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Job search and academic achievement

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ABSTRACT

The paper develops a structural model for the labor market behavior of students entering the labor market. We explicitly model the trade-off between devoting effort to studying and to job search. Furthermore, we allow for on-the-job search. The model is estimated using a unique data set of individuals who completed undergraduate education in the Netherlands between 1995 and 2001. Our estimation results show that labor market returns of high grades are low. Wage increases between jobs are explained by labor market friction rather than returns of early work experience. Our results indicate that a 1 percentage point decrease in the unemployment rate increases wage offers on average by 3 percent, but that the amount of job search effort is not very sensitive to business cycle fluctuations. Policy simulations show that study effort and hence academic achievement are much more sensitive to financial incentives than job search effort and labor market outcomes.

1. Introduction

In the final stage of their academic studies, students not only study hard to improve academically, but also start looking for work. This paper focuses on the trade-off between studying and job search. We develop a job-search model describing labor market behavior of individuals around the moment at which they complete their education. The model allows us to investigate the transition from college to the labor market and the returns of better academic performance. Moreover, we exploit the relatively long observation period to consider the importance of business-cycle fluctuations for the labor market prospects of students.

In the empirical analysis we use a discrete-time job-search model with endogenous job-search and study effort. Whereas the returns of job search while studying are that individuals start their first job earlier, the returns of study effort take the form of better grades, which may have long-lasting positive returns on the labor market. Academic achievement is thus endogenous and depends not only on study effort but also on ability. Explicitly modeling job search prior to graduation provides a natural model for individuals who anticipate the moment of graduation and have not been unemployed between leaving school and starting work. We also allow for on-the-job search, since quite a number of individuals switches jobs within the first few years after leaving college (see Topel and Ward, 1992). Wages in the first job are thus not a proper indicator for the present value of life-time earnings (e.g. Eckstein and Wolpin, 1995). We do not

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require that the structural parameters describing the job search environment to be similar for individuals looking for their first job and for employed workers.

A structural model has several advantages when analyzing the labor market behavior of students. The fact that labor market transitions, wages and academic achievement are jointly determined, makes it possible to study the interdependency between these variables. Since we explicitly model study effort and job-search effort, we can use the model to investigate behavioral responses to policy interventions. In particular, we simulate the effects of reducing unemployment compensation for recent graduates and the effects of providing financial rewards for good academic performance.

Our model builds further on Wolpin (1987) and Ferrall (1997). Wolpin (1987) stipulates that all individuals start searching the same fixed period before graduation and that in each period they devote the same amount of effort to job search. Ferrall (1997) assumes that at the moment of graduation all individuals have received exactly two job offers, and are employed if the wage associated with the best job offer exceeds the individual's reservation wage. In our model job-search effort before graduation is endogenous—and thereby also the number of job offers collected before graduation.[1] Other structural empirical analyses do not explicitly model the job-search process before graduation, which may cause selection bias. Bowlus et al. (2001) ignore search spells in which individuals start working immediately upon leaving school. Gras and Lindeboom (1994) adopt a similar strategy, but correct for potential selection among those who failed to find a job before graduation.

The empirical analyses in this paper use data from an annual survey of young workers who recently finished undergraduate education at Dutch universities. The data describe cohorts of individuals who graduated in economics, business, Dutch law or psychology between 1995 and 2001. Since labor market conditions for these individuals differ, we estimate our model separately for different studies. Our intention is not to estimate returns to education or to compare returns of the different studies. The data are described in a period in which the Dutch economy experienced a period of relatively fast growth until the end of the 1990s and a slowdown after 2000. We allow the structural parameters to depend on business-cycle indicators.

Our estimation results show that, conditional on graduating, the labor market returns to good academic performance are very low. This also explains the finding that study effort among college students in the Netherlands is low (e.g. Leuven et al., 2009). Low study effort is well recognized in the Dutch public debate, where students are often criticized for a lack of ambition to perform well in college. The very low labor market returns to good academic performance contradict most research on the transition from school to work coming from the US. However, Colonna (2007) finds that also in Italy the college premium is much lower than that in the US. Colonna (2007) and Krueger and Mueller (2008) show that there may be substantial differences between the US and European labor markets.

Because young workers lack relevant work experience, labor market outcomes of young workers are more sensitive to business-cycle fluctuations than are the labor market outcomes of older workers. Our empirical results show strong effects of macroeconomic conditions on labor market prospects of students. In particular, a 1 percentage-point decrease in the unemployment rate increases wage offers by around 3 percent. We find that the optimal job-search effort does not respond much to business-cycle fluctuations. This seems to contradict Shimer (2004), who argues that even though the returns of job search are lower during recessions, job-search effort can be increasing during recessions.

Between jobs, wages increase by about 16–19 percent. However, our models find evidence for substantial returns to early work experience. This implies that these wage increases are driven by labor market friction. This coincides with Topel and Ward (1992), who argue that young workers are searching for good matches and that the behavior of young workers is largely consistent with job search theory. Also Christensen et al. (2005) argue that the effect of tenure on wages is small in the wage growth of individuals.

Our estimated model will be used to perform two policy experiments. As of July 2009, individuals under the age 27 will no longer be entitled to collecting welfare benefits when unemployed. Since almost all individuals finish undergraduate education before that age, this policy change affects almost all individuals in our data set. Model simulations show only very modest effects on labor market outcomes. Reservation wages are already so low that most individuals accept all job offers. However, most students substitute study effort into job-search effort. Whereas grades drop dramatically, there is only a very modest increase in employment rates upon graduation. Our second policy experiment is to provide a financial reward to students who graduate with high grades. Simulations show that such a reward substantially increases study effort and academic performance. But because returns to high grades are low, labor market outcomes do not improve. A combination of both policies improves grades but leaves labor market outcomes almost unaffected. It should be noted that the amount paid to reward students with high grades is much lower than average welfare benefit payments.

The paper proceeds as follows. Section 2 provides institutional background on the Dutch educational system and business cycle variation during the observation period. Section 3 presents the structural model and describes the estimation of our structural model. The data are discussed in Section 4. Section 5 presents results of reduced-form analyses to investigate the validity of the structural model. Section 6 presents the estimation results of the structural model. Section 7 concludes.

[1] See Bloemen (2005), Fougère et al (2009), Stern (1989), and Yoon (1981), for structural empirical analyses of job-search models with endogenous search effort.

2. The Dutch educational system

Dutch universities are public, and tuition is low. Tuition is set by the government and does not vary by field of study or by university attended. Annual tuition fees for full-time students (under the age of 30) increased from around 800 euro in the early 1990s to around 1250 euro at the end of the 1990s. Undergraduate students are entitled to financial aid. The grant depends on parental income and whether or not students live with their parents (see Leuven et al., 2009, for a more extensive discussion).

Undergraduate education is accessible to students who graduated from college-preparatory secondary education and to students from higher vocational education. Universities are not permitted to select students: every student satisfying the entry requirements should be admitted. Traditionally, most students entered university after the pre-university track in secondary education. During the 1990s, however, entry through higher vocational education became more popular. This is particularly true for economics and business, where in 2002 around 45 percent of the students entered through higher vocational education (compared to only 25 percent in 1992). For law and psychology, for example these percentages are much lower.

Currently six Dutch universities offer undergraduate programs in economics and business, nine offer an undergraduate program in law and 10 in psychology. At all universities the nominal duration of an undergraduate program is 4 years (although most students do not actually graduate within this period). In the Netherlands, students take almost 90 percent of their courses within their chosen study. The undergraduate degree is typically the highest attained, since annually only around 200 Ph.D. students graduate in economics, business, law and psychology together (about 2.5 percent of all those completing their undergraduate studies in these fields). Even though undergraduate programs differ somewhat between universities, they are considered to be close substitutes. Oosterbeek et al. (1992) compare the labor market outcomes of students from the different economics departments in the Netherlands, and find that selection-corrected wage differentials are modest.

Fig. 1 presents total enrollment at Dutch universities during the period 1992 until 2002. From 1992 until 1998, the total number of students decreased from around 187,500 to just above 160,000. After 1998, the number of students increased again to the level at the beginning of the 1990s. Fig. 2 presents first-year enrollment and the number of students finishing

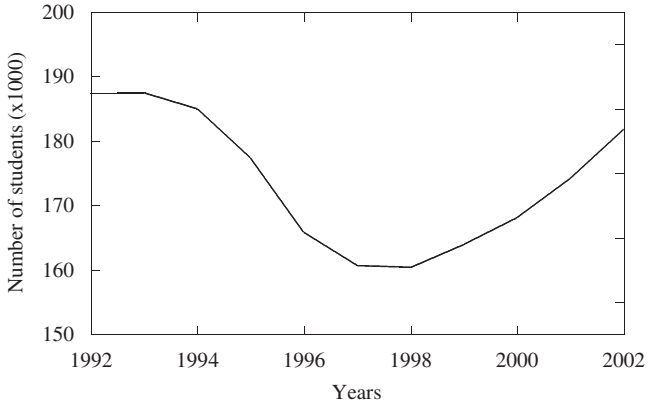

Fig. 1. The total number of students (×1000) registered at Dutch universities (source: *Statistics Netherlands*).

