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ABSTRACT

Good Skills in Bad Times: Cyclical Skill Mismatch and the Long-Term Effects of Graduating in a Recession*

We show that cyclical skill mismatch, defined as mismatch between the skills supplied by college graduates and skills demanded by hiring industries, is an important mechanism behind persistent career loss from graduating in recessions. Using Norwegian data, we find a strong countercyclical pattern of skill mismatch among college graduates. Initial labor market conditions have a declining but persistent effect on the probability of mismatch early in their careers. We provide a simple model of industry mobility that is consistent with our empirical findings. The initially mismatched graduates are also more vulnerable to business cycle variations at the time of graduation.

JEL Classification: E32, J31, J62

Keywords: mismatch, business cycle, graduation

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1 Introduction

There is a growing literature showing that labor market conditions at the time of labor market entry have large and persistent negative effects on careers. For example, recent papers by Kahn (2010) and Oreopoulos, von Wachter, and Heisz (2012) show that college graduates in North America suffer persistent declines in earnings lasting up to ten years. Similar evidence has been found using data sets from other countries.[1] Understanding the mechanisms driving these persistent career losses is essential to the design of government employment programs aimed at helping young workers.

While much is known about the overall magnitude and heterogeneity of these persistent losses, less work has been done on the mechanisms driving the highly persistent career losses. The difficulty is to explain the persistence in career losses from presumably short-lived labor market shocks. The literature has pointed out that the quality of first job placement is important in explaining the long-term career losses. Hagedorn and Manovskii (2010) and Frühwirth-Schnatter, Pamminger, Weber, and Winter-Ebmer (forthcoming) provide evidence that idiosyncratic match quality is affected by the tightness of the labor market. Kwon, Milgrom, and Hwang (2010) find that those who graduate in booms are promoted faster, even when conditional on proxies for productivity. Oreopoulos et al. (2012) find that the lower quality of the first job can explain the persistence of earnings losses, but only when combined with search frictions that intensify with age.

We add to this literature by showing that skill mismatch, defined as mismatch between the skills supplied by college graduates and skills demanded by hiring industries, is another important mechanism behind the persistent career loss from graduating in recessions. The existing literature pays little attention to the matching of heterogeneous skills within each cohort of graduates and heterogeneous demand for skills by hiring industries. We define the type of skill supplied as the field of study in college. Mismatch occurs when a worker is matched to an industry which

[1] See Oyer (2006) (US), Brunner and Kuhn (2010) (Austria), Kondo (2007); Genda, Kondo, and Ohta (2010) (Japan) and Stevens (2007) (Germany). While not focusing on college graduates, papers by Ellwood (1982), Burgess, Propper, Rees, and Shearer (2003) and Raaum and Røed (2006) find persistent effects of youth unemployment on the careers later in life.

does not value her/his skill. We motivate our definition of skill mismatch by a simple two-period model in which individuals have heterogeneous skills that depreciate if not utilized. In each period, they choose which of two industries to work in. In this setting, shocks to industry productivity can induce some to work in an industry they did not expect to choose, and even transitory shocks to productivity have long-term consequences because of skill dynamics. In the absence of market inefficiencies, mismatch is efficient and neutral with respect to the business cycle. We show, however, that with credit constraints and a minimum level of consumption, mismatch can be inefficient, and there is more such inefficient mismatch in recessions.

Our paper also relates and extends the mismatch literature in the economics of education by analyzing how skill mismatch varies over the business cycle and how a business cycle shock may give a persistent career shock.[2] Our theoretical model distinguishes two types of mismatch, efficient mismatch and inefficient mismatch, and derives the conditions under which they arise. We do not study the career differences between mismatched and nonmismatched workers. Our focus is on how skill mismatch varies over the business cycle.

Using administrative panel data from Norway, we show that there is a strong countercyclical pattern of skill mismatch among college graduates entering the labor market: a typical recession, with a rise in unemployment rate by three percentage points, implies an initial increase of about 30% in the probability of mismatch and a 9% downgrading in the average quality of their matches. The effects of initial labor market conditions on mismatch decline over time but remain highly persistent over early careers, suggesting that some graduates never switch back to the "right" industry. The effects are stronger and more persistent for graduates at the bottom of the IQ-score distribution and for graduates majoring in subjects with cyclical labor demands. We also find that initially mismatched graduates (i.e., those who were matched to the wrong industry in their first job) graduating in bad times experience persistently worse labor market outcomes when compared with mismatched work-

[2]See Leuven and Oosterbeek (2011) for an overview of the economics literature on skill mismatch. Note that skills in this literature are defined by types of education, and skill mismatch is equivalent to over- or undereducation.

ers graduating in good times. The careers of graduates who are matched to the right industry are less affected by graduating in recessions and their small initial career losses do not persist over time. Our findings suggest that the cyclical mismatch of college graduates could be an important driving force behind the persistent career loss found in many studies. For graduates whose mismatch is due to bad labor market conditions, industry mobility and job mobility are important channels to recover from initial losses. For other graduates, within-firm recovery is an important margin of adjustment. We also make efforts to check how robust our results are in relation to students' timing of graduation and region of graduation relative to the regional unemployment rates. In addition, on a male subpopulation, we control for differences in the composition of graduates over the business cycle using proxies for cognitive ability.

The paper is organized as follows: Section 2 describes a model that highlights how skill mismatch might arise over the business cycle, Section 3 explains our empirical strategy and relates it to previous literature. In Section 4 we present our data and situate the period we study in recent Norwegian business cycle history before we provide our results in Section 5 with some robustness tests in Section 6 and concluding remarks in Section 7.

2 How Skill Mismatch Can Arise Over the Business Cycle—An Analytical Framework

In this section, we provide a simple analytical framework to demonstrate how skill mismatch might arise and how it relates to the business cycle.

Assume that there are two industries, 1 and 2, and that firms are homogeneous within each industry. Every worker (recent college graduate) is endowed with a skill bundle $z_i = (z_i^1, z_i^2)$, where z_i^j is the productivity of worker i matched to a firm in industry j. Some graduates are ex ante more productive in the first industry ($z_i^1 > z_i^2$). Such a worker would have an ex ante expectation of working in industry 1, and we say that such a worker has been *trained for* industry 1, and we shall consider it a form of mismatch if he or she works in industry 2. Similarly, the other

workers are trained for industry 2.

We assume that α^j is an industry-wide productivity shock to industry j. This is a random variable realized in each period, just before individuals choose which industry to work for. We normalize the expectations of α^1 and α^2 to zero. When worker i is matched to industry j, production is

$$y(i,j;\alpha) = z_i^j + \alpha^j. \tag{1}$$

We assume that workers are paid their marginal product, $w(i,j;\alpha) = y(i,j;\alpha)$, and allow the αs to be potentially correlated in the cross-section, but we assume that the current realization of α is not informative about future values of α.

We further assume workers to be risk-neutral, and to live for two periods. In each period, they choose one of the two states in the labor market: they work in industry 1, or they work in industry 2. Denote the choices as $D_{it} \in \{1,2\}$. The value to a young worker i of working in industry j in period t is

$$V_t(i,j) = w_t(i,j;\alpha_t) + \beta E_t \max\left\{w_{t+1}(i,1;\alpha_{t+1},D_{it}), w_{t+1}(i,2;\alpha_{t+1},D_{it})\right\}. \tag{2}$$

The expectation is taken with respect to the second period's realization of the industry-wide productivity shock α_{t+1}, and β is the discount factor.

The current choice can affect future wages because the evolution of skills, z_{it}, might depend on the worker's choice of industry. We assume that skills that are not used depreciate at rate γ,

$$z_{it+1}^j = \begin{cases} z_{it}^j \times (1-\gamma), & \text{if } D_{it} \neq j, \\ z_{it}^j, & \text{if } D_{it} = j. \end{cases} \tag{3}$$

In the case of unemployment, both types of skills depreciate. Skill dynamics can be motivated by the model of vintage human capital developed in Violante (2002). In that model, skills are vintage-specific to the technology in one industry. With technological progress, original skills are only partially transferable to the new technology, exhibiting as skill loss for individuals.[3]

[3] See Neal (1995) for empirical evidence using displaced workers.

Thinking first about the second period's choice, it is clear that individuals with $z^1(1-\gamma)+\alpha^1 \geq z^2+\alpha^2$ will be offered higher wages in industry 1 regardless of their first-period choice. This defines a region in which $\alpha^2 \leq \alpha^1+(z^1-z^2)-\gamma z^1$. Similarly, if $\alpha^2 \geq \alpha^1+(z^1-z^2)+\gamma z^2$, individuals work in industry 2 regardless of their first-period choice. There is, however, a band in between, in which choice in the second period is determined by choice in the first period. This is illustrated in panel (a) of Figure 1, with the cutoffs being parallel lines with slopes of unity and vertical distance $\gamma(z^2-z^1)$. Choices in the first period have an effect on choices in the second period, so even if the realizations of αs are not persistent, outcomes (wages and matches to industry) will be persistent because of the skill dynamics.

