduation. While earnings conditional on employment are unaffected, the higher employment rates of graduates who began college under worse economic conditions do not come at the expense of job quality. We find no evidence of deterioration in job characteristics—measured by full-time employment, self-employment, occupation type, firm size, and job satisfaction—or of mismatches in education or skills.

We further investigate the channels underlying the improved labor market outcomes of college graduates who faced more adverse economic conditions in the first year of their undergraduate studies. The mediation analyses show that occupation and industry choices account for up to 46% of the gains in employment probability and earnings. Additionally, college entrants in regions with higher unemployment rates respond by acquiring additional certificates, switching to STEM majors, or intensifying their job search efforts. Taken together, these results suggest that individuals who face worse economic conditions at the start of college exert greater effort to prepare for the labor market, enabling them to better navigate uncertainty and expand their job opportunities.

To explain why adverse economic conditions at college entry lead to increased effort, we develop a simple model of optimal effort under ambiguity aversion. Building on the Maxmin Expected Utility framework of Gilboa and Schmeidler (1989), our model considers how individuals make decisions when the distribution of labor market tightness is unknown. Under normal circumstances, individuals form probabilistic beliefs about market tightness and choose their optimal level of effort accordingly. In contrast, during a crisis, ambiguity about market tightness leads individuals to evaluate outcomes based on the worst-case scenario, which induces greater effort. This mechanism explains why students who face higher unemployment rates at college entry acquire additional certificates and engage in more intensive job search activities, thereby improving their employment probabilities and earnings.

This study contributes to three strands of literature. First, our findings extend the literature on the long-term labor market consequences of recessions for young, college-educated job candidates. While extensive research documents the long-term penalties of graduating during a recession (e.g., Kahn, 2010; Oreopoulos et al., 2012; Altonji et al., 2016; Schwandt and von Wachter, 2019; Rothstein, 2023),[1] far less is known about how economic conditions at college entry shape later labor

[1]See von Wachter (2020) for an overview of the "scarring effects" literature. Choi et al. (2020) analyze the long-term impact of graduating from college during the AFC in South Korea.

market outcomes. Among the few prior studies in this area, the most closely related are Bičáková et al. (2021, 2023), which document wage gains for college graduates who enrolled during recessions in the UK and the US.[2] Our results complement these studies by revealing the larger effects on labor market attachment and earnings in the context of an unprecedented, large-scale recession in South Korea. By providing direct evidence of effort adjustment and introducing a theoretical framework of ambiguity aversion, we extend the prior work and clarify the mechanisms through which adverse economic conditions at college entry translate into improved later outcomes.

Second, our findings contribute to the broader literature on effort responses to adverse conditions that transform negative shocks into long-term improvements. Prior studies document such behavioral adjustments across diverse settings: productivity gains within a firm during recessions driven by increased worker effort (Lazear et al., 2016); countercyclical job-search intensity that lowers unemployment and stabilizes labor market fluctuations (Mukoyama et al., 2018); enrollment in community colleges for retraining among unemployed workers, yielding later earnings gains (Leung and Pei, 2023); the development of non-cognitive skills and resilience among Ethiopian youth following adverse weather shocks (Wantchekon and Zhang, 2024); and greater pre-marital educational investment in unfavorable marriage markets that enhances spouse quality (Lafortune, 2013). We extend this literature by providing new evidence of an effort-induced resilience channel, showing that students who began college under more adverse economic conditions during the AFC responded with greater preparatory effort—through certification, field choice, and job-search intensity—and thereby achieved stronger long-term employment outcomes.

Lastly, our study is among the few to apply ambiguity aversion to labor market behavior. Since Ellsberg (1961) introduced the concept of ambiguity aversion and Gilboa and Schmeidler (1989) formalized it through the Maxmin Expected Utility model, this concept has been actively applied in macroeconomics and finance (see Ilut and Schneider (2023) for a review). In contrast, its application to the labor market remains limited. A recent exception is Chan and Yip (2023), who incorporate ambiguity aversion into the Diamond-Mortensen-Pissarides-type search model and show that ambiguity-averse workers lower their reservation wages, thereby accelerating job acceptance and reducing unemployment. Since we find no empirical evidence of a decline in job quality, we

[2] In addition, Blom et al. (2021) show that US college students exposed to high unemployment shift toward majors with higher wages and better employment prospects, leading to earnings gains after graduation.

focus on job market preparation and examine how ambiguity aversion shapes preparatory efforts, such as human capital investment and job search intensity, which enhance employability.

2 Background

The 1997–98 Asian Financial Crisis triggered the most severe economic downturn in South Korea since the Korean War. The crisis began with the sudden collapse of the Thai baht in July 1997, which sparked a reversal of capital inflows across East and Southeast Asia. South Korea was especially vulnerable because of its heavy reliance on short-term foreign borrowing. As investor confidence evaporated and foreign creditors refused to roll over loans, foreign reserves dwindled, ultimately forcing the government to accept a 60 billion USD bailout package from the International Monetary Fund in November 1997 (Eichengreen, 1999). Within months, the South Korean won (KRW) lost nearly half its value, and the stock market index fell by 50%. The crisis spread rapidly beyond the financial sector. By early 1998, the economy had contracted sharply: real GDP growth dropped from 4.2% in Q4 1997 to −7.3% in Q2 1998, while the unemployment rate more than tripled from 2.6% in Q4 1997 to a peak of 8.5% in Q1 1999 (Figure S2).

The AFC-induced recession in South Korea provides a quasi-experimental setting with multiple advantages for causal identification. First, the shock was not only large in scale but also unexpected, as pre-crisis indicators—such as sustained GDP growth, stable inflation, and low public debt—pointed to solid fundamentals in the South Korean economy (Baliño and Ubide, 1999; Barnes et al., 2003). Second, the AFC delivered a sharp, one-time disruption that facilitates a clear distinction between crisis and non-crisis cohorts. Before the crisis, South Korea had achieved an economic miracle, sustaining an average annual GDP growth of approximately 8% over three decades (Lee, 1998; Radelet and Sachs, 2000). After a rapid recovery from the crisis, economic conditions stabilized from 2000 onward, and labor market performance remained largely unaffected even during the Great Recession (Lee, 2017). Third, the severity of the recession varied considerably across regions due to differences in industrial structure. In 1998 (1999), regional unemployment rates ranged from 3.5% (3.9%) to 8.9% (9.0%) (Figure S3). Labor market distress was most severe in the Southeast, specializing in automobiles and labor-intensive manufacturing, and in the Seoul metropolitan area in the Northwest, characterized by a high concentration of subcontracting small-

and medium-sized enterprises (SMEs).

Massive layoffs and restructuring at both large firms and SMEs displaced over 1.4 million workers by 1999 (Cho and Keum, 2004). Young workers and first-time job seekers were particularly hard hit as job openings dried up. In 1997, eleven of the fifty largest conglomerates collapsed, and ten more faced bankruptcy (Lee, 1998). SME bankruptcies nearly doubled, from 11,600 in 1996 to 22,800 in 1998 (Gregory et al., 2002). Consequently, 33 of the largest conglomerates suspended hiring, job fairs were canceled, and few new positions opened, heightening labor market uncertainty (Dong-A Ilbo, 1998; Korea Economic Daily, 1998; Maeil Business Newspaper, 1998). In 1998–99, the unemployment rate for 20–29 year olds exceeded 10%, about 4%p above the overall unemployment rate (Figure S2).

3 Data and Empirical Strategy

3.1 Data and Analysis Sample

We construct our analysis sample using data from the first 25 waves of the Korean Labor and Income Panel Study (KLIPS). The KLIPS is a longitudinal survey of representative urban households in South Korea conducted annually since 1998. Its panel structure allows us to track each individual's labor market activities over time, including employment, earnings, and job characteristics. The data also include detailed information on education, training, and job search activities. The analysis sample comprises college graduates who enrolled in two- or four-year colleges between 1989 and 2006 and completed their degrees between the ages of 20 and 32. The sample includes 3,959 individuals and 21,809 person-year observations. To ensure comparability of early career outcomes across cohorts, we restrict the analysis of labor market outcomes to the first ten years of potential experience.[3]

We use regional unemployment rates from 1989 to 2006 as the main treatment variable.[4] Regional unemployment rates are calculated from labor force statistics at the regional level, including

[3]The KLIPS person survey data used in our main analysis do not capture early career outcomes for individuals who graduated before 1998. However, Appendix S1 shows, our results remain unchanged when we incorporate retrospective employment and earnings information from work history records.

[4]Regions are the major administrative divisions comprising nine provinces (Gyeonggi, Gangwon, North Chungcheong, South Chungcheong, North Jeolla, South Jeolla, North Gyeongsang, South Gyeongsang, and Jeju) and seven metropolitan cities (Seoul, Busan, Daegu, Incheon, Gwangju, Daejeon, and Ulsan).

the working-age population, the employment-to-population ratio, and the size of the labor force. These labor market indicators are produced and published by Statistics Korea, using data from the Economically Active Population Survey. We link regional unemployment rates to our KLIPS sample based on the year of college entry and the location of the college. Table S1 presents summary statistics of the key variables used in the analysis.

3.2 Empirical Strategy

We estimate the effect of labor market conditions at college entry on post-graduation outcomes using a regression model similar to the standard empirical strategy in the scarring effects literature. However, we exploit regional variation within cohorts of entrants rather than graduates. Our baseline specification is given by:

$$y_{it} = \beta UR_{cr} + \mathbf{X}_i'\boldsymbol{\gamma} + f(c) + \delta_r + \lambda_a + \phi_t + \varepsilon_{it}, \tag{1}$$

where y_{it} is the labor market outcome of person i (who entered college in region r and year c) in calendar year t. UR_{cr} denotes the unemployment rate in college entry year c and region r, representing the economic conditions individuals face during their first year of college. The region is determined by the location of the college attended by the individual. A vector of person i's predetermined characteristics $\mathbf{X}_i$ controls for demographic characteristics and family background, such as sex, type of college attended (two- vs. four-year), father's education level, and parents' job status at age 14. $f(c)$ is a cubic function of college entry year c (i.e., entry cohort), which captures the smooth national trend in economic conditions at college entry and baseline ability across cohorts.[5] The regression also includes fixed effects for college region (δ_r), individuals' age a in year t (λ_a), and calendar year (ϕ_t).[6] ε_{it} is the error term representing the remaining unobserved determinants of the outcome. The standard errors are clustered at the cohort-by-region level to align with the variation in the main treatment variable UR_{cr}, following Abadie et al. (2023).

[5] We do not include mother's education in the regression because it is missing for 15.5% of individuals in our analysis sample, as the KLIPS began collecting this information in wave 4.

[6] A perfect multicollinearity problem arises when college graduation year, calendar year, and years of potential experience are included in the regression without imposing a restriction (Deaton, 1997). However, a regression using college entry year is not prone to this issue because individuals entering college in the same year do not necessarily graduate in the same year. Additionally, we use age fixed effects instead of fixed effects for years of potential experience. The results are similar when we use potential experience fixed effects instead of age fixed effects in the regression analysis.