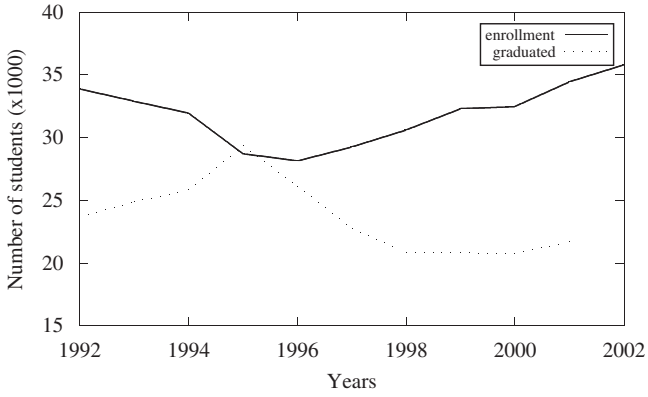

Fig. 2. The number of students (×1000) enrolling in the first year and graduating (source: *Statistics Netherlands*).

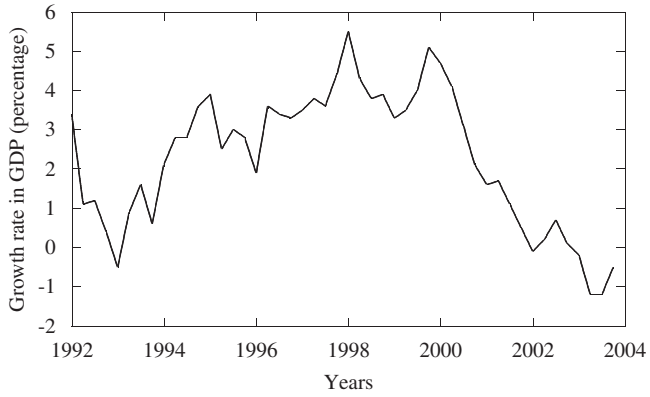

Fig. 3. Economic growth measured in percentage increases in GDP (source: *Statistics Netherlands*).

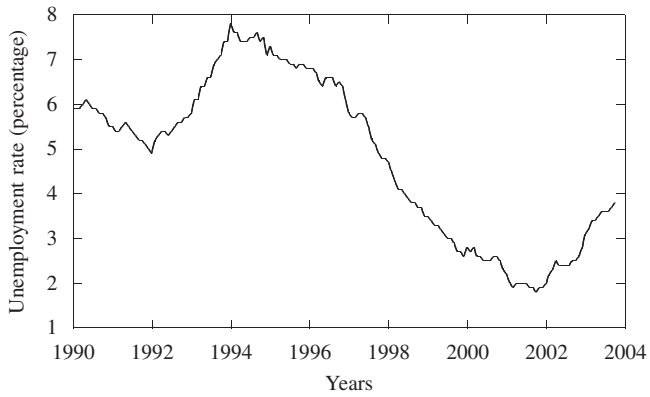

Fig. 4. The unemployment rate (in percentage) (source: *Statistics Netherlands*).

undergraduate education. The number of graduates shows a peak in 1995/1996, attributed to the fact that the 1990/1991 cohort of students received government grants for six years and the 1991/1992 cohort for five years. The pattern in first-year enrollment follows that of total enrollment closely. At the beginning of the 1990s the size of the relevant birth cohort decreased. In 1992 around 14 percent of the individuals between 18 and 23 years old were enrolled in a university. This rose to 15 percent in 1997 and it increased further to 17 percent in 2002. The latter can be explained from the increased popularity among graduates from higher vocational education of continuing with university education.

Trends in graduation, first-year and total enrollment in economics, business, law and psychology follow the general trends closely. The only exception can be found for first-year enrollment in economics at the end of the 1990s, which was somewhat larger than the general trend. Again, this is attributed to the fact that economics is particularly popular among graduates from higher vocational schools.

At the end of the 1990s the Dutch economy experienced a period of rather robust economic growth. Fig. 3 reports GDP growth during our observation period and Fig. 4 shows the unemployment rate. The year 2000 can be considered as the top of the business cycle. From 1994 until 2000, the growth rate of GDP was increasing and the unemployment rate was decreasing. Growth in GDP started to decline after 2000 and the unemployment rate started to increase at the end of 2001.

3. The model

Our model is a discrete-time job-search model with endogenous search effort and on-the-job search, which we use to describe the transition from college to work. Burdett (1978) first derived a job-search model that allowed for on-the-job search, and Mortensen (1977) explicitly modeled search effort as an individual decision variable. Following Eckstein and Wolpin (1999), we assume that students nearing graduation face a trade-off between studying and job search. Study effort increases grades; job-search effort generates job offers. Students (usually) do not start working in regular jobs before the actual moment of graduation. They become employed upon graduation if the best job offer exceeds their reservation wage. We assume the moment of graduation to be exogenous and known to individuals. In a sensitivity analysis reported in Section 6.1 we find that estimation results do not change when this assumption is relaxed. Students usually round off their undergraduate study by writing a short thesis (and perhaps completing some final courses). Students can graduate in any

given month, but over 40 percent of our sample graduates in August. The main reason is that academic programs are constructed such that final (re-take) exams occur during the summer. Furthermore, with the start of the new academic year in September, students have to pay tuition again (although they get back part of this fee if they graduate before the end of the academic year). In the Dutch educational system, students have no financial incentive to postpone graduation. High skilled jobs, at international companies, banks, law firms or the government, for example, often require a completed undergraduate education. Furthermore, after graduation individuals are entitled to welfare benefits that exceed student grants, which have only a limited entitlement period—not to mention the fact that students have to pay tuition fees.

3.1. The search process after graduation

The job-search process after graduation follows a standard stationary job-search model with endogenous search effort and on-the-job search. Upon graduation, an individual either becomes unemployed or starts working. An individual starts working if he or she has already accepted a job before graduation. Individuals are free to search for a better job once they are employed. We do not allow employed individuals to quit or to get fired.[2] Workers are characterized by grades g obtained during their study. The next subsection discusses the way in which grades are determined.

First, consider a person working at wage w. At the start of each period the worker chooses how much effort $s_e \geq 0$ to devote to on-the-job search. The costs of job search effort $c_e(s_e)$ depend on the amount of this effort, which involve checking newspapers for job advertisements, sending out applications, etc. An individual who does not search actively does not incur these costs, i.e. $c_e(0) = 0$.[3] The costs of job-search effort are increasing in effort, $c'_e(s_e) > 0$, and we assume $c''_e(s_e) > 0$ (Mortensen, 1986; Stern, 1989 make similar assumptions to guarantee the existence of a reservation wage).

The probability of receiving a job offer in a particular period is given by $0 \leq \lambda_e(s_e; g) \leq 1$. Individuals who do not devote any effort to job search cannot receive job offers (i.e. $\lambda_e(0; g) = 0$). Increasing the amount of job-search effort increases the probability of receiving a job offer, ($\lambda'_e(s_e; g) > 0$), but returns to job search effort diminish ($\lambda''_e(s_e; g) < 0$). A job offer is characterized by its wage w, which is a realization from the (continuous) wage-offer distribution function $F_e(w; g)$ (with finite mean, $\mathrm{E}_{F_e}[W|g] < \infty$). A worker receives at most one job offer during each period, and the individual has to decide immediately whether to accept or reject it. Once a job offer is accepted, the individual starts working in the new job in the next period.

Individuals have an infinite horizon, and they know the values of $\lambda_e(\cdot; g)$, $c_e(\cdot; g)$, and $F_e(\cdot; g)$. However, they do not know in advance when job offers will arrive and what will be the associated wages. Individuals maximize the expected present value of future utility. Future utility is discounted at the subjective rate $\rho > 0$. For an employed worker with grades g we define $R_e(w; g)$ as the present value of work with wage w, which comes from Bellman's equation:

$$R_e(w; g) = \max_{s_e \geq 0} \left\{ \frac{w - c_e(s_e)}{1+\rho} + \frac{\lambda_e(s_e; g)}{1+\rho} \mathrm{E}_{F_e}[\max\{R_e(W; g), R_e(w; g)\}|g] + \frac{1 - \lambda_e(s_e; g)}{1+\rho} R_e(w; g) \right\}. \tag{1}$$

Bellman's equation implies that wages are received at the end of a period. The equation can be rewritten as

$$\rho R_e(w; g) = w + \max_{s_e \geq 0} \{-c_e(s_e) + \lambda_e(s_e; g) \mathrm{E}_{F_e}[\max\{R_e(W; g) - R_e(w; g), 0\}|g]\}. \tag{2}$$

From Bellman's equation it follows that $R_e(x; g) > R_e(y; g)$ if $x > y$: the value of work increases with the wage received by a worker. Therefore, employed workers accept a job offer if the associated wage exceeds their current wage w. The optimal effort devoted to job search follows from the first-order condition

$$\frac{c'_e(s_e)}{\lambda'_e(s_e; g)} = \int_w^\infty (R_e(y; g) - R_e(w; g))\, dF_e(y; g). \tag{3}$$

Since the right-hand side is a positive and decreasing function in w, and the left-hand side is an increasing function in s_e, optimal job-search effort s_e is lower if individuals receive higher wages w. Individuals devote positive effort to job search only if

$$\frac{c'_e(0)}{\lambda'_e(0; g)} < \int_w^\infty (R_e(y; g) - R_e(w; g))\, dF_e(y; g).$$

Since the left-hand side is positive and the right-hand side is decreasing in w, there is some wage $\bar{w}(g)$ above which employed workers no longer search for work, a result already established by Mortensen (1986).[4] An individual who reaches the wage level $\bar{w}(g)$ stays in this job forever, and above $\bar{w}(g)$ the value of working $R_e(w; g)$ equals w/ρ.