Choices in the first period are made with regard to the expected depreciation of skills before entering the second period. However, because the αs are not persistent, the differences in future values between working in industry 1 and industry 2 today do not involve current realizations of α. This means that the optimal cutoff in the period is a line with slope of unity in α space, illustrated in panel (b) of Figure 1.

Workers who graduate with skills $z_i^1 > z_i^2$ expect to work in industry 1 rather than industry 2. However, as they enter the labor market, α is realized, and there is some probability that wages in industry k are high enough to ensure that $V(i,2) > V(i,1)$ even when $z_i^1 > z_i^2$. We say that these individuals are *efficiently mismatched* when they end up working in a different industry than they trained for because of transitory shocks to the labor market. This involves no loss to society or the workers. In order to induce the current mismatch, current wage benefits to the mismatch must not only be positive, but also larger than the increase in future depreciation of skills.

To illustrate what the business cycle could mean in such a context, imagine that the α process can be decomposed such that

$$\alpha_t^j = \zeta_t + \nu_t^j,$$

into a cyclical factor shared by both industries, ζ_t, and an industry-wide component independent of the cyclical factor, ν_t^j. In such a setting, the cyclical component does not impact on the relative utility of industries 1 and 2, the α-values are shifted parallel to the cutoffs in Figure 1, and the amount of efficient mismatch would be

the same.[4]

In the model so far, there is no unemployment and all production outcomes are efficient. But assume that workers are credit-constrained and have to achieve a minimum consumption level $\underline{c}$, which can, if necessary, be financed with unemployment benefits (which we, for simplicity, fix at $\underline{c}$). Now only those jobs with $\alpha^j \geq \underline{c} - z^j$ are feasible matches. In Figure 2 we have drawn this for a worker trained for industry 1; the dashed lines indicate the feasibility constraints. The area A is the set of α-realizations such that neither industry can help the worker realize the minimum consumption requirement, and the worker collects unemployment benefits instead. However, there is now also a triangular area B where the worker would, barring the market inefficiencies, choose to work in industry 1. Doing so would preserve skills better than taking the currently higher wage offered in industry 2. In the presence of credit constraints, however, this worker cannot finance maintaining the skills he or she trained for and is forced to work in industry 2, inefficiently mismatched.

While we saw that the cyclical component of the productivity shock shared by both sectors was neutral with respect to mismatch with no market frictions, this is no longer the case with the credit constraint. In good times, the α-realizations are moved to the northeast of Figure 2 and fewer people are forced to accept a mismatch because of credit constraints (in the B area). Inefficient mismatch is therefore countercyclical in the same way as unemployment.

If the realizations of α^1 and α^2 are highly correlated, we will tend to see more unemployment, because shocks cannot be buffered by workers going to work in industries other than the ones they trained for. If the realizations are less correlated there will be more mismatches, and the wage effects in the second period will be smaller. Depreciation of skills that are not used will have the effect that mismatch will tend to persist even if shocks to α are not. Mismatch will persist both with and without the presence of credit constraints, but with credit constraints there will be stronger long-term effects on realized wages, because workers will have to realize more inefficient mismatches.

We have shown that skill mismatches, defined by workers choosing industries

[4] A modification in which industry-wide productivity works multiplicatively instead of additively as in (1) would tend to induce pro-cyclical efficient mismatch.

valuing their skills less than others, could arise out of aggregate shocks, and the model predicts that inefficient mismatch, as can arise with market imperfections, is countercyclical. Efficient mismatch is neutral with respect to business cycle shocks. In the empirical analysis below, we provide evidence that measured mismatch is countercyclical. The model also predicts that mismatch will be persistent. We provide evidence that skill mismatch is indeed very persistent over the first ten years after entering the labor market, even though business cycle shocks are presumably temporary in nature.

3 Empirical Strategy

3.1 Measuring Skill Mismatch

Our approach is similar to Gottschalk and Hansen (2003), who classify noncollege and college occupations according to estimated wage premiums paid to college-educated workers. To measure skill mismatch, we first need to estimate z_i, the vector of efficiency units in different industries for a given worker ($z_i = (z_i^1, \ldots, z_i^J)$). Assuming that the type of the worker can be predicted by his major in college, we estimate z_i by estimating industry-specific wage premiums paid for a given major. Specifically, we run industry- and year-specific log earnings regressions on dummies for fields of study in college, using young workers who have less than ten years of potential experience. The estimated skill premiums are thus allowed to vary by year. As well as eight dummies for fields of study, each regression includes a dummy variable for females, a dummy variable for full-time workers, fixed effects for region of residence to control for regional differences in rental prices, and a quadratic in potential experience measured by years since graduation.[5] To ensure that each industry employs a large enough number of graduates in each field, we combine data for years $t-1$, t, and $t+1$ when estimating returns in t.

Every type of skill faces a distribution of wage premiums from all industries in a given year. We define skill mismatch as when workers are working in industries

[5] We have tried adding a third-order polynomial term in experience, but this makes no substantial difference.

that reward their skills less than the median skill premium they would receive in that year. We use the rank of an industry for a given skill as a proxy for the quality of the worker-industry match. Note that because the regressions are run by year, any common trend in wage growth will not affect the distribution of the skill premiums. If the worker is unemployed for an entire calendar year, no mismatch indicator is assigned.

The estimated industry- and year-specific skill premiums are biased, because workers self-select into different majors and different industries. However, our goal is to estimate changes in the mismatch (defined below using the estimated skill premiums) over the business cycle, and it is reasonable to assume that college major choice does not vary over the business cycle at the time of graduation. Berger (1988) and Beffy, Fougère, and Arnaud (2012) provide evidence that the choice of field by college students is not very responsive to business cycle variations in labor market conditions. Part of the self-selection into industries may be correlated to the business cycle, but this is precisely what we are after: we are interested in how industry choices for a given type of skill vary with labor market conditions at the time of graduation. We attempt to control for ability when estimating the long-term consequences of the first industry choice in bad times. Our results indicate that cyclical changes in skill mismatch measure changes in labor demand rather than pure changes in the composition of supply of skills.

3.2 Estimating the Short- and Long-term Effects of Initial Labor Market Conditions

We approximate initial labor market conditions using the regional unemployment rate at the time of graduation. We start by assuming that variations in unemployment rates reflect exogenous changes in local labor demand. In Section 6, we conduct various robustness tests providing support for this assumption. Our goal is to identify the short- and long-term effects of initial labor market conditions on our indicators of skill mismatch and on a range of other labor market outcomes such as earnings, unemployment, and labor mobility.

Following Oreopoulos et al. (2012), we model the outcome variable in period t

for a graduating cohort c from region r as

$$y_{crt} = \beta_1 + \beta_2^e U_{cr} + \phi_t + \theta_r + \gamma_e + \xi_c + u, \tag{4}$$

where $\theta_r, \xi_c, \gamma_e, \phi_t$ are fixed effects for region of the college at the time of graduation, year of graduation (or graduating cohort c), year of potential labor market experience and calendar year. U_{cr} is the regional unemployment rate measured at the time of graduation and the region of the graduating school. The coefficients on the initial unemployment rate, β_2^e, are allowed to vary with levels of potential experience. Provided that variations in U_{cr} capture exogenous changes in labor demand, the β_2^e estimated using ordinary least squares captures the causal effect of initial labor market conditions. As Oreopoulos et al. (2012) points out, β_2^e estimates the average change by experience level, given the regular evolution of the regional unemployment rate faced in the future. It captures short- and long-term changes in experience profiles from region-cohort-specific variations in unemployment rates.

In order to estimate the model, we first cluster our panel data into cells defined by cohort, calendar year, and region of graduation. We then estimate equation (4) weighted by the corresponding cell sizes. Since the main regressor U_{cr} varies by region of graduation and cohort, we cluster the standard errors at region of graduation and cohort level. We drop one additional cohort effect from the regression in order to identify cohort, experience, and year effects separately.

4 Data and Sample Selection

The data on workers used in our study are derived from administrative registers and prepared for research by Statistics Norway. The data covers all Norwegian residents aged 16–74 years old in the years 1986–2006. We have information about employment relationships, labor income, educational attainment, field of education and date of completion, labor market status, and a set of demographic variables such as gender, age, experience, and marital status. A unique person identifier allows us to follow workers over time. Likewise, each worker is matched to a firm, allowing us to identify each worker's employer. Regional labor market characteristics such

as unemployment rates are also available.

The sample used in our main analysis is constructed by first identifying the cohorts graduating between 1980 and 2006. We then drop those who ever became self-employed or ever returned to school and people with missing years of observations. In our main sample, we include both men and women. We focus on the first ten years following graduation from college. In the specifications of the main analysis, only cohorts graduating in 1988 or later are used in the regression because certain outcome variables such as the duration of registered unemployment is not available before 1988 (but we use the cohorts prior to 1988 when calculating the skill premia).