When analyzing educational outcomes, we modify the regression model as follows because they are cumulative and measured at a single point during or after college, unlike time-varying labor market outcomes observed at multiple points:

$$y_i = \beta UR_{cr} + \mathbf{X}_i'\boldsymbol{\gamma} + f(c) + \delta_r + \varepsilon_i. \tag{2}$$

In both specifications (1) and (2), the key parameter is β, which measures the effect of a 1%p increase in the regional unemployment rate at college entry on the outcome variable. Controlling for both entry year and region, our empirical strategy exploits variation across individuals who entered college in the same year but faced different regional economic conditions. Following Choi et al. (2020), we capture cohort trends with a polynomial function $f(c)$ rather than fixed effects for college entry year because regional unemployment rates in South Korea exhibit nearly parallel secular movements (Figure S4). Using entry year fixed effects would absorb much of the identifying variation in UR_{cr}, including the sharp increase during the AFC. Identification thus relies on deviations from smooth long-term cohort trends in regional unemployment rates, largely driven by the unexpected occurrence of the AFC.[7] The key identifying assumption is that within-cohort differences in labor market and educational outcomes across regions are attributable to economic conditions at college entry, rather than to other confounding factors.

We use the regional unemployment rate as the main treatment variable because it reflects the local economic conditions that students directly face upon entering college. However, as noted by Choi et al. (2020), national economic conditions may be more relevant for college-educated workers, since South Korea is geographically comparable in size to the US state of Indiana, and jobs for college graduates are concentrated in a few metropolitan areas. In Figure S5, the estimates are similar when we use the national unemployment rate at college entry as the main treatment variable, exploiting variation across cohorts at the national level instead of within-cohort regional differences. The results are also robust to alternative definitions of labor market conditions, such as regional or national unemployment rates for young workers aged 25–29.

[7] In Appendix S1, we conduct placebo exercises that demonstrate the AFC is the primary source of identifying variation.

4 Empirical Findings

4.1 Labor Market Outcomes

In Table 1, we first show the relationship between economic conditions at college entry and labor market outcomes after graduation, estimating equation (1). We examine the effects on employment probability and (log) monthly earnings within ten years after college graduation. Monthly earnings are inflation-adjusted to the 2020 value and in thousands of KRW when analyzed in levels.[8] For log earnings, we take the natural logarithm of monthly earnings in 2020 KRW, imputing zero earnings with 1 KRW before applying the log.

Individuals who began their undergraduate studies in a region with a 1%p higher unemployment rate are 0.9%p more likely to be employed during the first ten years after graduation than their peers from the same entry cohort who faced less severe downturns (column 1). This stronger labor market attachment increases monthly earnings by 25,000 KRW (column 3) or 0.126 log points (column 5).[9] However, conditional on employment, earnings are unaffected by economic conditions at college entry (columns 4 and 6), indicating that the earnings gains operate through the extensive margin. Relative to the mean of each outcome, these estimates correspond to a 1.2% increase in employment and a 1.4% increase in earnings—substantially larger than those reported in prior studies for the UK and the US (Bičáková et al., 2021, 2023).

The internal validity of our analysis is assessed in Section S1 of the online appendix. We show that the improved labor market outcomes among college entrants exposed to more severe downturns are not attributable to positive selection into college entry or completion, nor merely to recovering economic conditions at the time of graduation. Our estimates are robust to (1) applying the bias-adjustment method proposed by Oster (2019), (2) including college dropouts in the sample, (3) incorporating region-specific linear cohort trends, (4) controlling for economic conditions at graduation, and (5) excluding individuals who graduated during the AFC in 1998 or 1999. Overall, these robustness checks support that the estimates in Table 1 reflect a causal relationship between

[8] 1 USD is worth approximately 1,400 KRW.

[9] The estimated effect on log(1 + earnings) should not be interpreted in percentage terms. Chen and Roth (2024) document that treatment effect estimates based on log-like transformations of the outcome variable are sensitive to the outcome's unit of measurement, particularly when the treatment affects the extensive margin, as in our setting. In Table S3, we compare the estimated effects on log(1 + earnings) across different earnings units. The estimated effects range from 0.126 to 0.009 log points when imputing zero earnings with values from 1 to 1 million KRW.

labor market conditions at college entry and post-graduation labor market outcomes.

The higher employment probability, without earnings gains among the employed, may suggest that individuals facing worse economic conditions at college entry lowered their reservation wages and accepted lower-quality jobs. To explore this possibility, Table 2 examines whether job characteristics or match quality deteriorate among those exposed to more severe downturns, restricting the analysis to employed individuals. We find precisely zero effects on job characteristics (panel A) and match quality (panel B). The regional unemployment rate at college entry is not associated with the likelihood of full-time employment, self-employment, holding a white-collar job, working in a large firm (300 or more employees), public sector employment, or overall job satisfaction. Likewise, it does not affect the share of workers reporting that their job's education or skill requirements match, fall short of, or exceed their own. These results indicate that the higher employment rates among graduates who began college under more adverse economic conditions are not achieved at the expense of job quality.

4.2 Potential Mechanisms

Mediation analysis. In Figure 1, we examine which factors account for the higher employment probabilities and earnings of graduates who experienced a more severe recession during their first year of college. The potential mediators include migration, post-college education, college major, and the industry or occupation of the first job. The figure shows how the estimated coefficient on UR_{cr} changes when fixed effects for each factor are added to the baseline specification in equation (1).[10] Panels A–C present the results for employment, earnings, and log earnings, respectively, with baseline estimates matching columns (1), (2), and (4) of Table 1.

The industry and occupation choices explain up to 46% of the increase in employment and (log) earnings, whereas migration, post-college education, and college major play a limited role. Adding fixed effects for region of residence, educational attainment, or college major barely changes the coefficient estimate. Because college majors are typically observed only once for most individuals, we interact ten major dummies with calendar year dummies to allow their effects to vary over time. The ten fields are humanities, social sciences, natural sciences, engineering, medicine, education, music, arts, sports, and others. It is unsurprising that majors contribute little to explaining the

[10] See Table S4 for detailed regression results corresponding to Figure 1.

improved labor market outcomes, as most South Korean students choose their majors when applying to college, and only a small number change fields during their studies. Consequently, they have limited scope to adjust their majors in response to economic conditions at college entry.

Because industry and occupation information is available only for the employed, we use the first job's industry or occupation and treat having no job within ten years after college graduation as a separate industry or occupation category in the analysis. This approach enables mediation analysis using the full sample of graduates, not just the employed, and helps identify the factors underlying the higher employment probability—a key aspect of improved labor market outcomes. Fixed effects are constructed from twenty industry categories or eleven occupation categories, including the no-job category.[11] Adding industry-by-year fixed effects reduces the estimated coefficient on UR_{cr} by 21–46% for employment and (log) earnings. When we incorporate occupation-by-year fixed effects, the estimate decreases by at least 43% and loses statistical significance even at the 10% level. These results suggest that the improved labor market outcomes of individuals who began college in a worse economy stem from beginning their careers in jobs with better employment prospects after graduation.

Increased effort. Next, we examine behavioral changes among individuals who faced a more severe economic downturn at college entry and find evidence of increased effort to prepare for the job market. For this analysis, we estimate regression equation (2) with education, training, and job search activities as the dependent variables.

In Table 3, we find that students exposed to a more severe recession during their freshman year tend to earn more certificates while in college (columns 1–4, panel A). In South Korea, obtaining certificates in finance, computer programming, or foreign languages is a common form of training for college students seeking to enhance their employability. The effect is statistically significant and economically relevant: a 1%p increase in the regional unemployment rate at college entry raises the number of certificates earned by 0.05 (3.7% of the mean), driven by the intensive margin. This heightened job-market preparation aligns with a small increase in the time to graduation (column 1, panel B): the duration rises by 0.053 years per 1%p increase in the unemployment rate at entry. However, the probability of graduating on time remains unchanged (column 2, panel B).[12]

[11] See the notes to Figure 1 for the full list of occupations and industries.

[12] We define an indicator for on-time college graduation as graduating from a four-year college within four years for

The estimated effects on college GPA (column 5, panel A), the likelihood of pursuing post-college education (columns 3–4, panel B), and the probability of college dropout (column 5, panel B) are all precisely zero.[13]

Panel C of Table 3 shows that college major choice is largely unresponsive to economic conditions at college entry, consistent with majors being predetermined for most students, as noted previously. Nonetheless, the estimated effect on STEM major, though statistically insignificant, is positive and considerably larger than the near-zero or negative estimates for other fields, such as humanities, education, arts, music, and sports. These results provide suggestive evidence that, despite the limited scope for post-entry major changes, some students shift toward fields with potentially higher labor market returns after experiencing a recession.

Table 4 examines job search intensity for individuals' first post-college employment, measured by the number of search methods used. Beginning in wave 2, respondents are asked to report up to three methods they used to find their current job.[14] We find that individuals who faced a more severe recession at the start of college employ more search methods to obtain their first job. Conditional on engaging in any search activity, a 1%p increase in UR_{cr} raises the probability of using three or more methods by 1.5%p (3.9% of the mean).

Lastly, we estimate equation (1) using the unemployment rate at different points in time—from one year before college entry to five years after—and compare the coefficient estimates, $\hat{\beta}$, across regressions in Figure S8. The positive effects on labor market outcomes are largest when high unemployment occurs in the year of college entry and diminish when the shock is encountered in later college years. This declining pattern provides further evidence that effort is likely a key channel, as those facing unfavorable conditions later in college have less time to adequately prepare for the labor market. The estimated effect eventually becomes negative, particularly four years after college entry, which is consistent with the adverse impact of entering the labor market during a recession, as documented in the scarring effects literature.

women and six years for men, or from a two-year college within two years for women and four years for men. The gender differences reflect the roughly two-year period of mandatory military service for men in South Korea.

[13]The KLIPS collects information on college GPA only through the supplementary education survey conducted in 2008 as part of wave 11. Accordingly, this analysis is limited to respondents from wave 11, resulting in a smaller sample size.

[14]See the notes to Table 4 for the eleven job search methods listed in the KLIPS.

5 Theoretical Framework

In this section, we introduce a simple model of optimal effort under ambiguity aversion to explain why students entering college in a worse economy exert greater effort, leading to improved labor market outcomes. Ambiguity aversion originates from the concept of unmeasurable uncertainty introduced by Knight (1921), and its existence is demonstrated by Ellsberg (1961) through a simple thought experiment. Building on this, Gilboa and Schmeidler (1989) formalize ambiguity aversion within the Maxmin Expected Utility framework, in which individuals facing ambiguous situations maximize utility based on the worst-case probability. Experimental evidence confirms that individuals are averse to ambiguity (Abdellaoui et al., 2011; Sutter et al., 2013), and the concept has been applied primarily in macroeconomics and finance (Ilut and Schneider, 2023). The AFC, as an unexpected and large-scale economic shock, exemplifies the type of situation noted by Ellsberg (1961), where ambiguity aversion arises from the unknown likelihood of risks.