Next, consider an individual who is unemployed at graduation. This individual is entitled to collect a particular type of welfare benefits, denoted by b. Welfare benefits for school leavers are reduced benefits compared to those collected by

[2] In our data set we hardly observe transitions from being employed to entering unemployment. Of the individuals who were observed to have had at least one job, 99 percent are employed at the end of our observation period.

[3] Yoon (1981) assumes that a job searcher incurs some fixed costs in every period.

[4] Mortensen (1986) has a continuous-time framework and parameterizes the job-offer arrival rate as λ's.

other welfare recipients, like job losers. The level of benefits depends on the housing situation. For most school leavers, the level of the monthly gross welfare benefits is about 435 euro. Since school leavers often qualify for housing subsidies, we set the net monthly benefit level b equal to 450 euro. These welfare benefits are paid for an unlimited period of time.

Although the search process of unemployed workers is similar to that of employed workers, they face different structural parameters. Search costs equal $c_u(s_u)$, the probability of receiving a job offer equals $\lambda_u(s_u;g)$ and offers are drawn from $F_u(w;g)$. These all have the same properties as $c_e(s_e)$, $\lambda_e(s_e;g)$ and $F_e(w;g)$, respectively. Since the model is stationary (after graduation) unemployed workers choose each period the same job search effort s_u and the same reservation wage ϕ_u. The present value of search $R_u(g)$ of unemployed workers follows from Bellman's equation

$$R_u(g)=\max_{s_u\geq 0}\left\{\frac{b-c_u(s_u)}{1+\rho}+\frac{\lambda_u(s_u;g)}{1+\rho}\mathrm{E}_{F_u}[\max\{R_e(W;g),R_u(g)\}|g]+\frac{1-\lambda_u(s_u;g)}{1+\rho}R_u(g)\right\},$$

which can be rewritten as

$$\rho R_u(g)=b+\max_{s_u\geq 0}\{-c_u(s_u)+\lambda_u(s_u;g)\mathrm{E}_{F_u}[\max\{R_e(W;g)-R_u(g),0\}|g]\}.$$

If an unemployed worker receives a job offer with wage w, he or she accepts the offer if $R_e(w;g)\geq R_u(g)$. The reservation wage ϕ_u can thus be found by solving

$$R_e(\phi_u;g)=R_u(g).$$

For a given value of ϕ_u, the optimal amount of job-search effort s_u follows the first-order condition

$$\frac{c_u'(s_u)}{\lambda_u'(s_u;g)}=\int_{\phi_u}^{\infty}(R_e(w;g)-R_e(\phi;g))\,dF_u(w;g). \tag{4}$$

The left-hand side of the first-order condition is positive, and it is increasing in s_u. Therefore, a necessary condition for individuals to devote a positive amount of effort to job search is that the reservation wage ϕ_u should be such that

$$\frac{c_u'(0)}{\lambda_u'(0;g)}<\int_{\phi_u}^{\infty}(R_e(w;g)-R_e(\phi;g))\,dF_u(w;g).$$

So far, we have conditioned on the grades g obtained at university while these grades are obviously determined before graduation, but generate wage returns after graduation. We may therefore expect that labor market prospects are better for workers with higher grades, i.e. $R_u(g)>R_u(g')$ and $R_e(w;g)>R_e(w;g')$ if $g>g'$. If these conditions are not satisfied, students will not find it worthwhile to study more to get better grades. We return to this issue below.

3.2. The search process before graduation

Although we consider the time before graduation as a single period, our main focus is on the time interval closest to graduation in which students start searching for their first regular job. It should be noted that during this period drop-out rates from university education are negligible. According to Statistics Netherlands, overall drop-out rates from university education in the Netherlands are about 30 percent, but this occurs mainly in the first two years of studying. Students devote effort $e\geq 0$ to studying and $s_s\geq 0$ to job search. Study effort and job-search effort are substitutes; the costs function equals $c(s_s,e)$, with derivatives $c_{s_s}(s_s,e)>0$, $c_e(s_s,e)>0$ and $c_{s_s,e}(s_s,e)>0$. Furthermore, the costs are 0 if the student does not devote any effort to both studying and job search $c(0,0)=0$.

The returns of study effort are an increased probability of getting high grades. Stinebrickner and Stinebrickner (2008) show that study effort is indeed important for academic achievement. We impose the condition that grades can only take two values: high (1) and low (0). The probability of receiving high grades $\Pr(G=1|e,a)$ is increasing with study effort e and also depends on the student's ability a. We use G for the stochastic variable describing grades and g as its realization. Colonna (2007) and Eckstein and Wolpin (1999) use similar inputs in their educational production functions. Job search effort generates job offers. Let $N=0,1,\ldots$ denote the number of job offers received before graduation and $\Pr(N\leq n|s_s)$ is decreasing in s_s. Each job offer is associated with a wage from the same offer distribution $F_u(w;g)$ as for unemployed individuals. At the moment of graduation, a student decides to accept the best job offer and to start working immediately after graduation or to reject all job offers and to become unemployed. The value of study R_s is given by Bellman's equation

$$R_s=\max_{s_s\geq 0,e\geq 0}\left\{-c(s_s,e)+\sum_{g=0}^{1}\Pr(G=g|e,a)\Big(\Pr(N=0|s_s)R_u(g)+\sum_{n=1}^{\infty}\Pr(N=n|s_s)\mathrm{E}_{F_u^n}[\max\{R_e(W;g),R_u(g)\}|g]\Big)\right\}, \tag{5}$$

where $F_u^n(\cdot)$ represents the distribution function of the nth order-statistic. The equation can be rewritten as

$$R_s = \max_{s_s \geq 0, e \geq 0} \left\{ -c(s_s, e) + \sum_{g=0}^{1} \Pr(G = g|e, a) \Big(R_u(g) + \sum_{n=1}^{\infty} \Pr(N = n|s_s) \mathrm{E}_{F_u^n}[\max\{R_e(W; g) - R_u(g), 0\}|g] \Big) \right\}. \quad (6)$$

Recall that students often receive grants and financial support from their parents. Since we impose that study duration is exogenous, this income does not affect optimal behavior and can be excluded from Bellman's equation. Above we made the implicit assumption that job offers already take into account the student's grades and that the student decides about accepting the best job offer after the grades are known to the student.

The optimal reservation wage of students is similar to those of unemployed workers. Because at graduation students may have generated multiple job offers, expected starting wages for students are higher than for unemployed workers. The optimal study effort and job search effort follow from the first-order conditions

$$\frac{\partial c(s_s, e)}{\partial e} = \sum_{g=0}^{1} \frac{\partial \Pr(G = g|e, a)}{\partial e} \left(R_u(g) + \sum_{n=1}^{\infty} \Pr(N = n|s_s) \int_{\phi}^{\infty} (R_e(w; g) - R_u(g))\, dF^n(w; g) \right) = 0$$

and

$$\frac{\partial c(s_s, e)}{\partial s_s} = \sum_{g=0}^{1} \Pr(G = g|e, a) \sum_{n=1}^{\infty} \frac{\partial \Pr(N = n|s_s)}{\partial s_s} \int_{\phi}^{\infty} (R_e(w; g) - R_u(g))\, dF^n(w; g) = 0.$$

Students devote positive effort to studying only if the labor market prospects for individuals with high grades are better than the labor market prospects for those with low grades.

3.3. Parametrization

The unknown structural elements of the model are the wage-offer distributions $F_u(w; g)$ and $F_e(w; g)$, the job-offer arrival probabilities $\lambda_u(s_u; g)$, $\lambda_e(s_e; g)$ and $\Pr(N = n|s_s)$, the cost functions of job search and study effort $c_u(s_u)$, $c_e(s_e)$ and $c(s_s, e)$, the probability of obtaining high grades $\Pr(G = 1|e, a)$, and the discount rate ρ. The identification of these structural parameters follows along the same lines as in Flinn and Heckman (1982). Estimating the discount rate ρ along with the other parameters turned out to be problematic. Therefore, we fixed the value of ρ to 0.10 annually.

We allow the structural parameters to be dependent on individual characteristics. Let x denote the vector of individual characteristics, including the grades g obtained at university (and including an intercept). The wage-offer distributions follow lognormal distribution functions. For nonemployed job seekers (i.e. students and unemployed workers), the location parameter is $\mu(x) = x\beta_w$ and the scale parameter is σ^2. For employed workers, the wage-offer distribution follows a lognormal distribution function with location parameter $\psi_\mu \mu(x)$ and scale parameter σ^2. The parameter ψ_μ can be interpreted as the returns of early work experience.

The job-offer arrival probability of unemployed workers follows an exponential distribution with intensity $\lambda(x) = \exp(x\beta_\lambda)$

$$\lambda_u(s_u; g) = 1 - \exp(-\lambda(x) s_u), \quad s_u \geq 0.$$

This functional form ensures that the job-offer probability equals 0 if an individual devotes no effort to job search ($s_u = 0$) and that it increases in s_u. For employed workers, the job-offer probability equals

$$\lambda_e(s_e; g) = 1 - \exp(-\psi_\lambda \lambda(x) s_e), \quad s_e \geq 0.$$

The parameter ψ_λ can be considered as a measure of the labor market efficiency of employed workers relative to unemployed workers and students.