The main focus of the study is college graduates with 13–16 years of education who graduate between the ages of 19 and 25. We have the exact date of graduation and the municipality of the college which any student attends, the latter being important for calculating mobility patterns. We also have the exact date of initial enrolment and whether students take a shorter or longer time than the scheduled time for a program. This is important when calculating whether students are delaying finishing or rushing to finish depending on the business cycle.

We define seven categories of field of study based on the international standard for education (Statistics Norway, 2003). These fields of study are given in Table 1. We fix the field of study at the graduation year. We drop people whose education relates to primary industries or who are in noncategorized fields. The other element used when calculating the mismatch index is the seven industries defined using the single-digit ISIC classification (Statistics Norway, 1983).[6]

Other outcomes used are annual earnings and mobility. Our measure of earnings is the sum of pretax market income (from wages and self-employment) and work-related cash transfers, such as unemployment benefits, sickness benefits, and parental leave benefits. Regional mobility is measured by mobility between coun-

[6]There is a trade-off in the choice of industry-field classifications. For example, to use more detailed industries we would have had to amalgamate certain fields of study in order to have a sufficiently large sample for each industry-field-year cell. To get a large enough sample size for all industries, we merge agriculture, mining, electricity and water, and construction into one. We also separate out social services, including health and education, because this comprises 30 percent of the employment.

ties (there are 19 counties in Norway).

We use regional (county) level unemployment rates in our regression analysis. The unemployment rate is taken from the Norwegian Labor and Welfare Organization (NAV). We exploit one major downturn and one smaller downturn plus two upturns that took place in Norway in the data period. The national unemployment rate is reported in Figure 3 for the period 1986–2006. Particularly interesting for this analysis is the severe bust that took place in Norway at the beginning of the data period starting in 1988/89. The downturn lasted until 1993, when unemployment rates began to decrease. This is the deepest and longest-lasting downturn in Norway since WWII. Unemployment rose from 1.5 percent to 5.5 percent, which is a historically large unemployment rate in Norway.[7] In addition to the unemployment rate, about 3 percent of the labor force was also on different labor market programs. One reason why the recession lasted so long was that a banking crisis was added to the problem in 1991/92 when the large private banks had to be saved by the government (Steigum, 2010). Following this recession, growth and employment picked up and a boom took place around 1998 where the unemployment rate was down to 2.4 percent of the labor force. The recovery flattened out in 1998, but lasted until 2001. In 2001–2003 there was a mild recession before a new and strong expansion started.

Information on IQ test scores is from Norwegian military records. Military service is compulsory for all able males in Norway. Before entering the service, their medical and psychological suitability is assessed: this occurs for the great majority around their eighteenth birthday. The IQ measure is a composite score from three timed IQ tests: arithmetic, word similarities, and figures.[8] The composite IQ test score is an unweighted mean of the three sub-tests. The IQ score is reported in stanine (Standard Nine) units, a method of standardizing raw scores into a nine-point

[7]These numbers are based on those fully unemployed persons registered at the national insurance offices on a particular week each year. If the annual unemployment survey data from Statistics Norway is used, the unemployment rate is about one percentage point higher.

[8]The arithmetic test is quite similar to the arithmetic test in the Wechsler Adult Intelligence Scale (WAIS) (Sundet, Tambs, Harris, Magnus, and Torjussen, 2005; Cronbach, 1964). The word test is similar to the vocabulary test in WAIS, and the figures test is similar to the Raven Progressive Matrix test (Cronbach, 1964). See Sundet, Barlaug, and Torjussen (2004), Sundet et al. (2005), and Thrane (1977) for details.

standard scale with a normal distribution, a mean of 5, and a standard deviation of 2.

5 Estimation Results

We begin this section by documenting the short- and long-term effects of graduating in recessions using the Norwegian data. We then provide empirical evidence that cyclical skill mismatch is an important mechanism explaining the persistent career loss. Specifically, we examine how skill mismatch changes over the business cycle, and estimate the long-term effects of initial labor market conditions for initially mismatched and nonmismatched workers. Finally, we discuss some robustness checks relating to our assumptions about the initial unemployment rate (our measure of recessions) and on the impact of composition changes for initially mismatched workers over the business cycle.

5.1 The Short- and Long-term Effects of Graduating in a Recession

Figure 5 plots the experience profiles of log annual real earnings by cohorts. There are large variations in starting wages across cohorts, which appear strongly correlated with business cycles. The initial differences gradually fade out and earnings across cohorts converge in a little over five years. Indeed, the earnings for people who are five years into the labor market show only minor variations over the business cycle. Figure 6 provides a clear picture of the negative correlation between starting wages and the national unemployment rate, both expressed in terms of deviations from their means. The correlations with initial unemployment rate decrease quickly as labor market experience grows. This pattern is very similar to studies using data from other countries.

We then investigate the effect of initial labor market conditions on a range of labor market outcomes, using the regression framework described earlier.[9] Figure

[9]To be consistent with our definition of mismatch (which is based on the worker-industry match in the first year after graduation), we only look at workers who report an employer in the first year

7 shows the point estimates and the 95% confidence bands of the effects of regional unemployment rate on annual log real earnings, whether becoming unemployed at any time of the year, and months of registered unemployment in a year.[10] Panel A demonstrates that graduates in recessions suffer from significant earnings loss in the first few years after college. A one-percentage-point increase in the unemployment rate leads to four-percent-lower annual earnings in the first two years after graduation. The losses in annual earnings become insignificant by the fourth year after graduation. Compared with Oreopoulos et al. (2012), the magnitude of the initial earnings loss is similar, but the losses in earnings are less persistent.[11] With generous unemployment protection in Norway, workers are more likely to choose unemployment rather than working at jobs with significant wage reductions. This is confirmed when we turn to the effects on indices of unemployment in the last two columns in Panel A. While the effects on annual earnings have been limited to the first three years, the effects on unemployment are strong and persistent. We find that a one-percentage-point rise in the local unemployment rate increases the probability of unemployment by one percent in the first year after college, and the effects are persistent up to eight years after graduation. The effect on the duration of registered unemployment also persists over almost the entire first ten years.

Panel B shows the effects of graduating in a recession on labor mobility. The literature has argued that job mobility is the main mechanism of recovery from graduating in a recession. Our estimates are consistent with the literature. For people graduating in recessions, the probability of an annual job change increases significantly in the first few years, followed by a gradual decline. In addition, graduates entering the labor market in recessions are more likely to switch industries throughout their careers.[12] Regional mobility, however, does not appear to be correlated

after graduation. Assuming people who remain unemployed in the first year are more likely to fare worse, the estimates are likely to be lower bounds of the true effects of initial conditions over the whole sample.

[10]Unemployment is defined as having nonzero months of registered unemployment or being in one of the government-sponsored training programs targeting the unemployed.

[11]The initial loss in earnings remains less persistent even if we only include workers who are employed in all years in the sample (in this case, the initial loss is smaller).

[12]Job mobility and industry mobility are identified by annual change in employer ID and industry code, respectively.

with regional labor market conditions at the time of graduation.

Finally, we show the effects of initial labor market conditions on permanent firm characteristics. We measure firm characteristics by the mean size of establishment and the average wages paid to all workers over all years, which are typically regarded as a proxy for firm quality.[13] The estimated effects of regional unemployment rate reveal changes in employer quality over time. Panel C demonstrates that there is a significant decline in the quality of the first employer when graduating during recessions. Firm qualities quickly improve in the following two years, consistent with the periods when job mobility is highest.

5.2 The Effect of Recessions on Skill Mismatch

The mean estimated skill premiums over all years for all industries are summarized in Table 1. There are substantial differences in the wage premiums paid for a given type of skill. For example, graduates with a degree in Health and Welfare are valued most in the Social and Related Community Services sector and least in the Manufacturing sector. According to our definition, the manufacturing sector is a mismatch for these graduates. There are also considerable variations in the wage premiums for different skills within an industry. For example, the wage premium for skills in Business in the Financing, Insurance, Real Estate and Business Services sector is three times as much as the wage premium paid for skills in Humanities and Arts.

In Figure 4, we plot the probability of mismatch by experience level and the national unemployment rate against years of graduation. These are expressed as deviations from the mean. We find a positive correlation between the probability of mismatch and the national unemployment rate. This correlation appears highly persistent, and is evident even five years after labor market entry.

To identify the true cyclical variations in mismatch, we estimate equation (4) using mismatch as an outcome variable. The regression analysis allows us to control for permanent differences across regions of graduation and graduating cohorts. The first three columns in Table 2 present the estimated effects of initial regional

[13]Note that we use the mean annual earnings for all workers in a given plant at a given time (November of each year) as a proxy for firm-specific wages.

unemployment rate by years since graduation. Column (1) clearly shows a persistent positive effect on the probability of mismatch from graduating in a recession. A one percent increase in the regional unemployment rate at the time of graduation leads to a 3.4% increase in the probability of a mismatch in the first year. Given that the average probability of skill mismatch in the first year is 0.32, this represents an increase of more than 10%. The effect deteriorates by about one-third by five years after graduation, suggesting that some initially mismatched college graduates find their way back to the industries matching their skills. However, even five years after labor market entrance, the probability of mismatch remains nearly 2% higher for workers graduating from worse economic conditions. The persistent effects from initial labor market conditions indicate that a substantial number of mismatched graduates did not switch to the "right" industries in the long run.