Consider a labor market in which individuals aim to maximize their expected utility under ambiguity aversion. Utility depends on effort e and labor market tightness m.[15] Specifically, the utility function is given by:

$$u(e, m) = q(e, m)w(e, m) - c(e),$$

where $q(e, m)$ denotes the probability of being hired by firms, and $w(e, m)$ represents the corresponding wage. Both functions are assumed to be non-decreasing and concave in e and m. The cost of exerting effort, represented by $c(e)$, is increasing and strictly convex in e. To ensure that the maximization problem is well-behaved, we further assume that the utility function is strictly concave in e: $q_{ee}w + 2q_e w_e + q w_{ee} < c_{ee}$.[16]

The individual receives a signal about labor market tightness, $\mathcal{S} = [s - \frac{d}{2}, s + \frac{d}{2}]$. Under normal economic conditions, this signal implies that labor market tightness m follows a uniform distribution, $m \sim \text{Uniform}[s - \frac{d}{2}, s + \frac{d}{2}]$, with probability density function $f(m) = \frac{1}{d}$ for $m \in [s - \frac{d}{2}, s + \frac{d}{2}]$.[17] This setting reflects a situation in which the individual faces uncertainty but still

[15] Tightness is typically measured as the ratio of job vacancies to job seekers. A higher m reflects more favorable labor market conditions for workers, increasing the probability of securing employment for a given level of effort.

[16] Throughout in this section, subscripts on a function's arguments denote partial derivatives with respect to the corresponding variable; e.g., $q_e = \frac{\partial q(e,m)}{\partial e}$, $w_{em} = \frac{\partial^2 w(e,m)}{\partial e \, \partial m}$.

[17] The uniform distribution assumption is employed solely for analytical tractability. We expect our main qualitative

holds probabilistic beliefs about labor market conditions based on available information $\mathcal{S}$. This signal enables individuals to form expectations and make effort decisions accordingly. In contrast, during an economic crisis—especially one involving unexpected and large-scale economic shocks—the distribution of m becomes unknown or ambiguous. As a result, the individual lacks sufficient information to form rational expectations about the state of nature based on $\mathcal{S}$ and can only infer that m lies within the interval $[s - \frac{d}{2}, s + \frac{d}{2}]$.[18]

The individual exerts effort $e \in \mathbb{R}^+$ to enhance competitiveness in the labor market. The individual's optimal decision problem in a normal situation is given by:

$$\max_e E[u(e,m)] = \frac{1}{d}\int_{s-\frac{d}{2}}^{s+\frac{d}{2}} [q(e,m)w(e,m) - c(e)]\, dm. \tag{3}$$

The optimal level of effort in a normal situation is denoted by e^*.

In a crisis, however, because of ambiguity regarding the distribution of m, the individual cannot solve the problem by taking expectations. Specifically, although signal $\mathcal{S}$ is still observed, the exact distribution of m within this interval remains unknown. In such cases, an ambiguity-averse individual evaluates outcomes by considering the worst-case scenario within a plausible range of m. The decision problem under ambiguity is therefore reformulated as:

$$\max_{e\in\mathbb{R}^+} \min_{m\in[s-\frac{d}{2}, s+\frac{d}{2}]} \{q(e,m)w(e,m) - c(e)\}. \tag{4}$$

This formulation captures the individual's preference for minimizing potential losses in the face of ambiguity, particularly during a crisis. Let $\tilde{e}$ denote the optimal effort in this setting.

For a given signal $\mathcal{S}$, the optimal level of effort is higher in a crisis than under normal economic conditions (i.e., $\tilde{e} > e^*$) if the marginal benefit of effort, defined as $MB(e;m) \equiv q_e w + q w_e$, declines with labor market tightness m. A formal proof is provided in Appendix A.

Proposition 1 (Amplified Effort in Crisis)

The optimal level of effort is higher in a crisis situation than in a normal situation: $\tilde{e} > e^*$, if the

conclusions to hold under alternative distributional assumptions for m.

[18] Alternatively, one may assume that in a crisis workers are not only unaware of the distribution but also face a broader support, e.g., $[s - d, s + d]$. This assumption leaves our main results qualitatively unchanged and possibly strengthens them.

marginal benefit of effort $MB(e; m)$ is decreasing in m.

Intuitively, in a slack labor market where jobs are harder to find, additional effort or investment in skills yields higher returns by improving job-finding prospects or wages. By contrast, in a tight labor market where jobs are plentiful, the marginal return to extra effort diminishes, as employers can fill positions without requiring additional qualifications. Empirical studies of job vacancy postings show that employer skill requirements are counter-cyclical: even within the same jobs, employers become more selective and strategically target higher-skilled workers in a slack labor market (Modestino et al., 2016, 2020).

Proposition 1 shows that individuals exert greater effort under crisis conditions when ambiguity aversion is at play. This theoretical prediction aligns with our empirical findings in Section 4: students who entered college under higher unemployment and thus greater uncertainty about future labor market prospects increased their efforts, such as by acquiring additional certificates and engaging in more intensive job searches. In our model, such behavior reflects a rational response to the perceived worst-case scenario, consistent with the maxmin expected utility framework of Gilboa and Schmeidler (1989). These efforts appear to translate into long-run labor market gains, including higher employment probabilities and earnings.

6 Conclusion

This study examines how economic conditions at college entry affect post-graduation labor market outcomes. Exploiting within-cohort variation in regional unemployment rates generated by the Asian Financial Crisis, we find that students who entered college in a worse economy exhibit higher employment probabilities and earnings in the decade following graduation. These effects operate through increased effort during college and in the job search process—manifested in acquiring additional certificates, engaging more intensively in job search activities, and starting careers in industries and occupations with stronger employment prospects. A theoretical framework based on ambiguity aversion explains these behavioral responses: when facing uncertainty about labor market tightness during a crisis, students adopt the worst-case perspective that motivates greater effort and improves labor market outcomes ex post.

These findings highlight important policy implications. While most interventions during re-

cessions focus on damage control, such as unemployment insurance or temporary hiring subsidies, our results point to the potential of effort activation. If ambiguity and uncertainty already motivate young job candidates to increase their effort, policies can amplify and channel this response constructively—for instance, by expanding access to training programs and certification opportunities that help them prepare for the labor market. Universities can also play a proactive role by making curricula more adaptable, enabling students' heightened effort during economic downturns to translate into skills and fields that enhance long-term employability. By reframing recessions not only as economic shocks but also as windows of opportunity for effort and skill development, policymakers and educators can help transform periods of adversity into engines of reskilling and long-term productivity growth.

A Appendix: Omitted Proof

Proof of Proposition 1. We omit the second-order condition here, as the main text assumes that the objective function is strictly concave.

In the normal situation, the first-order condition for maximizing $E[u(e,m)]$ in equation (3) is

$$\frac{\partial c(e)}{\partial e} = \frac{1}{d}\int_{s-\frac{d}{2}}^{s+\frac{d}{2}} \left[\frac{\partial q(e,m)}{\partial e} w(e,m) + q(e,m)\frac{\partial w(e,m)}{\partial e}\right] dm. \tag{5}$$

Under the stated assumptions, equation (5) implicitly defines the optimal effort e^*.

In the crisis situation, for a given effort level e, the individual evaluates the worst-case utility:

$$U_{\text{worst}}(e,m) = \min_{m\in[s-\frac{d}{2},\ s+\frac{d}{2}]} \{q(e,m)w(e,m) - c(e)\}.$$

As q and w are increasing in m, the worst-case scenario corresponds to $m = s - \frac{d}{2}$, as this is the lowest value in $[s-\frac{d}{2}, s+\frac{d}{2}]$. Therefore, the worst-case utility is:

$$U_{\text{worst}}(e,m) = q(e, s-\tfrac{d}{2})w(e, s-\tfrac{d}{2}) - c(e).$$

The individual maximizes $U_{\text{worst}}(e,m)$ with respect to e. The first-order condition yields:

$$\frac{\partial c(e)}{\partial e} = \frac{\partial q(e, s-\frac{d}{2})}{\partial e} w(e, s-\tfrac{d}{2}) + q(e, s-\tfrac{d}{2})\frac{\partial w(e, s-\frac{d}{2})}{\partial e}. \tag{6}$$

Therefore, equation (6) implicitly defines $\tilde{e}$, the optimal level of effort in a crisis situation, given the worst-case scenario $m = s - \frac{d}{2}$.

Compare the first-order conditions under normal and crisis situations, represented by equations (5) and (6), respectively. The left-hand sides of both equations are identical, but the right-hand side of equation (6) is greater than that of equation (5) for any given e, provided that $MB(e;m)$ is decreasing in m. Therefore, substituting the normal-situation solution e^* from equation (5) into equation (6) results in the right-hand side exceeding the left-hand side. To satisfy equation (6), it becomes necessary to choose a higher value of e that increases the left-hand side and simultaneously reduces the right-hand side. This demonstrates that the solution to equation (6), denoted by $\tilde{e}$, must be greater than the solution to equation (5), denoted by e^*. ■

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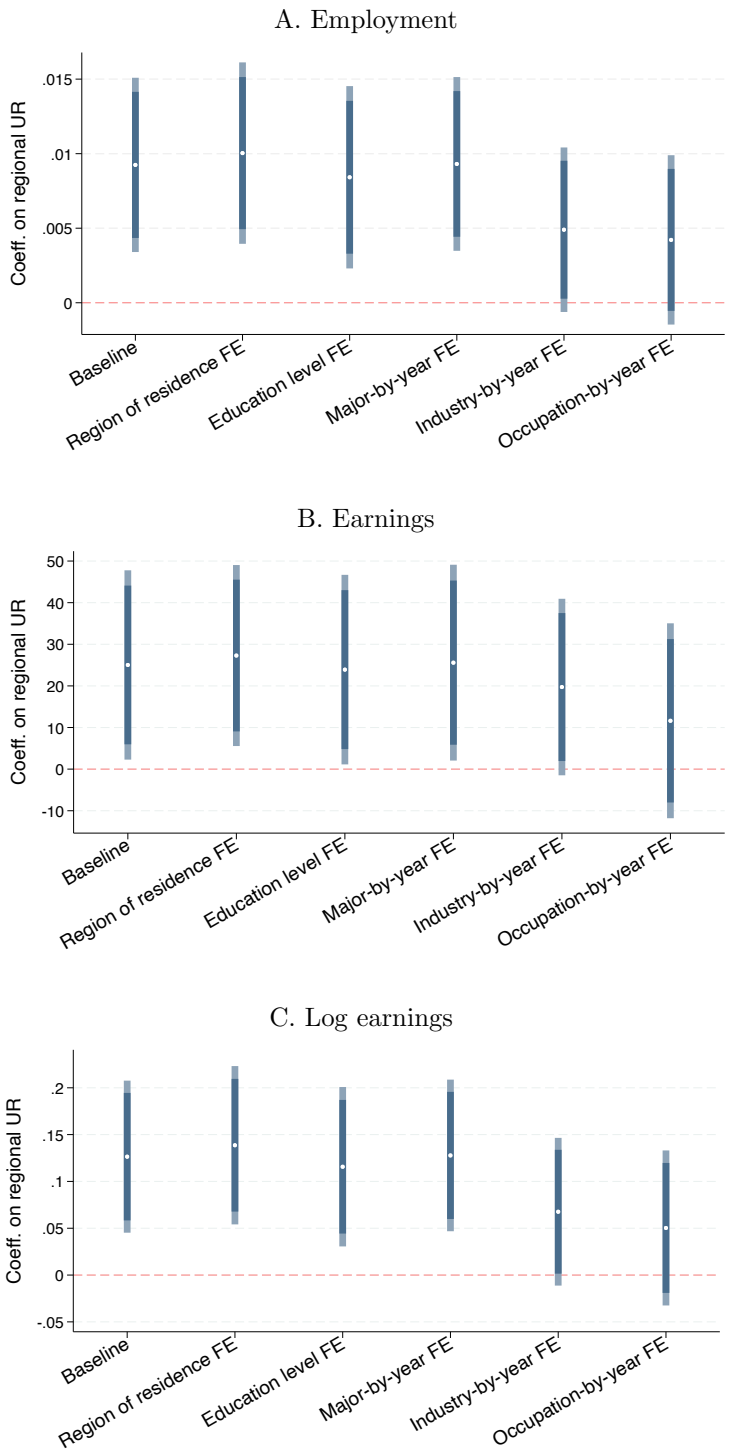