The number of job offers collected before graduation follows a Poisson process with intensity $\pi(z)s_s$. This implies that

$$\Pr(N = n|s_s) = \exp(-\pi(z)s_s) \frac{(\pi(z)s_s)^n}{n!}, \quad s_s \geq 0.$$

The intensity parameter $\pi(z)$ depends on individual characteristics z (i.e. $\pi(z) = \exp(z\beta_\pi)$). The vector z contains the same individual characteristics as x except for grades g, which are for obvious reasons not known prior to graduation.

The costs functions of job-search effort for unemployed and employed workers follow

$$c_u(s_u) = \exp(cs_u) - 1 \quad \text{and} \quad c_e(s_e) = \exp(\psi_c cs_e) - 1, \quad s_u, s_e \geq 0.$$

These costs functions equal 0 if an individual does not devote any effort to job search and are increasing in effort. The parameter ψ_c accounts for higher opportunity costs of time for employed workers compared to unemployed workers. The costs function before graduation equals

$$c(s_s, e) = \exp(c_0 s_s + c_1 e) - 1, \quad s_s \geq 0 \text{ and } e \geq 0.$$

The costs function imposes the restriction that studying e and job-search effort s_s are substitutes. The cross derivative is

$$\frac{\partial^2 c(s_s,e)}{\partial s_s \partial e} = c_0 c_1 \exp(c_0 s_s + c_1 e).$$

Since c_0 and c_1 are both larger than 0, the term is positive and study effort becomes more costly if job-search effort (for students) increases (and vice versa).

The probability of obtaining high grades equals

$$\Pr(G=1|e;a) = 1 - \exp(-\exp(\xi_0 + \xi_1 a)e), \quad e \geq 0.$$

Ability a is measured by high school grades and age of graduation.

3.4. Solving the model

The key problem of estimating the model is that at any point in time the present value of work $R_e(w;g)$ enters the individual's decision problem. Because the model does not provide a closed-form solution for $R_e(w;g)$, we need to approximate $R_e(w;g)$ for both high grades $g=1$ and low grades $g=0$.

Recall from Section 3.1 that there exists a wage level $\bar{w}(g)$ above which employed workers do not search for work ($s_e(w;g)=0$ for $w \geq \bar{w}(g)$). The wage level $\bar{w}(g)$ follows from solving

$$\frac{c_e'(0)}{\lambda_e'(0;g)} = \int_{\bar{w}(g)}^{\infty} (R_e(w;g) - R_e(\bar{w};g))\, dF_e(w;g).$$

Because employed workers receiving wages w above $\bar{w}(g)$ remain in their job forever, their present value of work $R_e(w;g)$ equals w/ρ. Furthermore, we have parameterized $c_e'(0) = \psi_c c$ and $\lambda_e'(0;g) = \psi_\lambda \lambda(x)$. Therefore, we can determine $\bar{w}(g)$ by solving the condition

$$\frac{\psi_c c}{\psi_\lambda \lambda(x)} = \frac{1}{\rho} \int_{\bar{w}(g)}^{\infty} (w - \bar{w}(g))\, dF_e(w;g).$$

Since $F_e(w;g)$ is specified as a lognormal distribution function, the integral on the right-hand side can be solved analytically.

Given that an employed worker earns a wage w less than $\bar{w}(g)$, the condition for the optimal job search effort is given by Eq. (3). Solving this condition, given our parametrization, we obtain the optimal amount of job-search effort

$$s_e^*(w;g) = \frac{1}{\psi_c c + \psi_\lambda \lambda(x)} \left(\log\left(\frac{\psi_\lambda \lambda(x)}{\psi_c c} \right) + \log\left(\int_w^{\infty} (R_e(y;g) - R_e(w;g))\, dF_e(y;g) \right) \right). \tag{7}$$

For employed workers who are actively searching for work, the present value of work $R_e(w;g)$ does not equal w/ρ, but instead is given by Eq. (2). If we substitute in this equation the condition for optimal job-search effort and the parametrization, we get

$$\rho R_e(w;g) = w - (\exp(\psi_c c s_e^*(w;g)) - 1) + (1 - \exp(-\psi_\lambda \lambda(x) s_e^*(w;g))) \frac{\psi_c c \exp(\psi_c c s_e^*(w;g))}{\psi_\lambda . \lambda(x) \exp(-\psi_\lambda \lambda(x) s_e^*(w;g))}.$$

Note that $R_e(w;g)$ depends on $s_e^*(w;g)$, which depends on $R_e(y;g)$ for all $y \geq w$. Therefore, we cannot obtain analytical solutions for $s_e^*(w;g)$ and $R_e(w;g)$. Although, we tried to approximate $R_e(w;g)$ by different types of polynomials, we were unable to find any polynomial that had both an analytic solution for $\int_w^{\bar{w}(g)} (R_e(y;g) - R_e(w;g))\, dF_e(y;g)$ and a sufficiently good fit.[5] We use therefore a step-wise approximation for $R_e(w;g)$.

Note that if $w \geq \bar{w}(g)$, then $s_e^*(w;g) = 0$ and $R_e(w;g) = w/\rho$. Since $F_e(w;g)$ follows a lognormal distribution function, there is an analytic solution for $\int_{\bar{w}(g)}^{\infty} (y - \bar{w}(g))\, dF_e(y;g)$. Next, taking the first-difference with respect to w of both the left-hand side and the right-hand side of Eq. (2) shows

$$\frac{\partial R_e(w;g)}{\partial w} = \frac{1}{\rho + \lambda_e(s_e^*(w;g))(1 - F_e(w;g))}.$$

For a small Δ we can approximate[6]

$$R_e(w - \Delta;g) \approx R_e(w;g) - \Delta \frac{\partial R_e(w;g)}{\partial w}$$

[5] Bloemen (2005) approximates $R_e(x) - R_e(w)$ by $(x-w)/(\rho+\sigma)$. In an equilibrium search model Christensen et al. (2005) use an alternative approximation for $s(w)$, where they let $s(w)$ iterate for different values of w until a fixed point was found. This method yields results numerically equivalent to our approximation.

[6] In our computer program we take Δ equal to 5 euro.

and

$$\int_{w-\Delta}^{\infty}(R_e(y;g)-R_e(w-\Delta;g))\,dF_e(y;g)\approx\int_{w}^{\infty}(R_e(y;g)-R_e(w;g))\,dF_e(y;g)+(R_e(w;g)-R_e(w-\Delta;g))\left(1-F_e(w;g)+\frac{\Delta}{2}f_e(w;g)\right),$$

and $s_e^*(w-\Delta;g)$ follows from substituting the approximation for this integral in Eq. (7). So if we start from $R_e(\bar{w}(g);g)=\bar{w}(g)/\rho$, $s_e^*(\bar{w}(g);g)=0$ and the analytic solution for $\int_{\bar{w}(g)}^{\infty}R_e(y;g)-R_e(\bar{w}(g);g)\,dF_e(y;g)$, we can approximate $R_e(w;g)$ and $s_e^*(w;g)$ by the recursive formulas above. This approximation provides the behavior of the individual while employed. Next, we should determine the reservation wage $\phi^*(g)$ while unemployed (after graduation) and the amount of search effort $s_u^*(g)$.

Since we know $R_e(w;g)$, we can compute for each w

$$s_u(w;g)=\frac{1}{c+\lambda}\left(\log\left(\frac{\lambda}{c}\right)+\log\left(\int_w^{\infty}(R_e(y;g)-R_e(w;g))\,dF_u(y;g)\right)\right).$$

We can therefore find $\phi^*(g)$ by solving

$$\rho R_e(\phi^*(g);g)=b-c(s_u(\phi^*(g);g))+\lambda_u(s_u(\phi^*(g);g);g)\int_{\phi^*(g)}^{\infty}(R_e(y;g)-R_e(\phi^*(g);g))\,dF_u(y;g).$$

The left-hand side is an increasing function in $\phi^*(g)$ and the right-hand side is a decreasing function in $\phi^*(g)$. The only numerical complication is that the integral on the right-hand side is taken with respect to $F_u(\cdot;g)$ instead of $F_e(\cdot;g)$. The individual's optimal job-search effort while unemployed equals $s_u^*(g)=s_u(\phi^*(g);g)$.

The procedure above can be used to approximate $\bar{w}(g)$, $R_e(w;g)$, $s_e^*(w;g)$, $\phi^*(g)$ and $s_u^*(g)$ numerically. The optimal effort of studying and job search while still being a student follows by solving the first-order conditions

$$c_1\exp(c_0s_s^*+c_1e^*)=\exp(\xi_0+\xi_1a)\exp(-\exp(\xi_0+\xi_1a)e^*)\sum_{g=0}^{1}(2g-1)\times\left(\sum_{n=1}^{\infty}\exp(-\pi(z)s_s^*)\frac{(\pi(z)s_s^*)^n}{n!}\int_{\phi^*(g)}^{\infty}R_e(y;g)-R_e(\phi^*(g);g)\,dF^n(y;g)+(R_e(\phi^*(g);g))\right)$$

and

$$c_0\exp(c_0s_s^*+c_1e^*)=\sum_{g=0}^{1}(g+(1-2g)\exp(-\exp(\xi_0+\xi_1a)e^*))\times\sum_{n=1}^{\infty}\exp(-\pi(z)s_s^*)\frac{(\pi(z)s_s^*)^n}{n!}\int_{\phi^*(g)}^{\infty}R_e(y;g)-R_e(\phi^*(g);g)\,dF^n(y;g).$$

It should be noted that $R_e(w;g)$ and $\phi^*(g)$ are already determined in an earlier step. This means that solving the first-order conditions numerically for the optimal job-search effort for students s_s^* and study effort e^* is relatively easy.