Column (2) reports results for graduates whose fields of study were most likely to lead to careers in health and education, which account for a large share of public employment. Interestingly, we do not find any significant effects of initial labor market conditions on the likelihood of an initial placement mismatch. In contrast, graduates majoring in other fields, which are more likely to lead to private sector employment, are more likely to be mismatched over their entire early careers (column 3). One possible explanation is that demand shocks in the public sector are less cyclical, which leads to acyclical mismatch under the assumptions of our theoretical model.

In columns (4)–(6), we consider an alternative approach and create an index of industry-skill match quality based on the estimated skill premiums. We rank all the industries from 1 to 7 (7 being the highest) according to the wage premium for a given skill type in a given year. We use this rank variable as a measure of match quality and estimate equation (4). The estimated coefficients β_2^e capture changes in the quality of the industry-skill match over time. Consistent with our findings from the mismatch indicator, we find persistent downgrading of the industry-skill match quality for workers graduating in recessions. Those graduating in recessions are more likely to accept jobs in "worse" industries than in industries they would have entered under normal economic conditions. Given that the mean match quality is around five, with an increase in unemployment of three percentage points (corre-

sponding to a shift in unemployment rate from good to bad times), match quality is about 9% lower in the first year and remains nearly 5% lower ten years later. The results are entirely driven by graduates majoring in fields aimed at work in the sector, who experience larger and more persistent negative effects on their match quality. Graduates with majors for careers in the public sector do not experience any downgrading in the quality of their matches.

The finding that temporary macroeconomic shocks can have persistent effects on the industry-skill match quality is striking. Nevertheless, this is consistent with our model, where temporary industry-wide technology shocks may generate persistent skill mismatch over the long run. In Table 3, we show how the persistence and magnitude of cyclical mismatch varies with age-adjusted IQ scores.[14] We divide our sample into four groups based on the quartiles of age-adjusted IQ scores and repeat our exercise on the probability of mismatch and the match quality on each group. We find that graduates whose IQ scores are in the bottom quartile fare worst in adverse economic conditions: they are almost twice as likely to be mismatched throughout the first ten years. A typical recession, with a rise in unemployment rate of three percentage points, leads to an 18% downgrading in the quality of their matches.[15] People who are in the lower and upper middle quartiles appear to be able to find the right match six years after graduating during recessions. Interestingly, the top quartile group appears to fare worse than the upper middle quartile.[16] Therefore, the pool of cyclical mismatched workers consists of individuals at both the bottom and the top of the IQ distribution.

[14] Age-adjusted IQ score is constructed by subtracting the age-specific mean (age at the time of the test) and dividing it by the age-specific standard deviation.

[15] The average match quality for this group is 4.5.

[16] We find that students in the top quartile are the least likely to choose a field of study leading to a career in the public sector. The percentages of people choosing public fields of study are 12.84, 11.01, 9.04, and 6.68% for the four quartiles from the bottom to the top, respectively. However, the fact that the lowest quartiles are more likely to choose the public sector, and yet they are still more likely to be mismatched, indicates that this isn't a complete explanation.

5.3 Cyclical Skill Mismatch and the Long-term Effects of Graduating in a Recession

In this section, we document the long-term effects on labor market outcomes and potential mechanisms of recovery of graduating in a recession for initially mismatched and nonmismatched workers, respectively. Our goal is to compare the labor market outcomes of initially mismatched workers in bad times with those of individuals who are mismatched in good times. Initial mismatch is defined by the field of study and the employer's industry in the first year following graduation.

We estimate the same empirical model described in equation (4). However, the composition of mismatched workers in good times may be different from the composition of mismatched workers in bad times. For example, in good times, low-ability workers may be more likely to be mismatched than high-ability workers. To identify the effects of business cycles on labor market outcomes of initially mismatched workers, we have tried to control for differences in ability through information on IQ test scores available only for males from Norwegian military records. Details of this exercise are discussed in the next section. In summary, controlling for IQ scores leads to minor changes in the estimated effects of initial labor market conditions. Given the presence of cohort and region effects, region-cohort-specific variation in IQ explains little of the changes in experience profiles in labor market outcomes. We therefore continue to focus on the entire sample (including both males and females) and estimate equation (4) on the initially mismatched and initially nonmismatched sample separately.

We find that initially mismatched workers from bad times suffer from persistent career losses compared with mismatched workers from good times. The careers of graduates who are initially matched to the right industry are largely immune from the negative impact of graduating in recessions in the medium run. Figure 8 shows that there are large differences in the extent of earnings loss in the first few years. Mismatched workers experience three-times-larger losses in annual earnings in the first few years than nonmismatched workers. Almost all of the persistent effects on unemployment are driven by mismatched workers. For initially mismatched workers, the effects on unemployment are strong and persistent up to eight years after

graduation. For nonmismatched workers, the positive effects on unemployment are small and limited to the first two years after graduation.

Figure 9 shows the effects of graduating in a recession on labor mobility. Workers who are mismatched in bad times are more likely to switch industries during the first ten years following graduation than mismatched workers in good times. The effects for nonmismatched workers are small and temporary. Consistent with the effects on industry mobility, we find more persistent effects on job mobility for mismatched workers graduating in recessions. The evidence on industry and job mobility indicates that cyclical mismatched workers from bad times search more intensively for better matches. Again, the effects on regional mobility are small, although nonmismatched workers in a recession appear more likely to be mobile across regions in the first few years following graduation.

Turning to the effects on firm quality, we find that there are important differences in the effects of initial labor market conditions between initially mismatched and nonmismatched workers. Initially mismatched workers from recessions are more likely to start working for lower-quality employers, and firm quality improves quickly in the first few years. For initially nonmismatched workers in recessions, there is no significant evidence on initial down-ranking of firm quality compared with nonmismatched workers in good times. It appears that within-firm recovery is a more important mechanism for nonmismatched graduates from recessions. For nonmismatched graduates from recessions, job mobility and industry mobility appear to be more important mechanisms behind the recovery process.

To summarize, we document important differences in the effect of initial labor market conditions and the process of recovery between initially mismatched and nonmismatched workers. Overall, a high unemployment rate leads to worse labor market outcomes for mismatched graduates than nonmismatched graduates, both in the short and long runs. Given that a higher unemployment rate also increases the probability of skill mismatch in the first job, we conclude that skill mismatch is an important factor accounting for the overall effects of graduating in recessions. The fact that initial unemployment rate has a very persistent effect on skill mismatch but a less persistent effect on wages provides indirect evidence that the accumulation of industry-specific human capital is an important mechanism in the recovery process.

Some workers manage to switch back to the "right" industry, as evidenced by high industry mobility for the initially mismatched workers. Some initially mismatched workers acquire new skills through on-the-job training, thereby changing the skill composition of the worker and the match qualities with their current employers. Still, for some workers, high-frequency industry/job mobility indicates that they never accumulate many industry-specific skills, leading to high rates of turnover between employment and unemployment.

6 Robustness Checks

Initial Unemployment Rate. So far, we have assumed that the local unemployment rate at the time of graduation captures exogenous labor demand shocks. However, if college students act upon the regional unemployment rate by choosing the regional of graduation and the timing of graduation, the initial unemployment rate is endogenous. To tackle the first source of endogeneity, we replace the school region with the region of residence at the time of graduation and use the initial unemployment rate at the region of residence as the key independent variable. Region of residence might differ from the school region, because during most of our time period, students would still be recorded in administrative registers as residing with their parents. We also experimented by clustering our preferred definition of labor market regions (at county level) into larger labor market areas (North, Mid-north, West, South, and East). Neither of the alternatives changed our previous results in any significant way.[17] The region of the school remains our preferred measure of local labor market, because graduates typically start looking for jobs in the school region.

To test whether there is selective timing of graduation, we use a variable created by Statistics Norway documenting the number of semesters beyond the program duration. From this variable, we create a dichotomous variable, D_{cr}, which equals one if a college graduate delays graduation. We collapse our individual-level data at the level of graduation cohort and region of graduation and estimate the following

[17] The complete results are available from the authors upon request.

equation using ordinary least squares:

$$D_{cr} = \beta_1 + \beta_2 U_{cr} + \theta_r + \xi_c + u, \tag{5}$$

where θ_r and ξ_c are unrestricted region and cohort fixed effects as before. If there is selective timing of graduation, we would expect β_2 to be positive. We do not find any direct evidence of selective timing of graduation at cohort-region level: the estimated β_2s in the first column of Table 4 are insignificant.