Figure 1: Mediation Analysis

Notes. Vertical spikes around each point estimate represent the 95% and 90% (darker) confidence intervals, clustered at the cohort-by-region level. In the baseline specification, regressions include a cubic function of college entry year and fixed effects for college region, age, and calendar year. Controls for background characteristics include indicator variables for sex, type of college (2-year vs. 4-year), father's education level (high school graduate, college graduate or higher) (high school graduate, college graduate or higher), and parents' job status at age 14 (standard worker, non-standard worker, business owner hiring employees, business owner with no employee). The twenty industry categories include: 1) Agriculture and forestry; 2) Fishing; 3) Mining; 4) Manufacturing; 5) Electricity, gas, and water supply; 6) Construction; 7) Wholesale and retail trade; 8) Accommodation and food services; 9) Transportation; 10) Communication; 11) Finance and insurance; 12) Real estate and rental; 13) Business services; 14) Public administration and defense; 15) Educational services; 16) Health and welfare; 17) Recreation and culture; 18) Public and personal services; 19) Domestic services; and 20) International and foreign services. The eleven occupation categories include: 1) Legislators, senior Officials, and managers; 2) Professionals; 3) Technicians and associate professionals; 4) Clerical workers; 5) Service workers; 6) Sales workers; 7) Skilled agricultural, forestry, and fishery workers; 8) Craft and related trades workers; 9) Plant and machine operators and assemblers; 10) Elementary occupations; and 11) Armed forces.

Table 1: Effects on Employment and Earnings

	Employment	Earnings	Earnings (employed only)	Log earnings	Log earnings (employed only)
	(1)	(2)	(3)	(4)	(5)
Regional UR	0.009***	25.032**	7.038	0.126***	−0.007
	(0.003)	(11.555)	(15.233)	(0.041)	(0.016)
Adjusted R^2	0.102	0.241	0.229	0.113	0.029
Observations	21,809	21,741	16,099	21,741	16,099
Mean of Y	0.741	1,824.5	2,464.0	10.634	14.360

Notes. Regressions include a cubic function of college entry year and fixed effects for college region, age, and calendar year. Controls for background characteristics include indicator variables for sex, type of college (2-year vs. 4-year), father's education level (high school graduate, college graduate or higher), and parents' job status at age 14 (standard worker, non-standard worker, business owner hiring employees, business owner with no employee). Robust standard errors in parentheses are clustered at the cohort-by-region level. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$.

Table 2: Effects on Job Characteristics and Job Mismatch

A. Job Characteristics

	Full-time ($\geq$ 40 hrs/wk) (1)	Self-employed (2)	White collar (3)	Large firm ($\geq$ 300 workers) (4)	Public sector (5)	Job satisfaction (6)
Regional *UR*	0.003	0.001	0.002	0.006	−0.002	−0.001
	(0.002)	(0.003)	(0.004)	(0.006)	(0.004)	(0.004)
Adjusted R^2	0.038	0.028	0.123	0.052	0.063	0.049
Observations	16,146	16,167	16,005	14,664	16,156	15,259
Mean of Y	0.936	0.078	0.842	0.381	0.138	0.438

B. Job Mismatch: Job Requirements Relative to Worker's Own Qualifications

	Education level			Skill level		
	Appropriate (1)	Lower (2)	Higher (3)	Appropriate (4)	Lower (5)	Higher (6)
Regional *UR*	−0.002	0.002	0.000	−0.001	0.000	0.001
	(0.003)	(0.003)	(0.001)	(0.003)	(0.003)	(0.001)
Adjusted R^2	0.027	0.028	0.002	0.026	0.029	0.003
Observations	15,731	15,731	15,731	15,711	15,711	15,711
Mean of Y	0.827	0.155	0.018	0.837	0.142	0.020

Notes. Regressions include a cubic function of college entry year and fixed effects for college region, age, and calendar year. Controls for background characteristics include indicator variables for sex, type of college (2-year vs. 4-year), father's education level (high school graduate, college graduate or higher), and parents' job status at age 14 (standard worker, non-standard worker, business owner hiring employees, business owner with no employee). Robust standard errors in parentheses are clustered at the cohort-by-region level. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$.

Table 3: Effects on Education Outcomes During and After College

A. Education and Training During College

	Any	N of certificates (given $N > 0$)			Graduation
	certificates	N	$\mathbb{1}[N \geq 2]$	$\mathbb{1}[N \geq 3]$	GPA
	(1)	(2)	(3)	(4)	(5)
Regional *UR*	0.003	0.050**	0.027**	0.020**	−0.007
	(0.005)	(0.022)	(0.013)	(0.010)	(0.009)
Adjusted R^2	0.021	0.045	0.028	0.011	0.065
Observations	3,922	709	709	709	1,763
Mean of Y	0.181	1.351	0.260	0.066	3.471

B. Educational Attainment

	Years until col. graduation	Col. graduation on time	Post-college education	Years of education	Drop out of college
	(1)	(2)	(3)	(4)	(5)
Regional *UR*	0.053***	−0.004	−0.004	−0.014	−0.001
	(0.020)	(0.005)	(0.003)	(0.013)	(0.002)
Adjusted R^2	0.501	0.069	0.066	0.536	0.015
Observations	3,959	3,959	3,959	3,959	4,058
Mean of Y	4.254	0.668	0.088	15.480	0.024

C. College Major Choice

	STEM	Social sciences	Humanities	Education	Arts, Music & Sports
	(1)	(2)	(3)	(4)	(5)
Regional *UR*	0.011	0.004	−0.003	−0.001	−0.005
	(0.007)	(0.004)	(0.006)	(0.002)	(0.004)
Adjusted R^2	0.109	0.011	0.049	0.032	0.024
Observations	3,939	3,939	3,939	3,939	3,939
Mean of Y	0.469	0.143	0.232	0.048	0.089

Notes. Regressions include a cubic function of college entry year and college region fixed effects. Controls for background characteristics include indicator variables for sex, type of college (2-year vs. 4-year), father's education level (high school graduate, college graduate or higher), and parents' job status at age 14 (standard worker, non-standard worker, business owner hiring employees, business owner with no employee). Robust standard errors in parentheses are clustered at the cohort-by-region level. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$.

Table 4: Effects on Job Search Activities for First Employment

	Any search activities	N of search methods (given $N > 0$)		
		N	$\mathbb{1}[N \geq 2]$	$\mathbb{1}[N \geq 3]$
	(1)	(2)	(3)	(4)
Regional UR	0.004	0.022	0.007	0.015*
	(0.006)	(0.014)	(0.008)	(0.008)
Adjusted R^2	0.005	0.031	0.019	0.032
Observations	3,063	1,371	1,371	1,371
Mean of Y	0.451	2.070	0.684	0.386

Notes. Regressions include a cubic function of college entry year and college region fixed effects. Controls for background characteristics include indicator variables for sex, type of college (2-year vs. 4-year), father's education level (high school graduate, college graduate or higher), and parents' job status at age 14 (standard worker, non-standard worker, business owner hiring employees, business owner with no employee). Robust standard errors in parentheses are clustered at the cohort-by-region level. The KLIPS lists the following job search methods: 1) through a school, private institute, or mentor/instructor; 2) through friends or relatives; 3) through a public employment agency; 4) through a private employment agency; 5) through advertisements in newspapers, on TV, or on bulletin boards; 6) contacting the employer directly; 7) through family members; 8) through the internet or other communication networks; 9) through someone employed at the desired workplace; 10) through contacts from a previous job; and 11) others.

Online Appendix

S1 Internal Validity Checks

Primary source of identifying variation. In our empirical strategy, identification is based on deviations from smooth long-term cohort trends in regional unemployment rates. In Table S2, we conduct two placebo exercises that show this variation is primarily driven by the unexpected occurrence of the Asian Financial Crisis (AFC). First, excluding individuals who entered college in 1998–1999 during the AFC-driven recession eliminates the estimated effects on post-graduation employment and earnings, rendering them statistically indistinguishable from zero (panel B). Second, controlling for the regional unemployment rate one year prior to college entry, $UR_{c-1,r}$, yields estimates that are very similar to the baseline results reproduced in panel A (see panel C). This suggests minimal endogenous adjustment in college entry year or region, given the abrupt onset of the AFC.

Selection. We conduct three validation exercises to assess whether the positive effects on post-graduation employment and earnings are spuriously driven by selection. First, we consider the possibility that individuals who experience a more severe recession at college entry are positively selected, such that their labor market outcomes may appear better than those of their peers even in the absence of behavioral responses to economic conditions. To test this, we apply the bias-adjustment method proposed by Altonji et al. (2005) and extended by Oster (2019) (hereafter AET-Oster) in Figure S6. This approach evaluates bias from omitted confounders under the assumption that selection on unobservables is proportional to selection on observables. For employment probability and log earnings (panels A, D, and E), the AET-Oster estimates are comparable to the baseline estimates, supporting robustness to selection. For earnings in levels (panels B and C), the AET-Oster estimates fall slightly outside the 95% confidence interval of the baseline results but remain strictly positive and larger in magnitude than the baseline estimates, suggesting that any selection, if present, is negative rather than positive. Thus, our main estimates are likely lower bounds, and the improved labor market outcomes are unlikely to reflect positive selection of college entrants. Second, we show that the results are not driven by the selection of college graduates. The estimates remain stable when we include college dropouts in the sample (Figure S7). Lastly, we obtain nearly identical results when controlling for region-specific linear cohort trends, which capture nonparallel across-cohort differences in baseline ability and earnings potential (Figure S7). This result confirms that any bias from nonrandom selection at college entry or graduation is minimal.