3.5. Likelihood function

We use data on grades, job-search spells, employment spells, wages and job-search effort to estimate the parameters ξ, π, λ, ψ_λ, c, ψ_c, μ, ψ_μ, and σ. For ease of presentation, we suppress the vectors of covariates x and z. Because we observe individuals from the start of their career, we do not face any initial condition problems.

In the previous subsection we showed how optimal study effort e^* and job-search effort s_s^* prior to graduation were determined. If we observe that an individual has obtained high grades, the likelihood contribution of this observation is

$$\Pr(G=1|e^*)=1-\exp(-\exp(\xi_0+\xi_1a)e^*).$$

Recall that ability a is an observed individual characteristic.

Let T_u describe the duration between the graduation date and start of the first employment spell. If $T_u=0$, the individual starts working immediately upon graduation. The probability of having found a job upon graduation depends on search effort s_s^* while studying and the reservation wage $\phi^*(g)$. Conditional on grades g, the probability that an individual starts working upon graduation equals

$$\Pr(T_u=0|s_s^*,\phi_s^*(g),g)=\sum_{n=1}^{\infty}\Pr(N=n|s_s^*)(1-F_u^n(\phi^*(g);g)).$$

If an individual starts working upon graduation, then the starting wage w_1 is drawn from the density function

$$f(w_1|T_u=0,s_s^*,\phi^*(g),g)=\frac{\sum_{n=1}^{\infty}\Pr(N=n|s_s^*)\dfrac{(n-1)f_u(w_1;g)F_u^{n-1}(w_1;g)}{1-F_u^n(\phi^*(g);g)}}{1-\Pr(N=0|s_s^*)}.$$

However, if the individual did not find a job upon graduation, then the probability of finding work after $t_u > 0$ periods of unemployment equals

$$\Pr(T_u = t_u | T_u > 0, s_u^*(g), \phi^*(g), g) = (1 - \lambda_u(s_u^*(g); g)(1 - F_u(\phi^*(g); g)))^{t_u - 1} \times \lambda_u(s_u^*(g); g)(1 - F_u(\phi^*(g); g)).$$

Once an unemployed worker has accepted a job, the first wage w_1 is drawn from the density function

$$f(w_1 | T_u > 0, \phi^*(g), g) = \frac{f_u(w_1; g)}{1 - F_u(\phi^*(g); g)}.$$

We assume that wages are observed with measurement error. Let $\tilde{w}_1$ denote the observed wage, which is related to the true wage w_1 according to $\log(\tilde{w}_1) = \log(w_1) + \varepsilon_1$. The measurement error ε_1 is normally distributed with mean 0 and variance σ_ε^2, so

$$f(\tilde{w}_1 | w_1) = \frac{1}{\sqrt{2\pi}\sigma_\varepsilon \tilde{w}_1} \exp\left(-\frac{1}{2} \frac{(\log(\tilde{w}_1) - \log(w_1))^2}{\sigma_\varepsilon^2} \right).$$

The parameter σ_ε is estimated along with all other parameters when optimizing the loglikelihood function. This parameter can be interpreted as a measure for how well the structural model fits the data on wages.

If the individual's wage in his first job w_1 exceeds $\bar{w}(g)$, then he will not search further ($s_e^*(w_1, g) = 0$) and will thus stay in this job forever with probability 1. However, if the wage in the first job is lower than $\bar{w}(g)$, then the probability of staying in the first job for $t_e > 0$ periods equals

$$\Pr(T_e = t_e | s_e^*(w_1, g), w_1, g) = (1 - \lambda_e(s_e^*(w_1, g))(1 - F_e(w_1; g)))^{t_e - 1} \lambda_e(s_e^*(w_1, g))(1 - F_e(w_1; g)).$$

Further, the wage w_2 in the second job is drawn from the density function

$$f(w_2 | w_1, g) = \frac{f_e(w_2; g)}{1 - F_e(w_1, g)}.$$

Again, the observed wage in the second job $\tilde{w}_2$ contains a measurement error, which has the same properties as the measurement error of the observed wage in the first job.

Job-search effort does not have a well-specified unit. Although, one may naturally interpret effort as hours spent searching for work, our data are not informative on in this regard. Therefore, like Bloemen (2005) we use the number of job applications as a measure for job search. In the 1997 and 1998 surveys, individuals were asked about the number of job applications they made before accepting their first job; in the later surveys, individuals had to report all job applications until the moment of the interview. In the first two waves the relevant search effort is thus $s^*(g) = s_s^* + t_u s_u^*(g)$, while in the later surveys relevant search effort is $s^*(g, w_1) = s_s^* + t_u s_u^*(g) + t_e s_e(w_1, g)$ if the individual held one job. Additional terms arise when the individual had multiple jobs until the interview. Since making a job application does not always take the same number of hours, we assume that the number of job applications measures job-search effort with a given error; this error has the same properties as the measurement error for observed wages, and is normally distributed with mean 0 and variance σ_s^2. Thus conditional on the true job-search effort $s^*(g, w_1)$, the density function for observed job applications ($\tilde{s}$) is

$$f(\tilde{s} | s^*(g, w_1)) = \frac{1}{\sqrt{2\pi}\sigma_s \tilde{s}} \exp\left(-\frac{1}{2} \frac{(\log(\tilde{s}) - \log(s^*(g, w_1)))^2}{\sigma_s^2} \right).$$

Again, the parameter σ_s is estimated together with all other parameters in the model.

The distribution functions and density functions described above are the parts of the likelihood function. In the ideal case, we observe for each individual the period of being unemployed, the number of job applications, the wage in the first job, the length of the first job spell, the wage in the second job, etc. Unfortunately, we do not observe exact job spells; instead, we observe the date at which an individual started working in the first job and in the current job, the first wage and current wage, and whether an individual has had one, two, or more jobs before the interview. Thus we lack information for individuals who have had more than two jobs. To keep the likelihood function tractable, we use only information until accepting the second job. If an individual has had more than two jobs, we use the wage in the first job and the duration of the first job spell (i.e. the first job spell ended at least before the current job started).[7]

[7] This approach might create problems with endogenous sampling. A better solution would be to apply simulated maximum likelihood, thereby generating the possible path between the first job and moment of interview. However, since our estimation procedure already involves numerical approximations of the value functions and integrals in the likelihood function, estimation becomes computationally impossible. It should be noted that around 12 percent of the individuals had more than two jobs before the interview. This percentage is highest (almost 22 percent) among psychology graduates.

Table 1
Sample size stratified by study.

	Total
Economics	1288
Business (administration)	741
Dutch law	875
Psychology	630
Total	3534

Below we present the likelihood contribution of an individual who held two jobs during the observation period, which is the most extensive case. For ease of exposition, we suppose that the individual participated in one of the first two interviews, and thus we report job-search applications until he or she accepts the first job. The likelihood contribution of this individual is

$$\begin{aligned}\mathscr{L} = \sum_{g=0}^{1} \Pr(G=g|e^*) \Bigg[I(t_u=0) \Bigg(& \Pr(T_u=0|s_s^*,\phi^*(g)) f(\tilde{s}|s_s^*) \int_{\phi^*(g)}^{\bar{w}(g)} f(\tilde{w}_1|w_1) f(w_1|T_u=0,s_s^*,\phi^*(g),g) \\ & \times \Pr(T_e=t_e|s_e^*(w_1,g),w_1,g) \\ & \times \int_{w_1}^{\infty} f(\tilde{w}_2|w_2) f(w_2|w_1,g)\, dw_2\, dw_1 \Bigg) + I(t_u>0)\big((1-\Pr(T_u=0|s_s^*,\phi_s^*(g))\big) \\ & \times \Pr(T_u=t_u|T_u>0 s_u^*(g),\phi^*(g),g) f(\tilde{s}|(s_s^*+t_u s_u^*(g))) \\ & \times \int_{\phi^*(g)}^{\bar{w}(g)} f(\tilde{w}_1|w_1) f(w_1|T_u>0,\phi^*(g),g) \Pr(T_e=t_e|s_e^*(w_1,g),w_1,g) \\ & \times \int_{w_1}^{\infty} f(\tilde{w}_2|w_2) f(w_2|w_1,g)\, dw_2\, dw_1 \Bigg) \Bigg].\end{aligned}$$

As the true wages in both the first and second job are not observed, the likelihood contribution contains two integrals. The upper bound in the integral over all possible wages in the first job is now the maximum wage $\bar{w}$ at which the individual continues on-the-job search. The second integral is over all possible true wages in the second job; the true wage in the second job should exceed the true wage in the first job. The second integral is the convolution of a lognormal distribution and a truncated lognormal distribution function, which has a relatively simple closed-form solution.