Finally, to provide direct evidence that qualities of graduating cohorts do not vary with initial unemployment rates, we use the age-adjusted IQ score defined earlier as the dependent variable in equation (5) (second column of Table 4). We do not find any evidence that cohort quality varies with initial labor market conditions, conditional on permanent cohort and region fixed effects.

Results on Initially Mismatched Men Controlling for Ability. To estimate the effect of initial labor market conditions for the initially mismatched workers, we need to control for differences in ability between mismatched workers from good and bad times. Therefore, when estimating equation (4), we include IQ and IQ interacted with experience dummies (collapsed at region-cohort level) in the independent variables. The interaction terms also allow experience profiles to shift with IQ levels. Because the IQ test scores are only available for males, we restrict our sample to male graduates only.

Figure 11-13 shows the estimated long-term effects of initial labor market conditions controlling for ability through IQ test scores. Overall, these pictures look very similar to our earlier findings over the entire sample without controlling for IQ. We find that initially mismatched male workers experience persistently negative effects on earnings and unemployment from graduating in recessions (Figure 11). Interestingly, the effects on unemployment are less persistent among initially mismatched men, suggesting that cyclical mismatched women are more likely to be persistently unemployed after graduating during recessions. In contrast, male workers who are matched with the right industry in bad times do not experience significant earnings or employment losses when compared with those matched to the same industries in good times. Industry mobility and job mobility toward higher-

quality firms remain the important mechanisms behind the catch-up process for mismatched male workers from bad times (Figure 12-13).

7 Conclusion

The explanations suggested for the long-term effects of short-term cyclical variations in labor market conditions vary from the initial quality of the firm-worker match to the pro-cyclical effect on promotion. None of the mechanisms proposed so far have paid specific attention to matching supply of heterogeneous skills within graduating cohorts of graduates and the heterogeneous demand for skills across different industries. In this paper, we define the type of skill supplied by the field of study in college. We propose that skill mismatch, defined as mismatch between the skills supplied by college graduates and skills demanded by hiring industries, is another important mechanism behind the persistent career loss caused by graduating in recessions.

We focus on how skill mismatch varies over the business cycle. We find that there is a strong countercyclical pattern of skill mismatch among college graduates entering the labor market, while initial labor market conditions have a declining but persistent effect on the probability of mismatch over the early career of these graduates. Based on this measure, we estimate the causal effect of initial labor market conditions on skill mismatched and nonmismatched workers separately by comparing mismatched workers graduating during recessions with mismatched workers graduating during booms. We do so conditional on permanent cohort and region characteristics, and in a robustness check on a male subpopulation we are also able to control for cognitive ability.

We find that initially mismatched graduates (i.e., those who were mismatched to the wrong industry on the first job) are much more vulnerable to business cycle variations at the time of graduation. The careers of graduates who are matched to the right industry are largely immune from the negative impact of graduating in recessions. Our findings suggest that cyclical mismatched workers, that is, workers who are mismatched due to worse labor market conditions, could be driving the long-term career loss found in many studies. For these workers, industry mobility

and job mobility are important mechanisms of recovery from initial losses.

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Table 1: The Mean Skill Premium by Field of Study and Industry

	Field of study						
Industry	Humanities and Arts	Teacher Training	Social Sciences and Law	Business	Natural Sciences	Welfare and Health	Communications and Transport
1	0.08	0.24	0.19	0.41	0.39	0.32	0.36
2	0.31	0.44	0.26	0.39	0.34	0.53	0.31
3	0.07	0.06	0.18	0.21	0.22	0.12	0.14
4	0.08	0.19	0.11	0.32	0.29	0.29	0.24
5	0.08	0.10	0.11	0.24	0.25	0.22	0.31
6	0.12	0.19	0.17	0.37	0.34	0.30	0.27
7	0.12	0.17	0.18	0.21	0.18	0.22	0.34

Skill premia are measured with respect to college-level educations classified as "general programs" (Statistics Norway, 2003, p. 8). Industries are defined as follows:

1-Agriculture, Hunting, Forestry and Fishing, Mining and Quarrying, Electricity, Gas and Water, Construction (ISIC, class 1, 2, 4, 5)

2-Social and Related Community Services, including education and medical services (ISIC, class 93)

3-Manufacturing (ISIC1, class 3)

4-Wholesale and Retail Trade and Restaurants and Hotels (ISIC, class 6)

5-Transport, Storage and Communication (ISIC, class 7)

6-Financing, Insurance, Real Estate and Business Services (ISIC, class 8)

7-Community, Social and Personal Services (ISIC, class 9 excluding 93).

Starting in 1999, industry codes are mapped from the Statistics Norway (1994) standard back to the Statistics Norway (1983) standard before grouping.

Table 2: The Effect of Initial Labor Market Conditions on Probability of Mismatch and the Quality of the Industry-Skill Match

	Mismatch			Rank of Matched Industry		
Effect by Years of Potential Experience	All Fields (1)	Public (2)	Private (3)	All Fields (4)	Public (5)	Private (6)
1	0.034***	0.004	0.047***	-0.141***	-0.006	-0.199***
	(0.006)	(0.004)	(0.006)	(0.025)	(0.018)	(0.024)
2	0.031***	-0.000	0.042***	-0.129***	0.009	-0.176***
	(0.006)	(0.004)	(0.006)	(0.026)	(0.017)	(0.024)
3	0.028***	-0.005	0.039***	-0.111***	0.028*	-0.152***
	(0.006)	(0.004)	(0.007)	(0.026)	(0.017)	(0.027)
4	0.022***	-0.009**	0.034***	-0.083***	0.041**	-0.124***
	(0.006)	(0.004)	(0.007)	(0.027)	(0.016)	(0.028)
5	0.022***	-0.008**	0.035***	-0.075***	0.039**	-0.114***
	(0.006)	(0.004)	(0.007)	(0.028)	(0.017)	(0.028)
6	0.021***	-0.011***	0.037***	-0.070**	0.050***	-0.126***
	(0.006)	(0.004)	(0.008)	(0.028)	(0.016)	(0.029)
7	0.017**	-0.009**	0.031***	-0.069**	0.042**	-0.132***
	(0.007)	(0.004)	(0.008)	(0.029)	(0.017)	(0.030)
8	0.017**	-0.008**	0.031***	-0.086***	0.038**	-0.159***
	(0.007)	(0.004)	(0.009)	(0.031)	(0.017)	(0.034)
9	0.022***	-0.010**	0.039***	-0.089***	0.050**	-0.166***
	(0.007)	(0.004)	(0.008)	(0.030)	(0.020)	(0.033)
10	0.024***	-0.008*	0.041***	-0.084***	0.039**	-0.154***
	(0.007)	(0.005)	(0.009)	(0.029)	(0.020)	(0.028)
R^2	0.69	0.44	0.53	0.74	0.52	0.63
Observations	2375	2375	2375	2375	2375	2375

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Public refers to fields of study in Teacher Training and Pedagogy and Health, Welfare and Sport. Private refers to all other fields.

Table 3: The Effect of Initial Labor Market Conditions on Probability of Mismatch and the Quality of the Industry-Skill Match, by Age-adjusted IQ Score

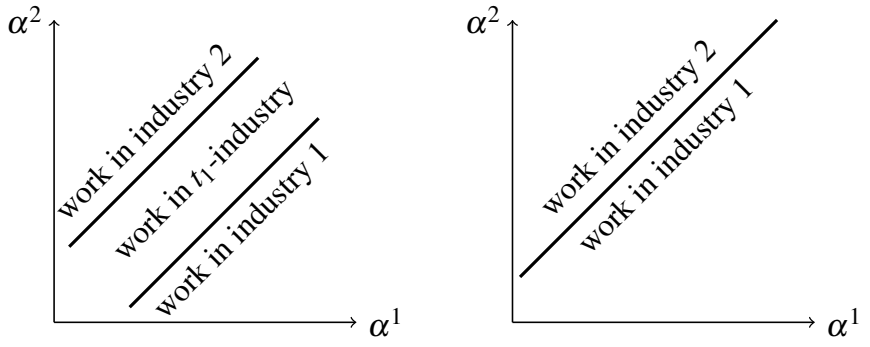
	Mismatch				Rank of Matched Industry			
Effect by Years of Potential Experience	Bottom Quartile (1)	Lower Middle Quartile (2)	Upper Middle Quartile (3)	Top Quartile (4)	Bottom Quartile (5)	Lower Middle Quartile (6)	Upper Middle Quartile (7)	Top Quartile (8)
1	0.061***	0.033***	0.032***	0.041***	-0.279***	-0.153***	-0.123**	-0.140***
	(0.010)	(0.012)	(0.011)	(0.011)	(0.047)	(0.049)	(0.050)	(0.048)
2	0.057***	0.037***	0.032***	0.049***	-0.278***	-0.158***	-0.133***	-0.160***
	(0.011)	(0.013)	(0.011)	(0.010)	(0.045)	(0.050)	(0.049)	(0.045)
3	0.057***	0.038***	0.032***	0.037***	-0.243***	-0.169***	-0.118**	-0.132***
	(0.010)	(0.013)	(0.011)	(0.009)	(0.043)	(0.051)	(0.051)	(0.042)
4	0.053***	0.034***	0.025**	0.031***	-0.210***	-0.145***	-0.085	-0.094**
	(0.011)	(0.013)	(0.011)	(0.009)	(0.046)	(0.052)	(0.052)	(0.042)
5	0.051***	0.030**	0.025**	0.034***	-0.189***	-0.120**	-0.071	-0.095**
	(0.011)	(0.013)	(0.012)	(0.009)	(0.046)	(0.053)	(0.053)	(0.043)
6	0.048***	0.030**	0.026**	0.030***	-0.179***	-0.115**	-0.063	-0.080*
	(0.012)	(0.013)	(0.013)	(0.010)	(0.047)	(0.053)	(0.056)	(0.045)
7	0.038***	0.024	0.015	0.026***	-0.151***	-0.111*	-0.065	-0.100**
	(0.013)	(0.015)	(0.013)	(0.010)	(0.050)	(0.058)	(0.059)	(0.046)
8	0.033**	0.019	0.014	0.024**	-0.171***	-0.125**	-0.092	-0.109**
	(0.014)	(0.016)	(0.015)	(0.011)	(0.054)	(0.062)	(0.063)	(0.051)
9	0.042***	0.019	0.022	0.041***	-0.191***	-0.111*	-0.101	-0.148***
	(0.012)	(0.016)	(0.014)	(0.011)	(0.054)	(0.067)	(0.062)	(0.045)
10	0.048***	0.028*	0.024*	0.043***	-0.193***	-0.087	-0.102*	-0.160***
	(0.012)	(0.016)	(0.014)	(0.011)	(0.050)	(0.054)	(0.055)	(0.049)
R^2	0.41	0.33	0.28	0.25	0.41	0.37	0.32	0.30
Observations	2375	2373	2369	2358	2375	2373	2369	2358