Economic conditions at labor market entry. Given business cycle fluctuations, economic conditions may have improved by the time individuals who began college during a recession graduated and entered the labor market. Because the extensive evidence shows that labor market entry conditions have lasting effects on employment and earnings, one might question whether our positive estimates are instead driven by improved conditions at graduation. To address this concern, we conduct two robustness checks. First, we control for economic conditions at labor market entry by adding the regional unemployment rate at college graduation to the regression. Second, we exclude individuals who graduated between 1998 and 1999, during the AFC, as they experienced the most severe scarring from poor initial labor market conditions (Choi et al., 2020). Figure S7 shows that our estimates change little in both cases, indicating that labor market conditions at graduation do not account for the improved outcomes of those who began college in a worse economy.

Extended sample. Because the Korean Labor and Income Panel Study (KLIPS) began in 1998, early career outcomes for individuals who graduated before that year are not available in the person survey data used in our main analysis. We can partially address this gap for employment status using retrospective job histories, which provide complete employment records from respondents' first to most recent jobs. In contrast, earnings and other characteristics of retrospective jobs are largely missing or too coarse for our analysis. For instance, the work history file reports only a single average of monthly earnings across all pre-KLIPS jobs, while information on hours worked, fringe benefits, and establishment characteristics suffers from very low response rates. Accordingly, we rely on the person survey data for our main analysis and use the work history records for robustness checks. Figure S7 shows that our regression results for both employment and earnings remain robust when we include observations from the work history file.

S2 Supplementary Theoretical Findings

Note that s represents the median of the range $\mathcal{S} = \left[s - \frac{d}{2}, s + \frac{d}{2}\right]$, over which the true market condition is distributed. Intuitively, a higher s implies that the signal $\mathcal{S}$ reflects a shift toward better labor market conditions. Our focus is on the sign of $\frac{\partial \tilde{e}}{\partial s}$—how optimal effort responds to changes in the perceived market condition.

Proposition 2 (More Effort in a Worse Market)
The optimal level of effort is decreasing in the signal s, $\frac{\partial e^*}{\partial s} < 0$, if the marginal benefit of the effort $MB(e; m)$ is decreasing in m

This proposition implies that if the market conditions in the previous period were worse, students exert more effort, represented by a higher e^*. Therefore, the theoretical implications of Proposition 2 are consistent with the empirical results, which show that individuals acquire more certificates during college and engage in more intensive job searches to better prepare for the job market.

Proof of Proposition 2.

The first-order condition (FOC) for the optimal effort e^* is:

$$\frac{\partial c(e^*)}{\partial e} = \frac{1}{d} \int_{s-\frac{d}{2}}^{s+\frac{d}{2}} \left[\frac{\partial q(e^*, m)}{\partial e} w(e^*, m) + q(e^*, m) \frac{\partial w(e^*, m)}{\partial e} \right] dm.$$

To analyze how e^* changes with s, we differentiate the FOC with respect to s:

$$\frac{\partial^2 c(e^*)}{\partial e^2} \frac{\partial e^*}{\partial s} = \frac{\partial}{\partial s} \left[\frac{1}{d} \int_{s-\frac{d}{2}}^{s+\frac{d}{2}} \left[\frac{\partial q(e^*, m)}{\partial e} w(e^*, m) + q(e^*, m) \frac{\partial w(e^*, m)}{\partial e} \right] dm \right].$$

The derivative of the integral with respect to s is:

$$\begin{aligned}
&\frac{\partial}{\partial s}\int_{s-\frac{d}{2}}^{s+\frac{d}{2}}\left[\frac{\partial q(e^*,m)}{\partial e}w(e^*,m)+q(e^*,m)\frac{\partial w(e^*,m)}{\partial e}\right]dm \\
=&\left[\left(\frac{\partial q(e^*,s+\frac{d}{2})}{\partial x}w(e^*,s+\frac{d}{2})+q(e^*,s+\frac{d}{2})\frac{\partial w(e^*,s+\frac{d}{2})}{\partial e}\right)\right. \\
&\left.-\left(\frac{\partial q(e^*,s-\frac{d}{2})}{\partial e}w(e^*,s-\frac{d}{2})+q(e^*,s-\frac{d}{2})\frac{\partial w(e^*,s-\frac{d}{2})}{\partial e}\right)\right] \\
=&MB(e^*;s+\tfrac{d}{2})-MB(e^*;s-\tfrac{d}{2}).
\end{aligned}$$

Substituting the result into the FOC:

$$\frac{\partial e^*}{\partial s}=\frac{\frac{1}{d}(MB(e^*;s+\frac{d}{2})-MB(e^*;s-\frac{d}{2}))}{\frac{\partial^2 c(e^*)}{\partial e^2}}.$$

The inequality $\frac{\partial e^*}{\partial s}<0$ holds if $MB(e^*;s+\frac{d}{2})-MB(e^*;s-\frac{d}{2})<0$. This inequality implies that the marginal benefit of effort (in terms of hiring probability and wage) at the lower bound $m=s-\frac{d}{2}$ must be greater than that at the upper bound $m=s+\frac{d}{2}$. Therefore, if the marginal benefit of the effort $MB(e;m)$ is decreasing in m, the optimal level of effort is decreasing in the signal s, $\frac{\partial e^*}{\partial s}<0$. ■

S2.1 Numerical Example

Here, we present a specific example of the model to illustrate the behavior of the marginal benefit function with respect to market tightness m. Consider the functions:

$$q(e,m)=1-\exp(-me),\quad w(e,m)=\sqrt{e+m},\quad c(e)=\frac{e^2}{60}.$$

These functions satisfy the necessary properties required by the general optimization problem in equation (3).

The derivative of the marginal benefit (MB) with respect to m is explicitly given by:

$$\frac{\partial MB(e;m)}{\partial m}=\exp(-me)\left[(1-me)\sqrt{e+m}+\frac{m}{2\sqrt{e+m}}\right]+\frac{2e\exp(-me)(e+m)-(1-\exp(-me))}{4(e+m)^{3/2}}.$$

This marginal benefit of effort initially increases with market tightness m when m is low, and subsequently decreases for higher values of m. Figure S1 below clearly demonstrates this pattern for several effort levels e:

Initially, when market tightness m is low, increases in m directly raise the marginal benefit of effort because the hiring probability, represented by $q(e,m)=1-\exp(-me)$, significantly increases with m, and wages, given by $w(e,m)=\sqrt{e+m}$, also improve. Both effects strongly incentivize additional effort. However, as m continues to grow, saturation effects emerge: the hiring probability $q(e,m)$ approaches its upper bound of 1, reducing the incremental gains from further increases in market tightness. Concurrently, the marginal wage improvement also diminishes because $w(e,m)$ exhibits decreasing marginal returns in m. Together, these factors lead to diminishing returns, eventually causing the marginal benefit to decline as m becomes large. This pattern—initially

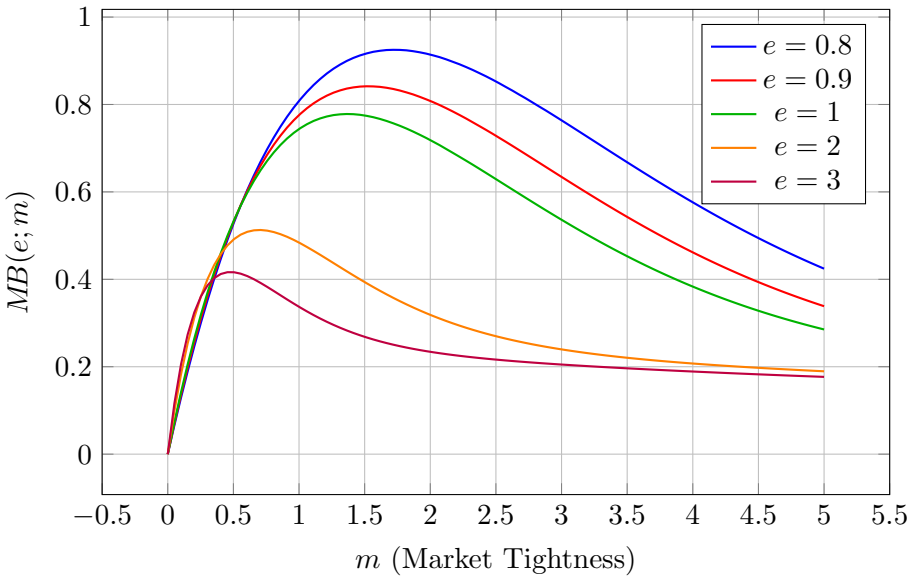

Figure S1: Marginal Benefit

increasing and subsequently decreasing marginal benefit—clearly captures the economic intuition behind diminishing returns under improved market conditions.

Additional Figures and Tables

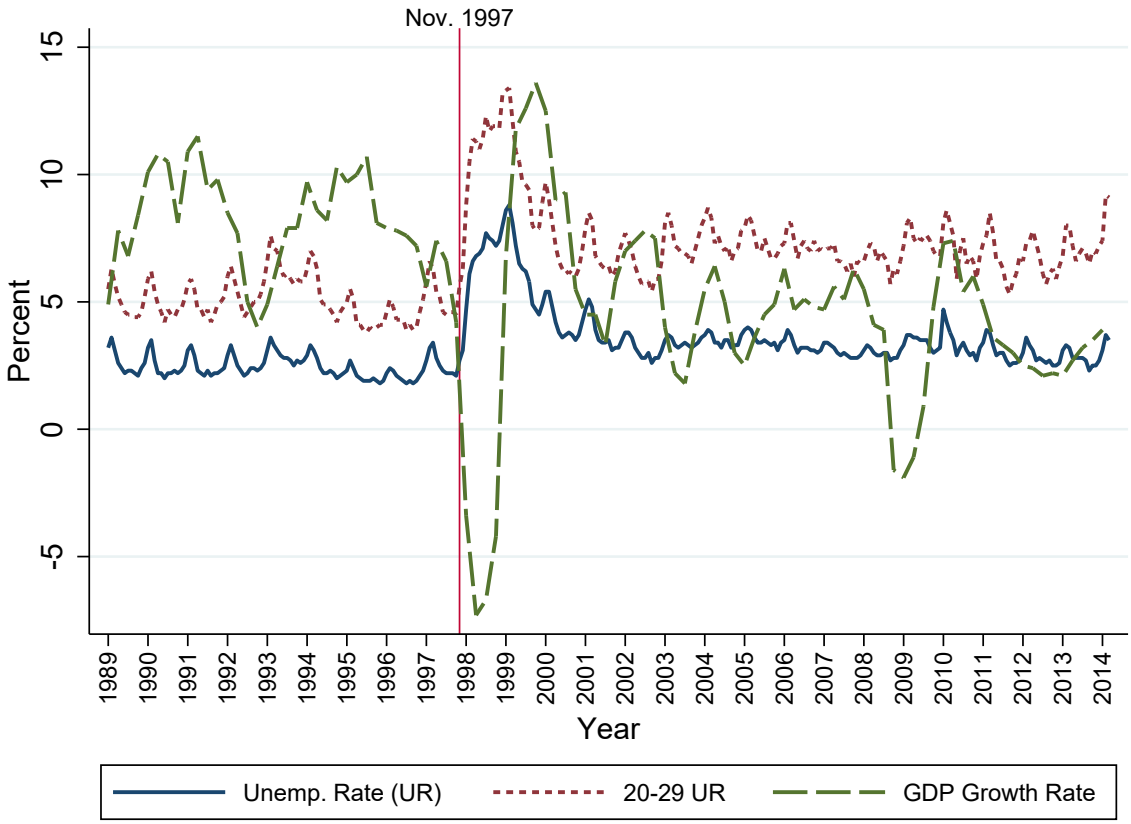

Figure S2: Macroeconomic Statistics

Notes. Taken from Choi et al. (2020) Figure 1. Monthly unemployment rates are from Statistics Korea. Quarterly real GDP growth rates are from the Bank of Korea, and measure the growth rate compared to the same quarter of the previous year.