4. Data

Our data are from a survey of individuals who completed undergraduate education in the Netherlands.[8] The survey is a written questionnaire that contains questions on education, job-search behavior, work history and personal characteristics. Each year (in January or February), individuals are interviewed who graduated in the academic year two years earlier. For example, the sample collected in January 1999 contains individuals who graduated between September 1996 and August 1997. Individuals are interviewed only once, and all information is retrospective. The data contain seven cohorts, interviewed between 1997 and 2003.

We use data on all individuals who graduated in economics, business, Dutch law and psychology. These are large studies—and the only studies that contain sufficient individuals in the data set to analyze in separate models. Since our model describes individuals who first enter the labor market, we excluded individuals who did part-time education, were over the age of 30 at the moment of graduation, and were working full-time before graduation. This resulted in a data set of 4505 individuals. Furthermore, we excluded 36 individuals who were unemployed at the moment of the interview, never searched for work and reported not to be interested in working, and 505 individuals with item nonresponse or whose answers were inconsistent (for example, reporting that the moment of starting job search was later than the moment they started working or that the second job started before the first job). Finally, we excluded 430 individuals who started working freelance or in a family company or their own company, became a Ph.D. student or continued with another study. For obvious reasons these individuals do not behave as described by our model (they did not, for example, have to send application letters to find work). In total, the reduced data set includes 3534 individuals. Table 1 provides the sample sizes for each study.

Table 2 provides some details of the data. We first consider the individual's situation at the moment of the interview. An individual is considered to be employed when he has a job that contains at least 12 contractual working hours. For individuals studying economics, business or Dutch law, employment rates at the moment of the interview are close to 1. For psychology graduates, employment rates at the moment of the interview display an increasing trend over the observation

[8] For each study a random sample of graduates was selected from the administration of the organization that coordinates the enrollment of students at all Dutch universities and that makes the payments of government grants to students.

Table 2
Summary statistics.

	Year of interview						
	1997	1998	1999	2000	2001	2002	2003
Employment rate at the interview							
Economics	0.99	1.00	1.00	1.00	1.00	1.00	1.00
Business	1.00	1.00	0.99	1.00	1.00	1.00	1.00
Dutch law	0.99	0.99	0.99	1.00	0.99	1.00	1.00
Psychology	0.92	0.97	0.99	0.98	1.00	0.98	1.00
Average contractual hours per week							
Economics	39.1	38.5	38.4	38.4	38.6	38.4	38.5
Business	39.2	38.9	39.0	38.8	38.9	38.8	38.8
Dutch law	38.2	37.9	38.1	38.6	38.4	38.4	38.3
Psychology	34.0	33.1	34.5	34.1	33.2	33.0	33.3
Real net monthly wage at interview (in euros)[a]							
Economics	1301	1321	1337	1435	1426	1544	1392
Business	1345	1317	1387	1440	1422	1500	1449
Dutch Law	1274	1243	1279	1359	1402	1500	1356
Psychology	1102	1081	1200	1196	1173	1219	1220
Fraction with multiple jobs before interview							
Economics	0.45	0.35	0.50	0.35	0.27	0.32	0.32
Business	0.49	0.42	0.45	0.50	0.41	0.42	0.49
Dutch law	0.49	0.47	0.53	0.53	0.35	0.39	0.41
Psychology	0.56	0.48	0.59	0.48	0.65	0.58	0.65
Fraction with more than two jobs before interview							
Economics	0.14	0.08	0.10	0.07	0.04	0.05	0.09
Business	0.15	0.07	0.07	0.11	0.08	0.08	0.18
Dutch law	0.18	0.17	0.19	0.08	0.10	0.09	0.13
Psychology	0.22	0.20	0.16	0.30	0.26	0.13	0.26
Real net monthly wage in first job[a]							
Economics	1200	1247	1226	1347	1378	1511	1344
Business	1205	1238	1271	1279	1372	1392	1393
Dutch Law	1139	1153	1136	1224	1042	1075	1109
Psychology	924	945	1031	995	1041	1075	1108

Table 2. (*continued*)

	Year of interview						
	1997	1998	1999	2000	2001	2002	2003
Job search before graduation							
Economics	0.78	0.77	0.82	0.76	0.72	0.74	0.72
Business	0.72	0.81	0.78	0.82	0.74	0.68	0.68
Dutch law	0.69	0.68	0.74	0.73	0.58	0.65	0.76
Psychology	0.77	0.70	0.63	0.72	0.58	0.62	0.62
Employment rate at graduation							
Economics	0.36	0.44	0.47	0.50	0.40	0.44	0.50
Business	0.34	0.46	0.50	0.52	0.42	0.32	0.37
Dutch law	0.26	0.27	0.39	0.42	0.22	0.45	0.42
Psychology	0.41	0.29	0.28	0.42	0.30	0.40	0.40
Number of job applications[b]							
Economics	13.4	12.1	11.6	7.8	5.2	4.7	5.6
Business	9.5	11.8	11.1	8.4	6.0	7.5	9.0
Dutch law	16.8	16.6	15.6	9.8	7.3	5.1	7.0
Psychology	13.3	17.5	14.3	9.9	15.1	13.1	11.0
Number of job interviews[b]							
Economics	4.2	4.1	5.3	5.2	4.9	5.1	5.4
Business	4.0	4.3	6.0	6.2	6.0	5.4	5.5
Dutch law	3.9	3.6	5.8	5.2	5.1	4.8	3.9
Psychology	2.7	2.6	4.2	3.5	3.9	4.6	3.9
High grades[c]							
Economics	0.20	0.24	0.22	0.22	0.26	0.36	0.37
Business	0.20	0.27	0.27	0.16	0.27	0.40	0.21
Dutch law	0.32	0.27	0.30	0.30	0.31	0.31	0.28
Psychology	0.38	0.43	0.37	0.40	0.37	0.56	0.38

[a] Real wages are measured in euros in February 1997.

[b] In the 1997 and 1998 surveys, individuals were asked to report the number of job applications and interviews until accepting the first job. Since 1999, individuals have to report the total number of job applications until the moment of the survey.

[c] An individual is considered to graduate with high grades if the average grade is above 7 on a 10-point scale.

period, from around 0.85 in 1997 to over 0.95 in 2002 and 2003. Conditional on being employed, almost all individuals work full-time. The average number of weekly contractual working hours is between 38 and 40 for economics, business and Dutch law graduates and about 34 for psychology graduates. None of the groups show trends over calendar time.

Real net monthly wages at the moment of the survey are measured in euros in February 1997 (the month of the first wave of the survey). Wages of psychology graduates are typically lower than wages for the other groups. The general picture is that there is an upward trend in real wages until 2002 and a (small) drop in 2003. This picture follows the business cycle closely. This job turnover rate is highest among psychology graduates: around 60 percent of the individuals had at least two jobs during the observation period, and it shows a slight upward trend.[9] In all groups, about 40–45 percent of the individuals held more than one job. The data are informative not only on the wage in the job at the moment of the interview, but also on the wage in the first job after graduation. The wage in this first job follows the same pattern as the current wage. In the data, about 26 percent of the individuals with multiple jobs have a real wage at the moment of the interview that is lower than the first wage.

The survey asks individuals in which month they graduated and in which month they started searching for work. There does not seem to be any trend in the number of months prior to graduation that students start their job search. However, there are some differences between the groups of students. Around 75 percent of the economics and business graduates start searching for work before graduation. For Dutch law and psychology this is lower: only around 65 percent start before graduation. Overall, about 20 percent of the individuals had not yet performed any job-search activities one month after graduation. It is well known that some students take some time off after graduating—going on holidays for example. Within our model we tried to endogenize this by imposing the restriction that some individuals derive additional utility from not working at graduation. However, estimating this additional utility term turned out to be problematic.

The data contain information about both the number of job applications and the number of job interviews. In the first two surveys, individuals were asked about the total number of job applications and job interviews until the moment the first job was accepted. Since 1999, individuals have to report the total number of job applications and job interviews until the moment of the interview. Our empirical analyses use the number of job applications as a measure for job-search intensity. For all groups (except for psychology graduates) we see a downward trend in the number of job applications. Although our empirical analyses do not use the number of job interviews, it is interesting to look at job interviews as these provide some insight into the tightness of the labor market. The number of job interviews is relatively constant over time, which implies that in the later years individuals needed fewer job applications to generate the same number of job interviews. Psychology students needed on average the most job applications to obtain a single job interview.

About 25 percent of the economics and business students in our data set graduated with high grades, defined as an average grade during one's study higher than 7 on a 10-point scale. Almost 30 percent of the Dutch law graduates obtained high grades, and about 40 percent of the psychology graduates. As a measure for ability we used whether or not individuals received high grades for their final exams at high school. All Dutch high school students finish with a nationwide exam.

The variables discussed above are the endogenous variables in our model. As mentioned in Section 3.3, we allow for observed heterogeneity in the job-offer arrival rate and the wage-offer distribution. Since we estimate the model separately for each study, the samples are already relatively homogeneous. Due to business-cycle variation, individuals who graduated in different years faced different labor market conditions. To capture business-cycle variation we use GDP growth and the unemployment rate. We also include a dummy variable for being older than 25 years at the moment of graduation. If an individual is over this age at the moment of graduation, it indicates that either the students entered university via the higher vocational school track or stayed in university for a long time. During our observation period there is a negative trend in the average age at graduation. This negative trend coincides with the shortening of the entitlement period for government grants (see Section 2). There is no indication that students stayed in university shorter as a consequence of the improved labor market conditions in the later years of the observation period.