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Robustness Checks: The Effect of Initial Labor Market Conditions on the Timing of Graduation and Age-adjusted IQ Score

	Delayed Graduation (1)	Age-adjusted IQ Score (2)
Regional Unemployment Rate	-0.009	0.005
	(0.009)	(0.017)
R^2	0.52	0.54
Observations	323	342

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.



(a) 2nd period (b) 1st period

Figure 1: Choices in first and second period in α space for a given (z^1, z^2).

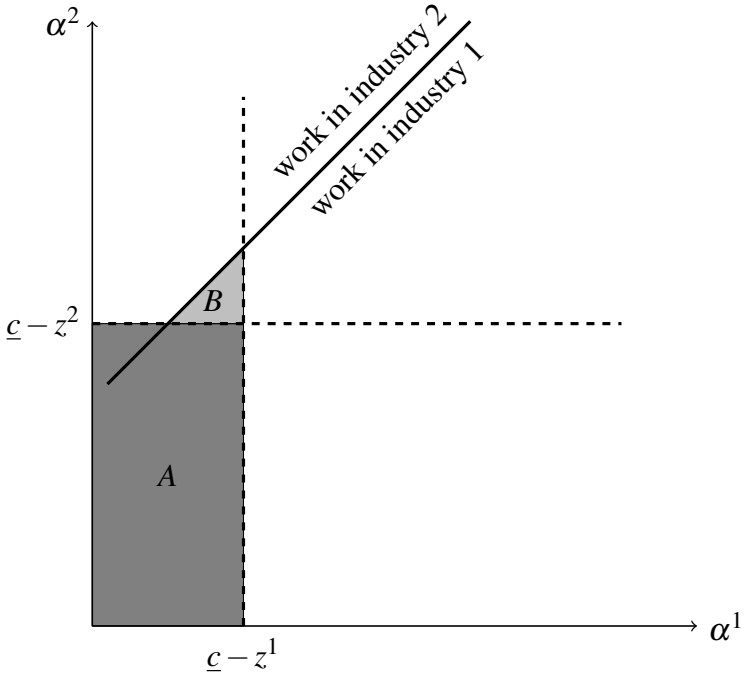


Figure 2: Unemployment and inefficient mismatch with a minimum consumption requirement for a given (z^1, z^2).

Figure 3: National Unemployment Rate in Norway, 1986–2006

Figure 4: Skill Mismatch by Experience and the National Unemployment Rate

Note: We regress the probability of mismatch on dummies for years of potential experiences and regress the national unemployment rate on a constant term. We plot the residuals against the year of graduation.