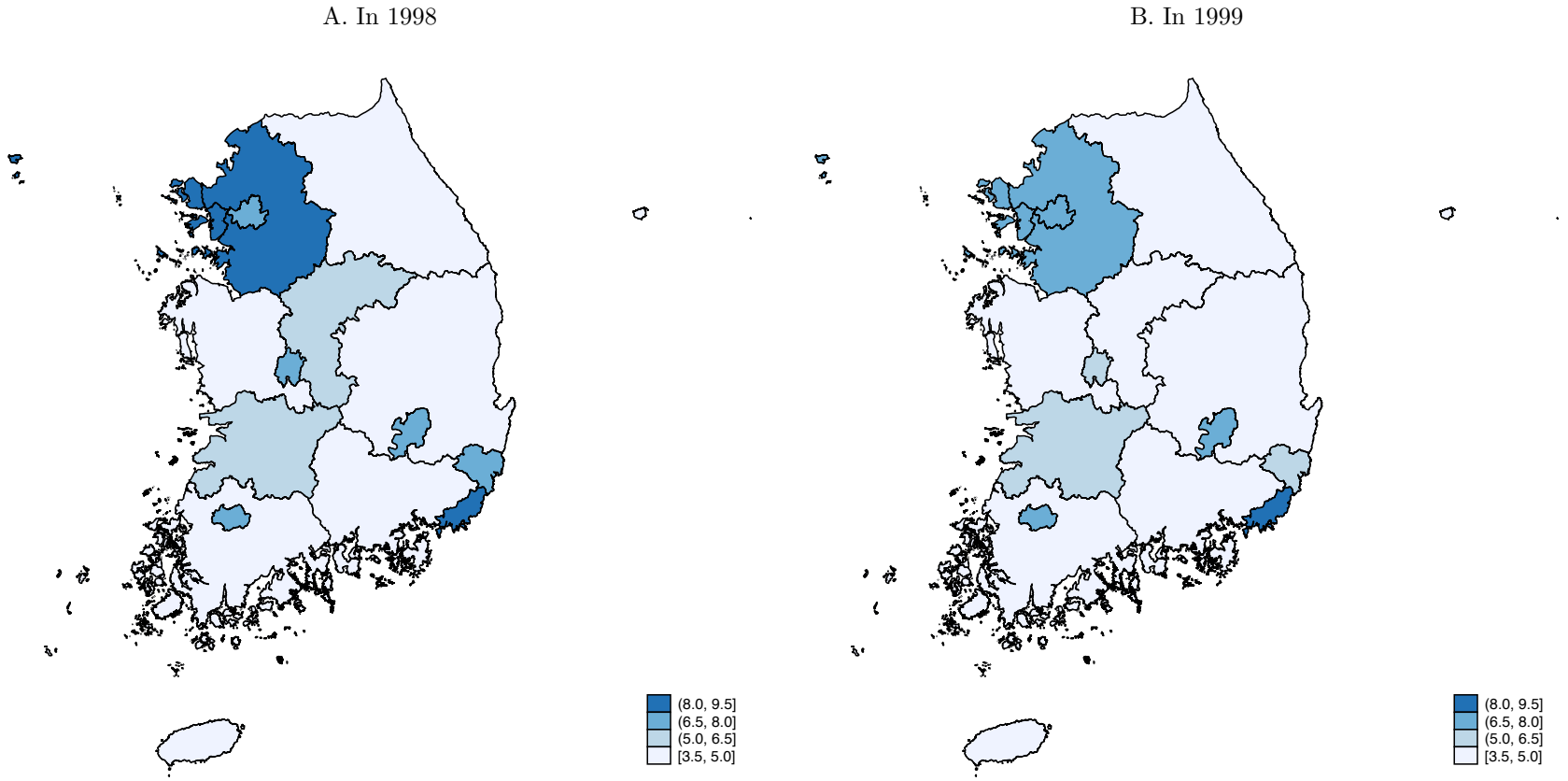

Figure S3: Regional Unemployment Rates in 1998 and 1999

Notes. Regional unemployment rates are calculated using regional labor force statistics from Statistics Korea, including the working-age population, the employment-to-population ratio, and the size of the labor force.

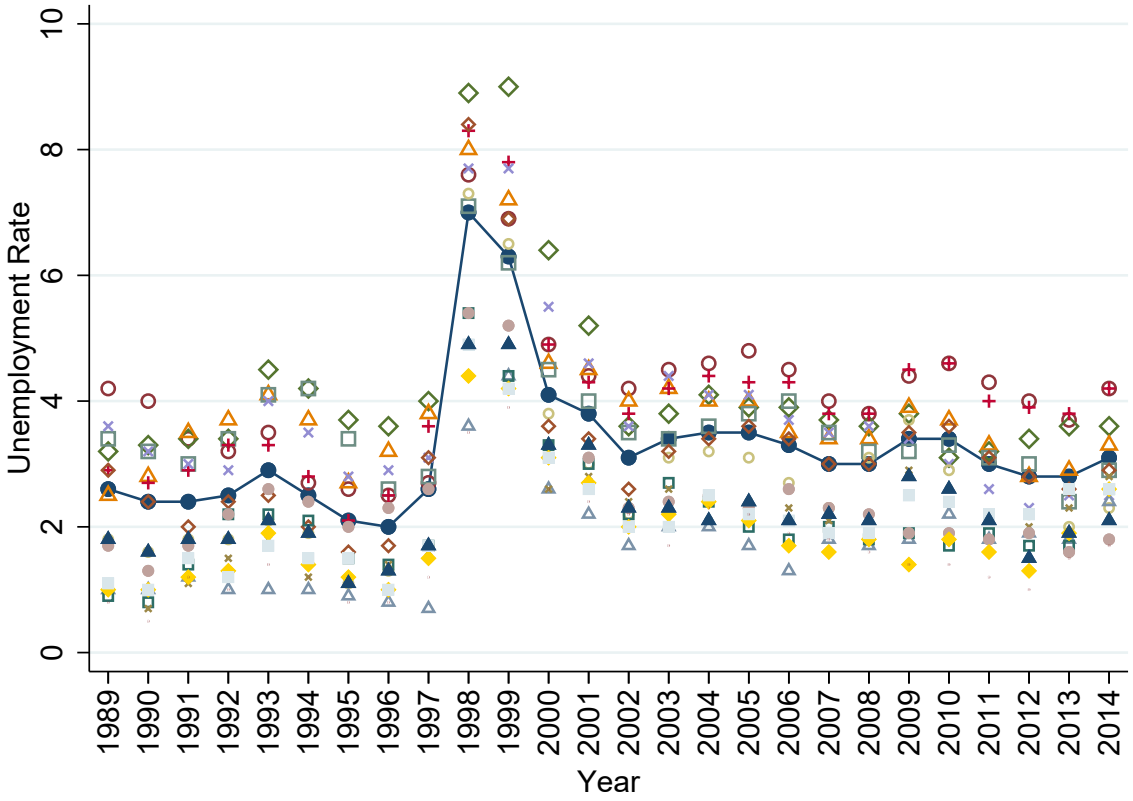

Figure S4: National and Regional Unemployment Rates

Notes. Taken from Choi et al. (2020) Figure A1 panel A. The solid line displays the national unemployment rate, and the various bullet shapes indicate regional unemployment rates.