About 53 percent of the individuals in our sample are men. There are large variations between studies. In economics, 75 percent of the graduates are men, while in psychology this is only 17 percent. This percentage is the same across studies and over time. And finally, we include the region in which an individual lives. We distinguish between living in the west or the rest of the Netherlands. The west area is the most urbanized area, containing the four largest cities. This area supposedly has more jobs available for university graduates and average wages are higher. In our sample, 65 percent of the individuals live in the west, while 55 percent of the individuals graduated from a university in the west.

5. Reduced-form analyses

This section tests some predictions of the theoretical model by performing reduced-form analyses.

In our theoretical model we imposed the condition the wage-offer distribution before and after graduation had to be the same. Prior to graduation, students could collect multiple job offers and choose the best job offer at graduation. After graduation, individuals had to decide immediately whether or not to accept a job offer. Our theoretical model thus predicts expected wages in the first job to be higher for individuals starting work immediately after graduation.

[9] The questionnaire explicitly mentions that individuals should consider job changes within a firm as job-to-job transitions.

Table 3
Results of regression on the logarithm of the wage in the first job.

	Economics	Business	Dutch law	Psychology
Intercept	7.302	7.222	7.318	7.338
	(0.032)	(0.039)	(0.039)	(0.059)
Found job before graduation	0.014	0.004	−0.029	0.000
	(0.015)	(0.019)	(0.022)	(0.031)
High grades	0.060	0.045	0.043	0.077
	(0.016)	(0.020)	(0.019)	(0.028)
Male	0.040	0.048	0.008	0.007
	(0.015)	(0.018)	(0.018)	(0.038)
Older than 25 years	0.016	−0.011	0.033	0.000
	(0.015)	(0.020)	(0.019)	(0.032)
West	0.026	0.073	0.068	0.000
	(0.026)	(0.020)	(0.019)	(0.028)
Unemployment rate	−0.032	−0.024	−0.041	−0.036
	(0.004)	(0.005)	(0.005)	(0.008)
GDP growth	0.002	0.003	−0.004	−0.004
	(0.004)	(0.005)	(0.004)	(0.008)

Table 4
Results of probit model for active job search in first job.

	Economics	Business	Dutch law	Psychology
Intercept	16.51	18.44	21.27	7.737
	(1.423)	(1.909)	(1.854)	(1.638)
Log wage in first job	−2.278	−2.479	−2.915	−0.895
	(0.193)	(0.260)	(0.253)	(0.217)
High grades	0.085	−0.018	−0.271	−0.086
	(0.090)	(0.118)	(0.111)	(0.127)
Male	0.048	0.086	−0.303	−0.386
	(0.087)	(0.108)	(0.108)	(0.169)
Older than 25 years	0.276	0.274	0.406	0.071
	(0.090)	(0.120)	(0.116)	(0.149)
West	0.177	0.077	0.075	−0.386
	(0.081)	(0.107)	(0.112)	(0.129)
GDP growth	−0.021	−0.050	0.016	−0.028
	(0.021)	(0.029)	(0.026)	(0.037)
Unemployment rate	−0.032	−0.073	−0.009	−0.063
	(0.025)	(0.034)	(0.031)	(0.038)

Table 3 shows results from regressing the logarithm of the wage in the first job on an indicator for starting to work upon graduation and some individual characteristics. For none of the groups could we find significant wage returns of finding work before graduation. This implies that students might find it difficult to attract multiple job offers. It should furthermore be noted that individuals with high grades get between 4 and 8 percent higher wages in the first job, which is also significant. The unemployment rate is the most important business-cycle indicator for explaining wage variation in the first job. Whereas the effect of GDP growth is very small and insignificant, we find for all groups that a percentage-point increase in the unemployment rate decreases the first wage by an amount between 2.5 and 4 percent.

Our theoretical model predicts that the decision to search on the job depends only on the wage. In particular, only if the wage in a job exceeds a threshold value will an individual refrain from devoting any effort to job search. Our data allow us to identify which individuals search actively in their first job. First, all individuals who had at least two jobs must have searched in their first job. Second, respondents were asked whether they actively search for a new job at the moment of the interview. Only if an individual is at the moment of the interview still in his first job and reports not searching actively for work, is this individual considered to have not searched in his first job. Table 4 provides results from a probit model for actively searching for work in the first job. We include as regressors the wage in the first job and individual characteristics. The estimation results show that, indeed, for all groups the observed wage in the first job has a significant negative effect on searching on the job.

The theoretical model is stationary and thus predicts that conditional on observing the wage in the first job, the wage in the second job does not depend on the duration in the first job. The wage in the second job is a draw from the distribution function $F_e(w|w>w_1)$, where w_1 denotes the wage in the first job. The wage in the second job is thus positively correlated to the wage in the first job. The wage in the second job is observed only if individuals actually found a second job in the observation period. Table 5 shows estimation results from regressing the logarithm of the wage in the second job on the

Table 5
Results from regression on the logarithm of the observed wage in the second job.

	Economics	Business	Dutch law	Psychology
Intercept	4.312	4.011	5.616	5.591
	(0.275)	(0.380)	(0.299)	(0.339)
Log wage in first job	0.427	0.459	0.244	0.247
	(0.038)	(0.054)	(0.041)	(0.045)
First job duration (in years)	0.024	0.007	0.019	−0.004
	(0.017)	(0.019)	(0.019)	(0.033)
High grades	−0.021	−0.012	0.002	−0.006
	(0.035)	(0.042)	(0.038)	(0.054)
Male	0.011	0.051	0.008	0.031
	(0.020)	(0.021)	(0.019)	(0.044)
Older than 25 years	0.028	0.05	−0.005	−0.050
	(0.020)	(0.022)	(0.019)	(0.036)
West	0.023	−0.032	0.033	−0.025
	(0.019)	(0.021)	(0.020)	(0.031)
GDP growth	0.001	−0.001	−0.007	−0.008
	(0.005)	(0.005)	(0.005)	(0.009)
Unemployment rate	−0.020	0.001	−0.026	−0.017
	(0.006)	(0.007)	(0.006)	(0.010)

logarithm of the wage in the first job, the first job duration, and individual characteristics. Indeed, for all groups we find a strong positive correlation between the observed wage in the first job and the observed wage in the second job. And as predicted from the theoretical model, for none of the groups did the observed duration in the first job have a significant impact on the wage in the second job.

6. Results

6.1. Parameter estimates

This section discusses the estimation results of the structural model. Since we will not explicitly compare the returns of the different studies, we will therefore (conditional on observed covariates) treat the choice of study as exogenous.

Table 6 provides the parameter estimates. The probability of graduating from college with high grades depends on both study effort and ability (measured by high school grades and age). Age is used as an ability measure to distinguish between students who enter university immediately after the academic track in secondary school and students who first completed higher vocational education. The estimation results show that high school grades are the only important ability measure. For all groups, at a given level of study effort, high-ability students are significantly more likely to graduate with high grades than are low-ability students. In particular, the fraction of high-ability students with high grades is 0.34, 0.41, 0.54 and 0.62 for economics, business, Dutch law and psychology students, respectively, while it is 0.18, 0.20, 0.17 and 0.34 for their low-ability counterparts. This difference also captures the fact that high-ability students devote between 66 and 129 percent more effort to studying than low-ability students do.

Labor market returns of high grades are very small. For all groups, wage offers are slightly higher for individuals with high grades—although it should be noted that the parameters are not significant. The job-offer arrival rate before graduation does not depend on grades (by assumption) and after graduation (also for all groups) the job-offer arrival rate only modestly depends on grades. Labor market prospects are thus only slightly better for students with high grades; better labor market prospects, of course, are a necessary condition for devoting positive effort to studying. It should be noted that the data seem to suggest that job search prior to graduating is uncorrelated to grades. The correlation between devoting some job search prior to graduation and obtaining high grades is −0.029, 0.054, −0.037 and 0.033 for economics, business, Dutch law and psychology students, respectively.

Within the Dutch context, the very modest labor market returns of graduating with high grades are not very surprising. It is generally believed among students that passing courses is much more important than getting high grades. We therefore performed a sensitivity analysis in which we replaced grades by a variable denoting whether or not someone had a relatively short study time (less than five years). One might argue that this is a more relevant margin for studying the trade-off between study effort and job-search effort, as a lack of study effort in the final phase of the study might cause an extended study duration. However, this specification shows that the labor market returns of graduating relatively quickly are as small as the returns of obtaining high grades.[10] This specification, moreover, yields the same predictions for study effort and job-search effort. In this light, it is interesting to note that the correlations between completing one's study quickly and obtaining high grades are positive but not very high (i.e. 0.11, 0.15, 0.14 and 0.09 for economics, business, Dutch

[10] The parameter estimates are available on request.

Table 6
Results of the structural model.