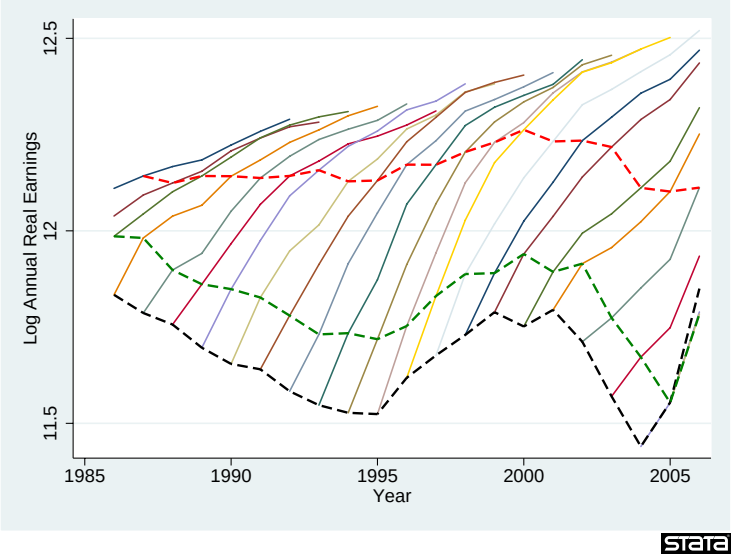


Figure 5: Experience Profiles of Log Annual Real Earnings by Cohorts

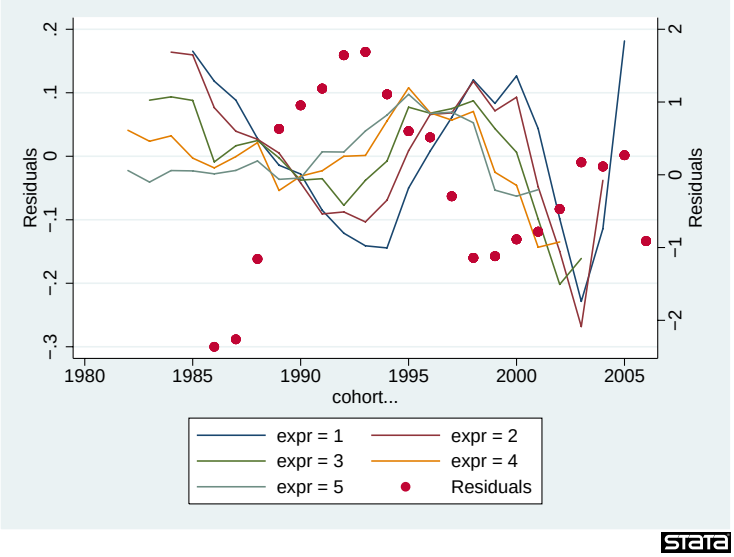


Figure 6: Log Annual Real Earnings and the National Unemployment Rate

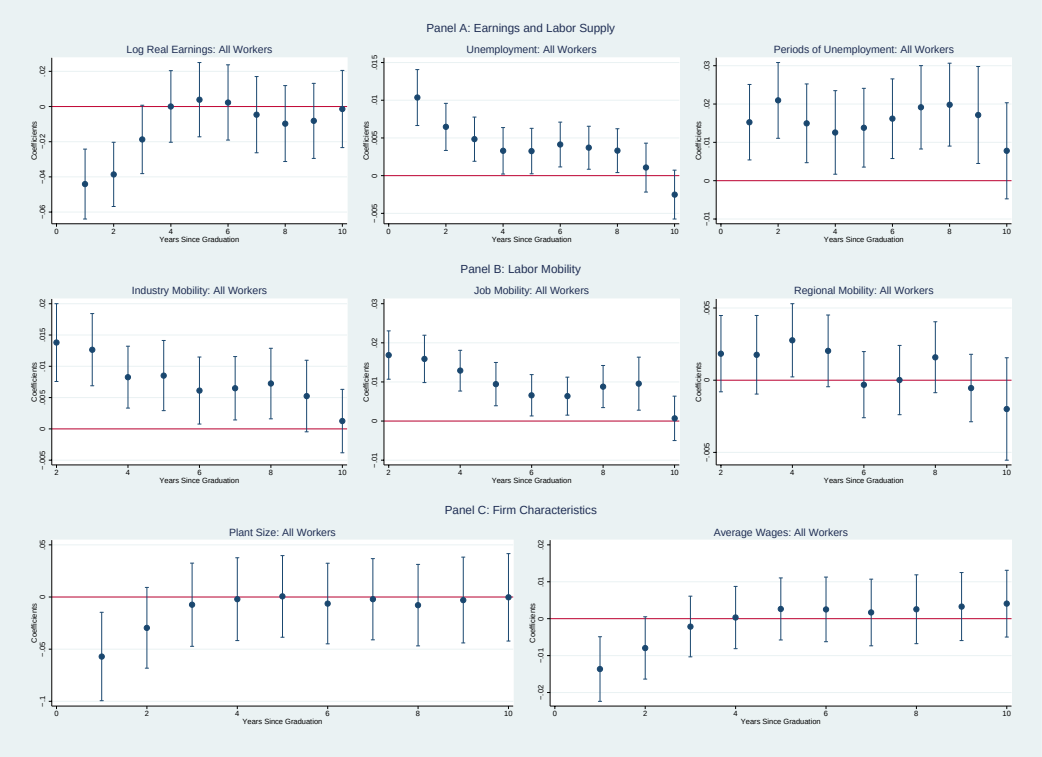


Figure 7: Long-term Effects of Initial Labor Market Conditions: All Workers

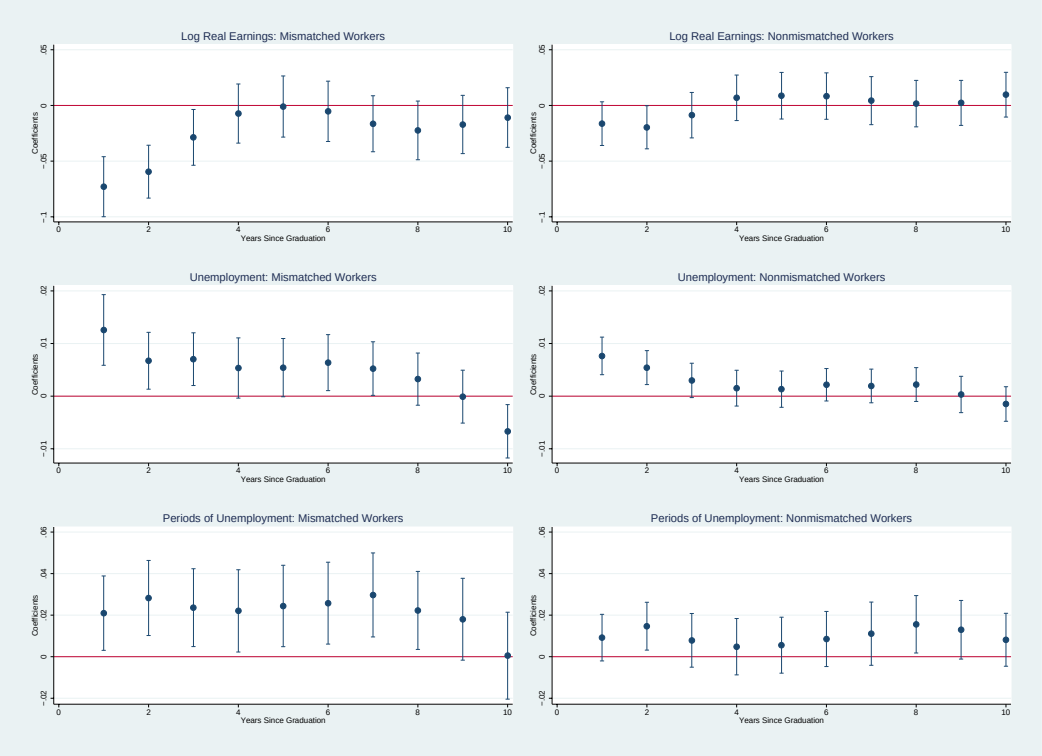


Figure 8: Long-term Effects of Initial Labor Market Conditions on Earnings and Employment: Initially (Non-)Mismatched Workers

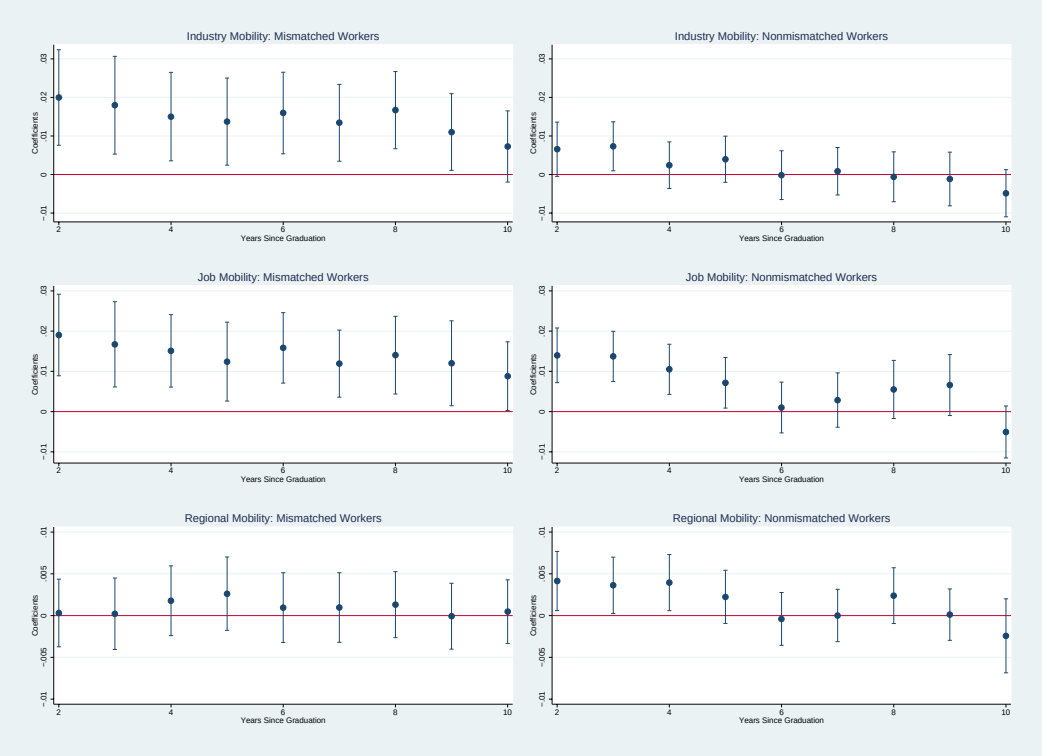


Figure 9: Long-term Effects of Initial Labor Market Conditions on Labor Mobility: Initially (Non-)Mismatched Workers

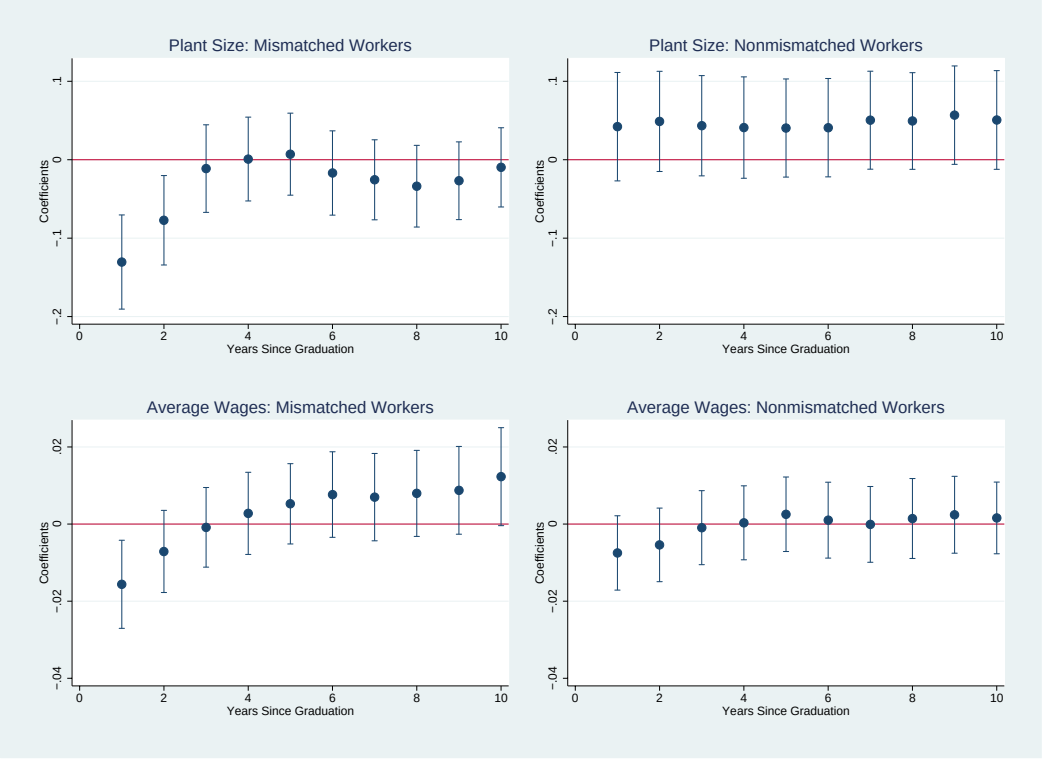


Figure 10: Long-term Effects of Initial Labor Market Conditions on Permanent Firm Characteristics: Initially (Non-)Mismatched Workers