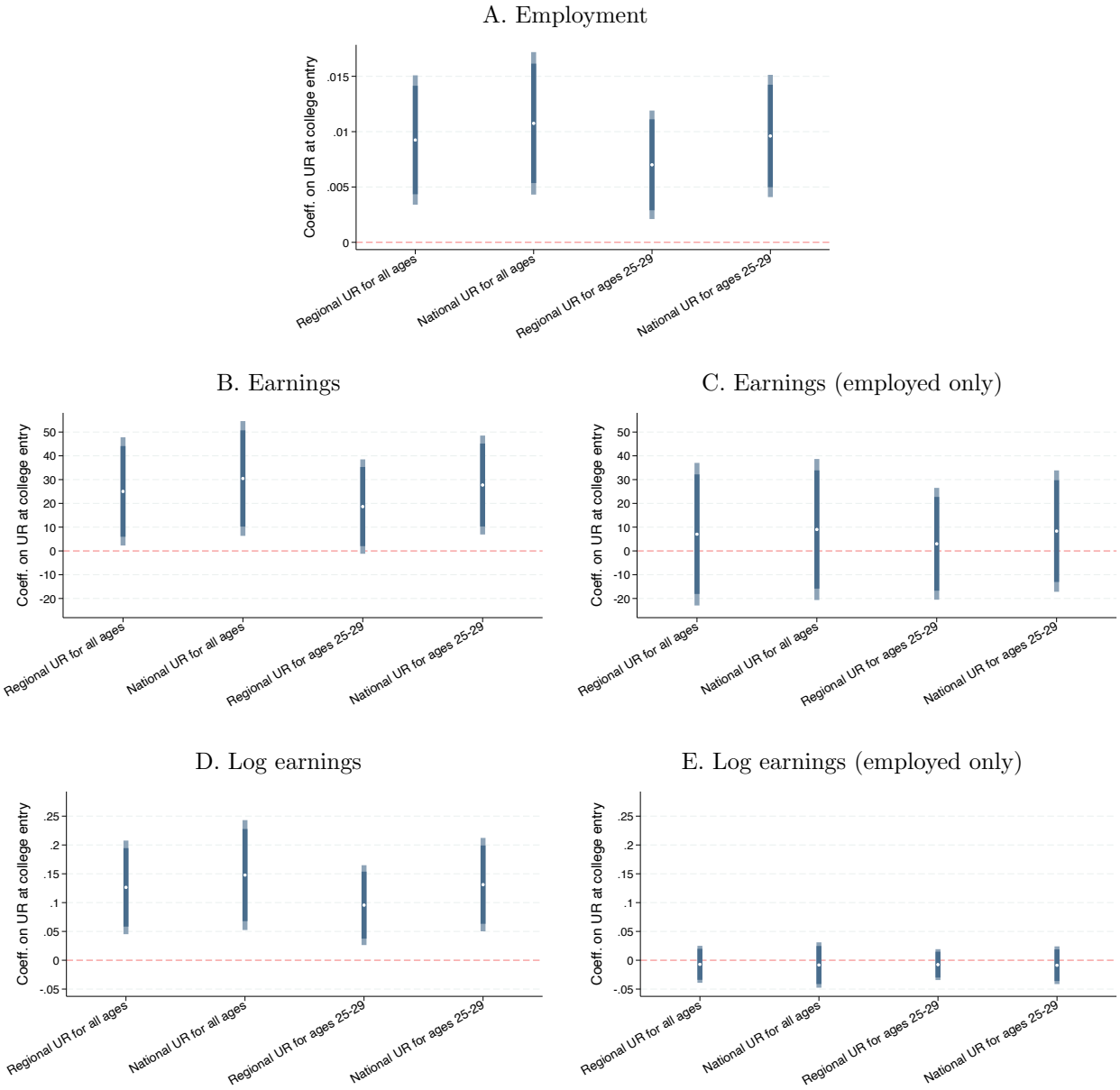

Figure S5: Robustness Checks: Alternative Measures of Unemployment Conditions

Notes. Vertical spikes around each point estimate represent the 95% and 90% (darker) confidence intervals, clustered at the cohort-by-region level. Regressions include a cubic function of college entry year and fixed effects for college region, age, and calendar year. Controls for background characteristics include indicator variables for sex, type of college (2-year vs. 4-year), father's education level (high school graduate, college graduate or higher), and parents' job status at age 14 (standard worker, non-standard worker, business owner hiring employees, business owner with no employee).

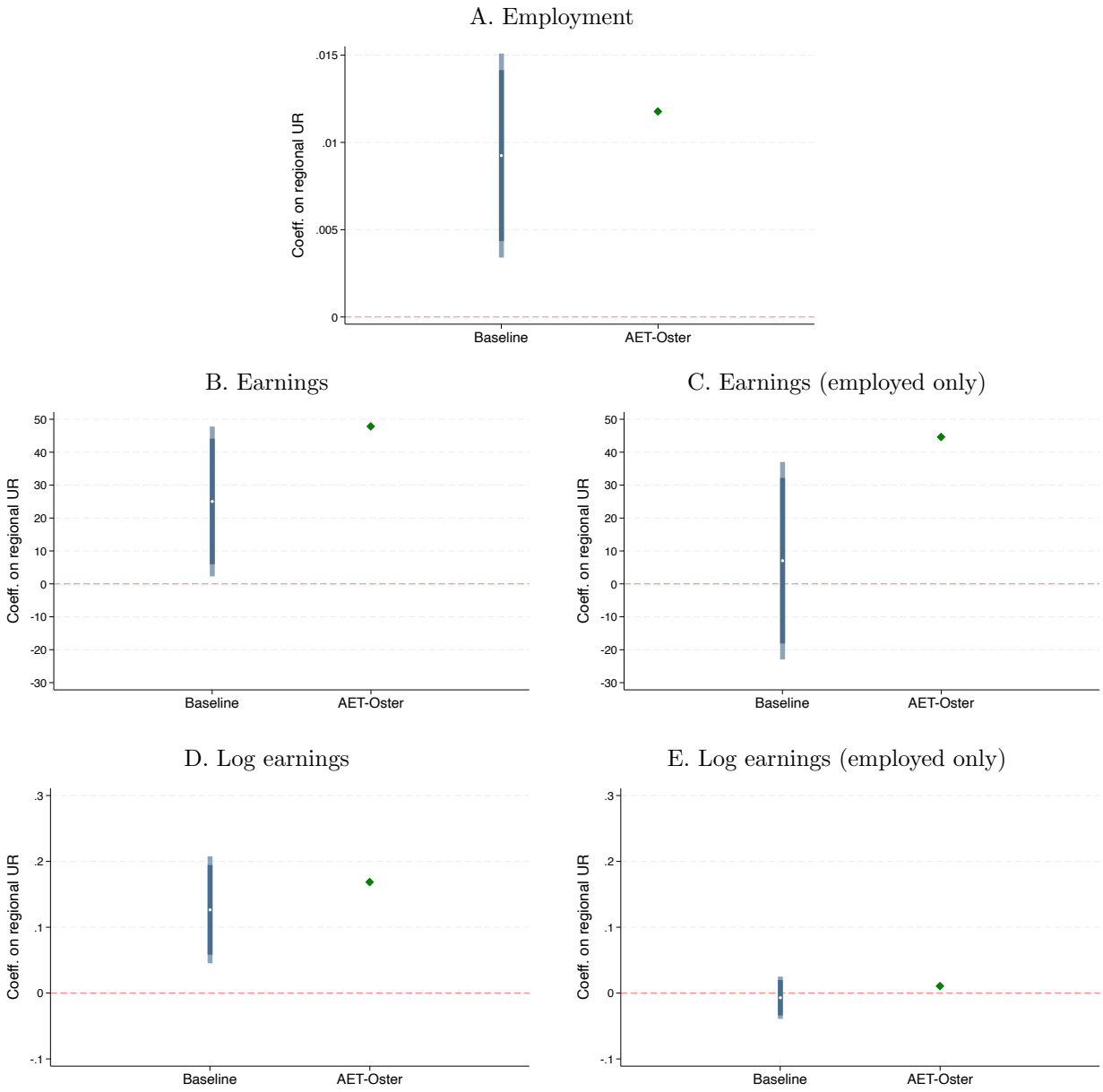

Figure S6: Selection on Unobservables

Notes. Vertical spikes around each point estimate from the baseline regression represent the 95% and 90% (darker) confidence intervals, clustered at the cohort-by-region level. Regressions include a cubic function of college entry year and fixed effects for college region, age, and calendar year. Controls for background characteristics include indicator variables for sex, type of college (2-year vs. 4-year), father's education level (high school graduate, college graduate or higher), and parents' job status at age 14 (standard worker, non-standard worker, business owner hiring employees, business owner with no employee). Green diamonds indicate the AET-Oster bias-adjusted estimates.

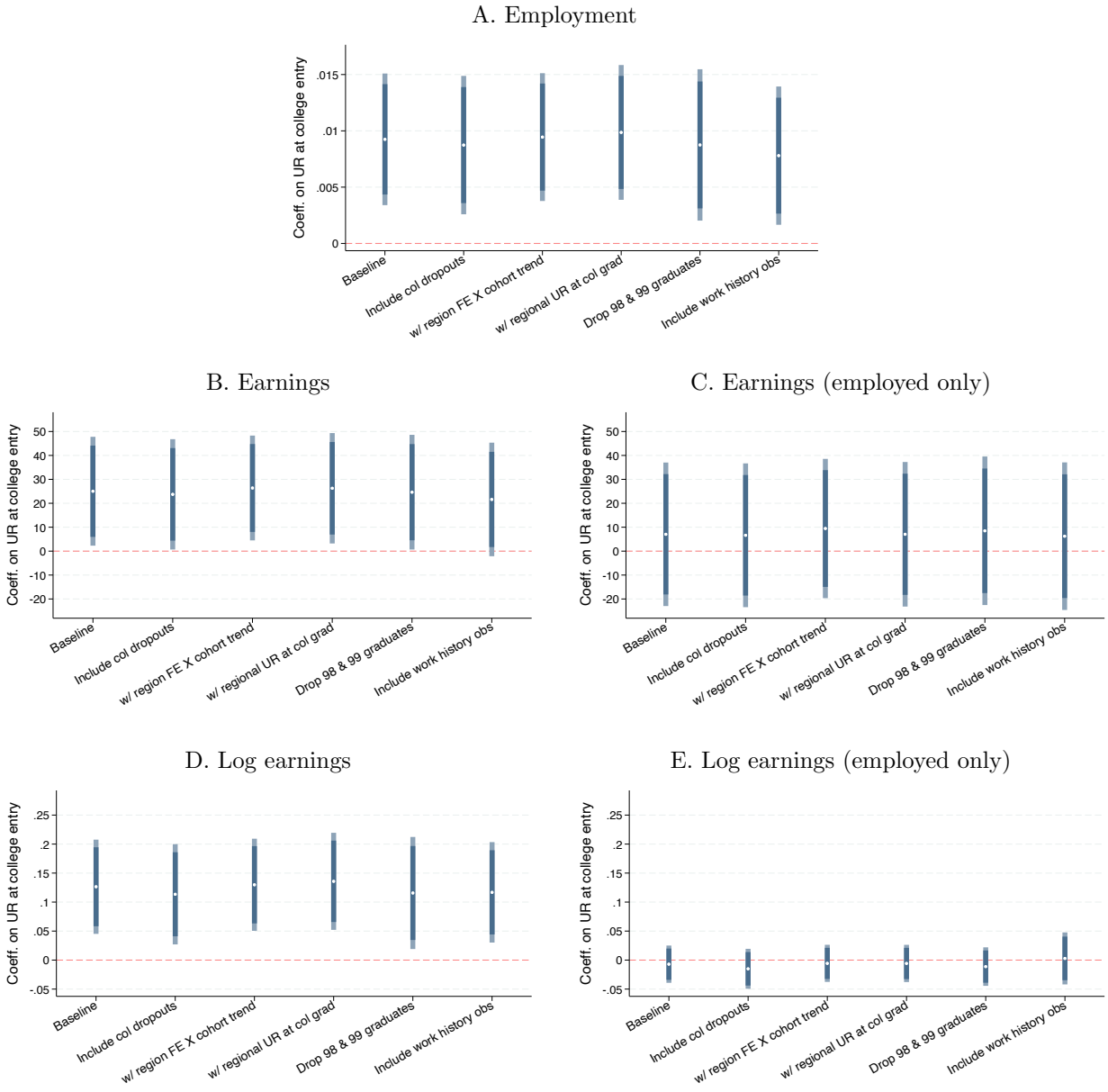

Figure S7: Robustness Checks: Alternative Samples and Specifications

Notes. Vertical spikes around each point estimate represent the 95% and 90% (darker) confidence intervals, clustered at the cohort-by-region level. Regressions include a cubic function of college entry year and fixed effects for college region, age, and calendar year. Controls for background characteristics include indicator variables for sex, type of college (2-year vs. 4-year), father's education level (high school graduate, college graduate or higher), and parents' job status at age 14 (standard worker, non-standard worker, business owner hiring employees, business owner with no employee).