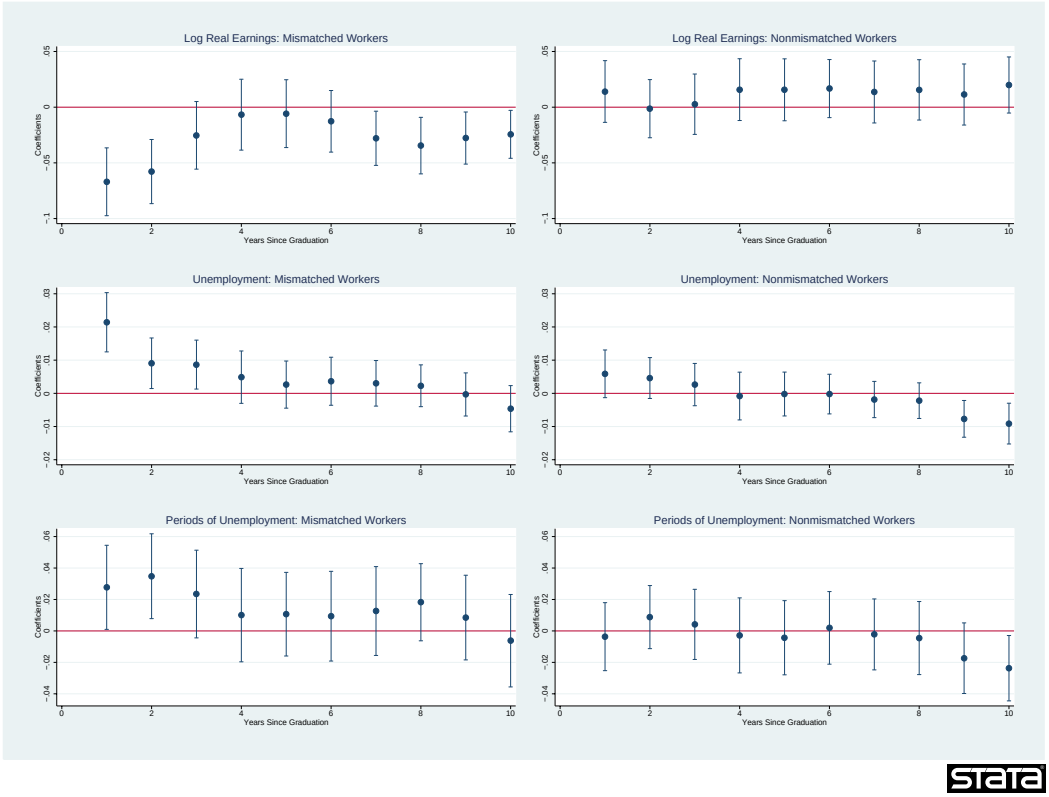


Figure 11: Long-term Effects of Initial Labor Market Conditions on Earnings and Employment: Initially (Non-)Mismatched Male Workers. Drawn for Average Level of Ability.

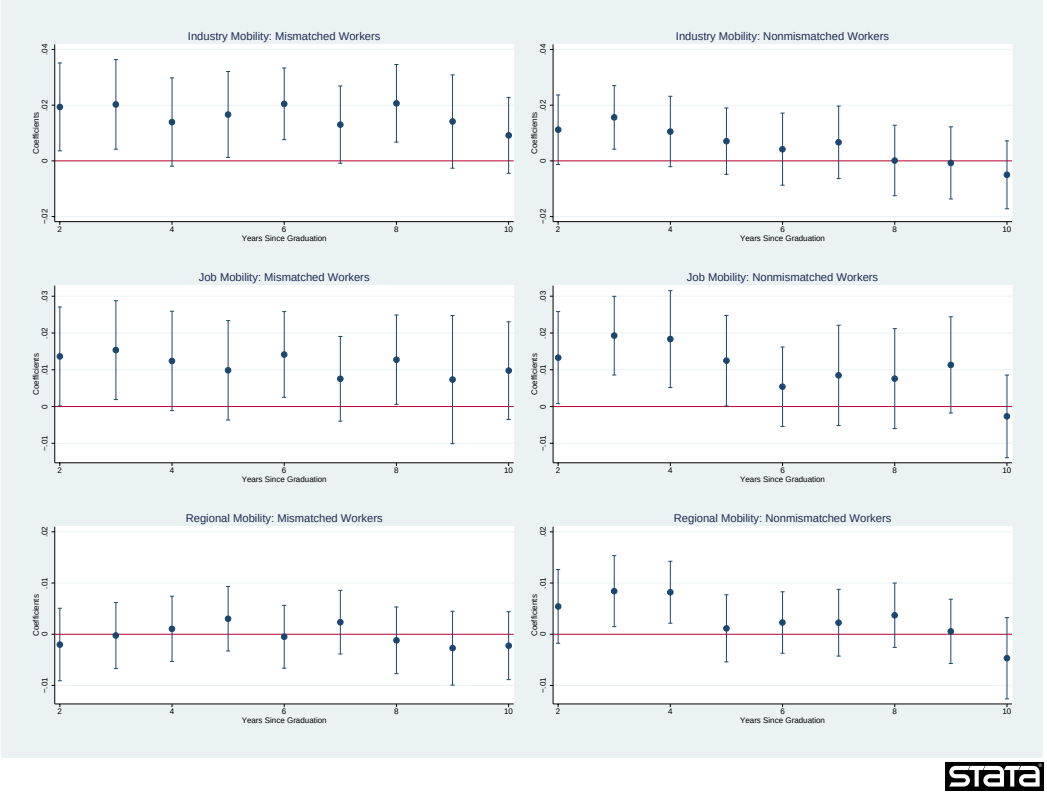


Figure 12: Long-term Effects of Initial Labor Market Conditions on Labor Mobility: Initially (Non-)Mismatched Male Workers. Drawn for Average Level of Ability.

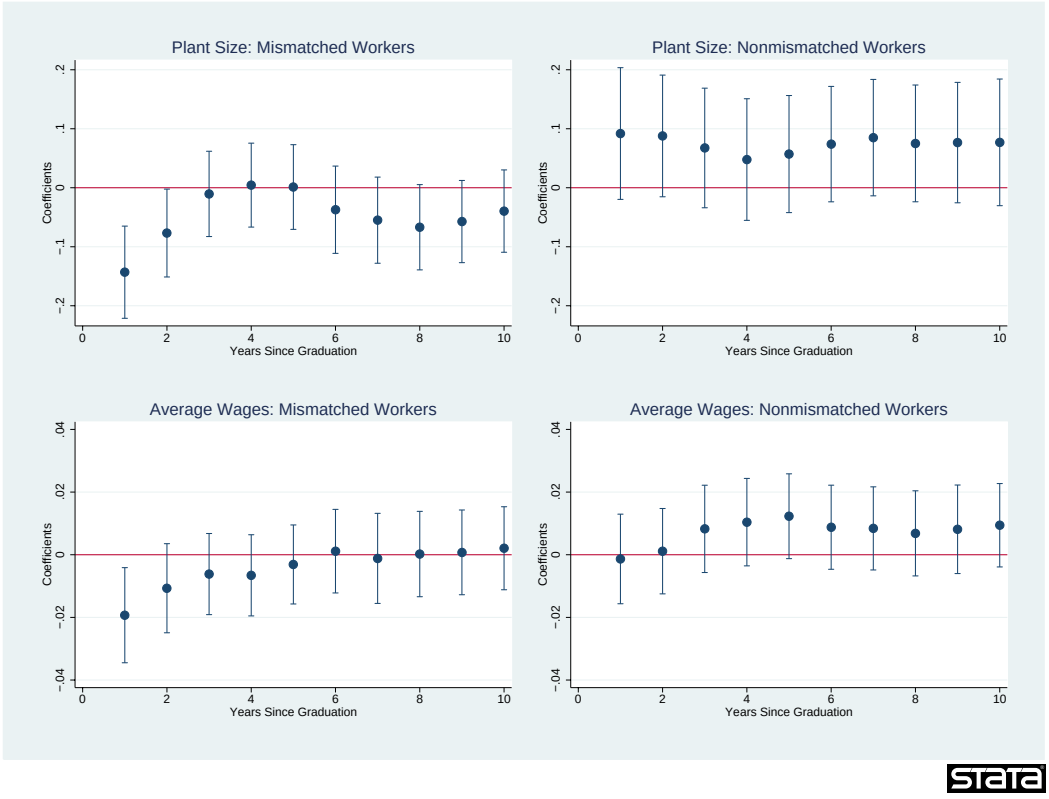


Figure 13: Long-term Effects of Initial Labor Market Conditions on Permanent Firm Characteristics: Initially (Non-)Mismatched Male Workers. Drawn for Average Level of Ability.