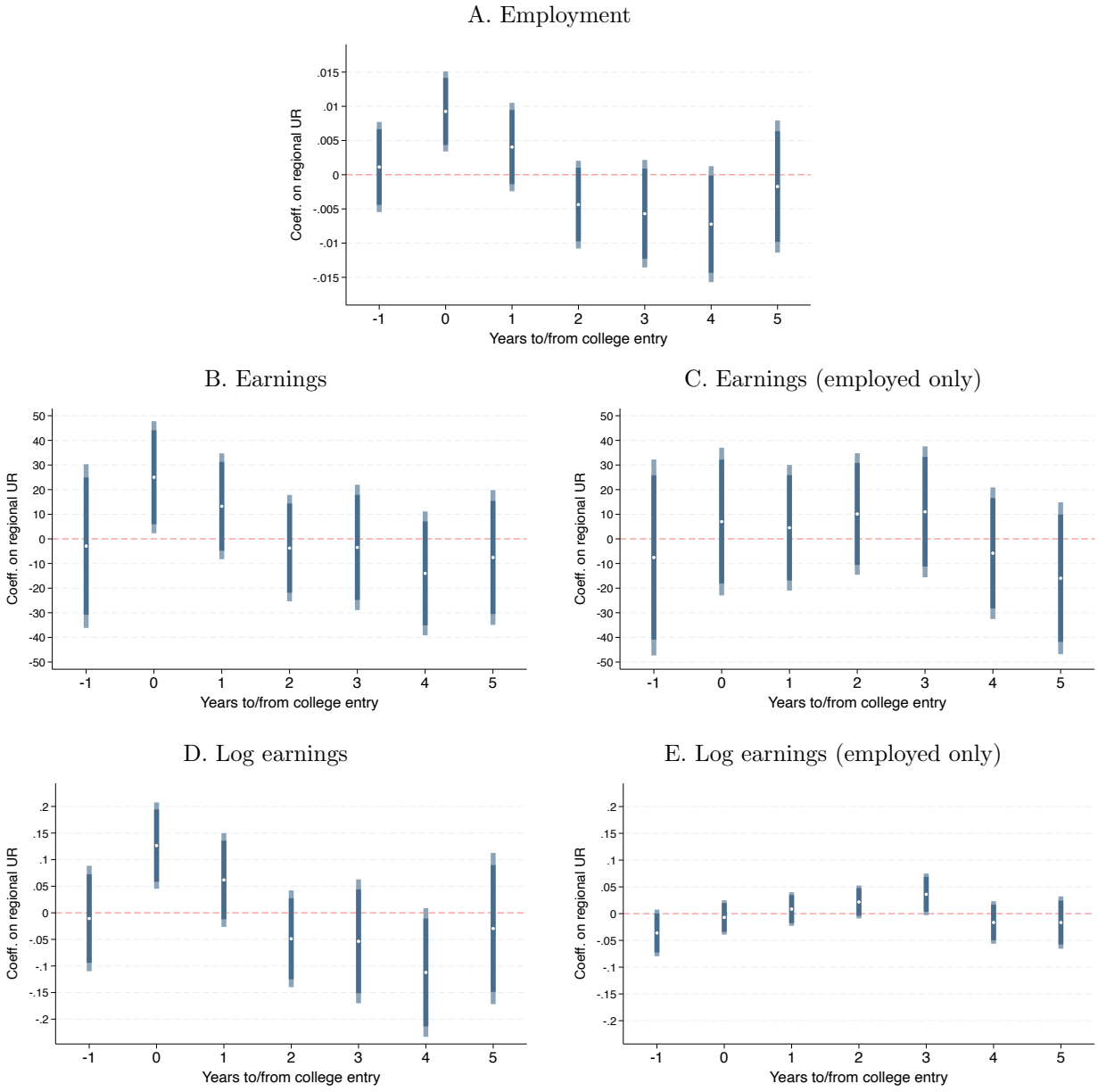

Figure S8: Effects of Unemployment Rates in the Years Before and After College Entry

Notes. Vertical spikes around each point estimate represent the 95% and 90% (darker) confidence intervals, clustered at the cohort-by-region level. Regressions include a cubic function of college entry year and fixed effects for college region, age, and calendar year. Controls for background characteristics include indicator variables for sex, type of college (2-year vs. 4-year), father's education level (high school graduate, college graduate or higher), and parents' job status at age 14 (standard worker, non-standard worker, business owner hiring employees, business owner with no employee).

Table S1: Summary Statistics

	Mean	SD	Obs.
A. Treatment variables			
Regional unemployment rate at college entry	3.412	[1.604]	3,959
College entry year	1998.1	[4.968]	3,959
B. Background characteristics			
Male	0.513	[0.500]	3,959
Attended 4-year college	0.621	[0.485]	3,959
Father's education			
Some high school or less	0.380	[0.485]	3,902
High school graduate	0.437	[0.496]	3,902
College graduate or higher	0.183	[0.387]	3,902
Parents' job status at age 14			
Regular wage worker	0.450	[0.498]	3,847
Irregular wage worker	0.071	[0.256]	3,847
Business owner (with employees)	0.136	[0.343]	3,847
Business owner (no employee)	0.327	[0.469]	3,847
Unemployed or unpaid family worker	0.016	[0.126]	3,847
C. Labor market outcomes			
Employed	0.741	[0.438]	21,809
Real monthly earnings (in 2020 1K KRW)	1,824.5	[1,645.7]	21,741
Real monthly earnings: employed only (in 2020 1K KRW)	2,464.0	[1,442.9]	16,099
Log real monthly earnings	10.634	[6.523]	21,741
Log real monthly earnings: employed only	14.360	[1.987]	16,099

Notes. The analysis sample includes 3,959 individuals and 21,809 observations at the person-year level. The observations vary due to missing values. Before taking the logarithm, monthly earnings are inflation-adjusted to 2020 KRW and zeros are imputed with 1 KRW. Standard deviations are in brackets.

Table S2: Placebo Analysis

	Employment	Earnings	Earnings (employed only)	Log earnings	Log earnings (employed only)
	(1)	(2)	(3)	(4)	(5)
A. Main					
Regional *UR*	0.009***	25.032**	7.038	0.126***	−0.007
	(0.003)	(11.555)	(15.233)	(0.041)	(0.016)
Adjusted R^2	0.102	0.241	0.229	0.113	0.029
Observations	21,809	21,741	16,099	21,741	16,099
Mean of Y	0.741	1,824.5	2,464.0	10.634	14.360
B. Placebo 1: Without Individuals Entering College in 1998 or 1999					
Regional *UR*	0.002	−26.786	−40.591	−0.008	−0.044
	(0.009)	(51.641)	(62.755)	(0.126)	(0.043)
Adjusted R^2	0.102	0.238	0.223	0.115	0.031
Observations	19,283	19,218	14,217	19,218	14,217
Mean of Y	0.741	1,829.2	2,472.6	10.624	14.360
C. Placebo 2: Control for Economic Conditions One Year Prior to College Entry					
Regional *UR*	0.010***	32.553**	13.524	0.155***	0.006
	(0.003)	(14.012)	(18.708)	(0.038)	(0.015)
Lagged regional *UR*	−0.004	−17.293	−13.346	−0.079	−0.039*
	(0.003)	(18.574)	(22.979)	(0.051)	(0.021)
Adjusted R^2	0.099	0.237	0.227	0.111	0.030
Observations	21,179	21,116	15,599	21,116	15,599
Mean of Y	0.740	1,814.8	2,456.7	10.607	14.359

Notes. Regressions include a cubic function of college entry year and fixed effects for college region, age, and calendar year. Controls for background characteristics include indicator variables for sex, type of college (2-year vs. 4-year), father's education level (high school graduate, college graduate or higher), and parents' job status at age 14 (standard worker, non-standard worker, business owner hiring employees, business owner with no employee). Robust standard errors in parentheses are clustered at the cohort-by-region level. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$.

Table S3: Sensitivity of $\hat{\beta}$ to the Scale of Earnings Using Log(1 + Earnings) as the Dependent Variable

	Earnings in				
	1 KRW	1K KRW	10K KRW	100K KRW	1M KRW
	(1)	(2)	(3)	(4)	(5)
Regional *UR*	0.126***	0.068***	0.048***	0.029***	0.009**
	(0.041)	(0.021)	(0.015)	(0.009)	(0.004)
Adjusted R^2	0.113	0.128	0.141	0.174	0.300
Observations	21,741	21,741	21,741	21,741	21,741
Mean of Y	10.634	5.609	3.934	2.259	0.585

Notes. Regressions include a cubic function of college entry year and fixed effects for college region, age, and calendar year. Controls for background characteristics include indicator variables for sex, type of college (2-year vs. 4-year), father's education level (high school graduate, college graduate or higher), and parents' job status at age 14 (standard worker, non-standard worker, business owner hiring employees, business owner with no employee). Robust standard errors in parentheses are clustered at the cohort-by-region level. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$.

Table S4: Mediation Analysis

	(1)	(2)	(3)	(4)	(5)	(6)
			A. Outcome: Employment			
Regional *UR*	0.009***	0.010***	0.008***	0.009***	0.005*	0.005
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Adjusted R^2	0.102	0.106	0.106	0.107	0.217	0.221
Observations	21,809	21,809	21,809	21,809	21,809	21,809
Mean of Y	0.741	0.741	0.741	0.741	0.741	0.741
			B. Outcome: Earnings			
Regional *UR*	25.032**	27.294**	23.911**	25.586**	19.725*	14.067
	(11.555)	(11.047)	(11.570)	(11.951)	(10.772)	(12.139)
Adjusted R^2	0.241	0.247	0.244	0.255	0.292	0.293
Observations	21,741	21,741	21,741	21,741	21,741	21,741
Mean of Y	1,824.5	1,824.5	1,824.5	1,824.5	1,824.5	1,824.5
			C. Outcome: Log Earnings			
Regional *UR*	0.126***	0.139***	0.116***	0.128***	0.068*	0.060
	(0.041)	(0.043)	(0.043)	(0.041)	(0.040)	(0.043)
Adjusted R^2	0.113	0.118	0.118	0.118	0.226	0.228
Observations	21,741	21,741	21,741	21,741	21,741	21,741
Mean of Y	10.634	10.634	10.634	10.634	10.634	10.634
Controls	✓	✓	✓	✓	✓	✓
Region of college FE	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
Age FE	✓	✓	✓	✓	✓	✓
Region of residence FE		✓				
Education level FE			✓			
Major-by-year FE				✓		
Industry-by-year FE					✓	
Occupation-by-year FE						✓

Notes. Regressions include a cubic function of college entry year and fixed effects for college region, age, and calendar year. Controls for background characteristics include indicator variables for sex, type of college (2-year vs. 4-year), father's education level (high school graduate, college graduate or higher), and parents' job status at age 14 (standard worker, non-standard worker, business owner hiring employees, business owner with no employee). Robust standard errors in parentheses are clustered at the cohort-by-region level. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$.