	Economics	Business	Dutch law	Psychology
Job-offer arrival rate λ (after graduation)				
Intercept	−2.416	−1.890	−2.096	−1.206
	(0.098)	(0.140)	(0.142)	(0.147)
Individual characteristics				
Average level of grades in study				
High grades	−0.002	0.002	0.004	0.006
	(0.070)	(0.026)	(0.037)	(0.028)
Male	−0.020	−0.447	−0.210	0.051
	(0.032)	(0.064)	(0.060)	(0.078)
Older than 25 years	−0.101	−0.112	−0.300	−0.055
	(0.059)	(0.069)	(0.059)	(0.065)
West	−0.025	−0.066	0.308	0.044
	(0.037)	(0.058)	(0.057)	(0.051)
χ^2-test statistic for joint significance	36.4	38.4	39.5	1.6
Business cycle variation				
GDP growth	−0.017	0.010	0.027	−0.017
	(0.008)	(0.016)	(0.014)	(0.016)
Unemployment rate	0.009	−0.004	−0.039	−0.159
	(0.015)	(0.018)	(0.019)	(0.019)
χ^2-test statistic for joint significance	3.0	0.5	6.6	88.4
Job-offer arrival rate π (before graduation)				
Intercept	−0.762	−0.783	−1.050	−0.337
	(0.156)	(0.201)	(0.148)	(0.276)
Individual characteristics				
Male	0.034	−0.377	−0.273	−0.031
	(0.074)	(0.109)	(0.081)	(0.135)
Older than 25 years	−0.049	0.063	−0.061	0.104
	(0.094)	(0.119)	(0.123)	(0.153)
West	0.117	−0.108	0.146	−0.059
	(0.072)	(0.080)	(0.083)	(0.093)
χ^2-test statistic for joint significance	9.1	10.0	6.8	11.8
Business cycle variation				
GDP growth	0.034	0.036	0.026	−0.025
	(0.019)	(0.022)	(0.014)	(0.029)
Unemployment rate	−0.052	0.031	−0.047	−0.127
	(0.022)	(0.025)	(0.020)	(0.038)
χ^2-test statistic for joint significance	9.4	10.9	27.0	1.5
Mean log earnings level μ				
Intercept	7.272	7.174	7.229	7.357
	(0.024)	(0.030)	(0.030)	(0.045)
Individual characteristics				
Average level of grades in study				
High grades	0.004	0.0005	0.00004	0.001
	(0.009)	(0.008)	(0.0004)	(0.006)
Male	0.032	0.098	0.005	−0.018
	(0.012)	(0.015)	(0.014)	(0.027)
Older than 25 years	0.032	0.026	0.057	−0.033
	(0.013)	(0.016)	(0.014)	(0.024)
West	0.035	0.063	0.038	−0.048
	(0.012)	(0.015)	(0.015)	(0.020)
χ^2-test statistic for joint significance	28.5	56.8	12.0	9.0

Table 6 (*continued*)

	Economics	Business	Dutch law	Psychology
Business cycle variation				
GDP growth	0.0003	−0.0006	−0.004	−0.004
	(0.003)	(0.004)	(0.004)	(0.006)
Unemployment rate	−0.032	−0.025	−0.028	−0.032
	(0.004)	(0.004)	(0.004)	(0.006)
χ^2-test statistic for joint significance	9.9	28.3	23.2	30.1
Probability to receive high grades ξ				
Intercept	2.113	1.966	1.996	0.867
	(2.448)	(16.830)	(8.203)	(4.522)
High grades at high school	0.224	0.307	0.587	0.555
	(0.045)	(0.066)	(0.081)	(0.135)
Older than 25 years	0.153	0.094	−0.018	0.049
	(0.154)	(0.105)	(0.134)	(0.133)
Additional parameters				
ψ_λ	15.782	7.842	13.960	8.316
	(2.790)	(1.520)	(3.659)	(2.116)
ψ_μ	0.997	1.001	0.995	0.997
	(0.002)	(0.003)	(0.003)	(0.004)
σ	0.229	0.236	0.209	0.189
	(0.005)	(0.007)	(0.006)	(0.011)
σ_ε	0.065	0.039	0.104	0.218
	(0.001)	(0.001)	(0.003)	(0.007)
c_0	3.107	3.570	2.675	2.776
	(0.126)	(0.227)	(0.147)	(0.205)
ψ_c	15.055	8.799	13.168	8.291
	(2.437)	(1.514)	(3.285)	(1.657)
σ_s	0.016	0.060	0.129	0.068
	(0.020)	(0.027)	(0.025)	(0.031)

The χ^2-test statistic for joint significance is based on a Wald-test.

law and psychology, respectively). Since (conditional on graduating) the returns to academic achievements are low, study effort is low among Dutch students. Indeed Leuven et al. (2009) document that economics students, on average, spend only about 22 h per week studying (which includes attending classes). Students in business, Dutch law and psychology do not have the reputation of devoting more effort to studying than economics students do.

There is substantial individual heterogeneity in the job-offer arrival rates λ and π and the wage-offer distribution μ. The χ^2-tests show joint significance of gender, age upon graduation and region for almost all groups in all structural parameters. Since the individual characteristics are not our main parameters of interest, we therefore do not discuss the covariate effects in detail. Covariate effects often differ between groups, and signs are often different between structural parameters. It should, however, be noted that in almost all cases the effect on the wage-offer distribution is the dominant effect on labor market prospects, which is reflected by reservation wages and the flow values of unemployment.

The job-offer arrival rate and the wage-offer distribution depend on the state of the business cycle at the moment of graduation.[11] The indicators for the business cycle are GDP growth and the unemployment rate (see Figs. 3 and 4). Because few individual start their job search more than six months prior to graduation, and most individuals have found their first job within six months after graduation, we smooth the values for GDP growth and the unemployment rate by taking their average values in this time period. The correlation between the smoothed series of GDP growth and the unemployment rate is −0.40. For all groups, the unemployment rate is a more important business-cycle indicator than GDP growth. Mean wage offers are significantly lower in periods with high unemployment. The impact of the unemployment rate on the wage-offer distribution differs little between groups: a 1 percentage-point increase in the unemployment rate lowers mean real-wage offers by approximately 3 percent. Between the mid-nineties and 2001, the unemployment rate dropped from around 7 to 2 percent, implying that real-wage offers increased on average by 15 percent. The impact of the business cycle is particularly striking when compared to the importance of high grades. Individuals can affect their grades by increasing study effort, but the returns are negligible compared to the effects of the business cycle, which is beyond the individual's control.

[11] Ideally, one would like the business cycle to have an ongoing effect on the job-offer arrival rate and the wage-offer distribution. However, including such business-cycle effects in the model requires making assumptions about individuals' predictions of the business cycle and to what extent they are aware of uncertainty concerning economic conditions. In such a model not only the current state of the business cycle is relevant, but also beliefs about future economic conditions directly enter Bellman's equations, which were described in Section 3.

Fig. 5. Optimal monthly job-search effort (measured in job applications) at the moment of graduation as a function of the unemployment rate.

The business cycle also affects job-offer arrival rates. Again, in most cases the unemployment rate is the business-cycle indicator with the greatest influence. The overall picture (except for business students) is that a higher unemployment rate lowers the probability that search effort will result in a job offer. Although for economics students this is only the case before graduation, it applies for Dutch law and psychology graduates also after graduation. We also looked at how job-offer acceptance probabilities vary over the business cycle. These almost always seem to be very close to 1, however, which leaves little possibility for variation over the business cycle.

It is interesting to explore why the unemployment rate has such a large impact on the wage-offer distribution. The individuals in our sample all finish undergraduate education and are among the highest educated individuals in the population. As already mentioned in Section 4, finding work is not a great problem, even during recessions. Therefore, the increased demand for skilled labor associated with the improved business-cycle conditions at the end of the nineties compelled employers to increase wages to attract employees. This is expressed in the increased fraction of individuals that find a first job that requires university education. This percentage increased from 60 percent at the beginning of the observation period to almost 70 percent in the later years for economic, business and Dutch law graduates. Only for psychology graduates did this percentage remain relatively stable—around 50 percent during the complete observation period (although in later years they mention that the content of the job connects better to their study). For all groups, improved business-cycle conditions provided more access to higher-skill jobs with better wages.

Shimer (2004) argues that if labor market conditions improve, then individuals might lower their job-search effort. In our model, the search environment is mainly determined by the unemployment rate. Fig. 5 shows for all groups the average optimal amount of search effort (upon graduation, conditional on being unemployed) as a function of the unemployment rate. Dutch law and psychology graduates make on average the most job applications, while business graduates have the lowest level of search effort. The level of search effort is not very sensitive to changes in business-cycle conditions. There is only a very modest reduction in search effort if the unemployment rate increases. This seems to contrast with the theoretical prediction of Shimer (2004). However, Shimer (2004) faces a setting in which the business cycle only directly affects the job-offer arrival rate. If in our model we would allow the business cycle to affect only the job-offer arrival rate, we would indeed find that individuals search harder during periods of high unemployment. Furthermore, we should note that our estimated probabilities of receiving a job offer are much lower than the values Shimer (2004) requires for obtaining his predictions.

Figs. 6 and 7 show the estimated reservation wage at the time of graduation (ϕ) and the estimated lowest wage at which point employed workers do no longer devote any effort to job search ($\bar{w}$). The reservation wage upon graduation is a measure for the labor market prospects of students, while the highest wage at which employed workers still search for work reflects the opportunities for employed workers to find better-paying jobs. Reservation wages are lowest for economics graduates and highest for Dutch law graduates. Individuals who graduated in Dutch law stop their job search at lower wages than the other groups, while business graduates continue searching up to higher wages. This reflects the relatively high variance in the wage-offer distribution σ^2 for business graduates.

We allow the structural parameters to be different for employed and unemployed individuals. For all groups, a job application of an employed worker is more likely to generate a job offer than a job application of an unemployed worker. The parameter ψ_{λ} is for all groups large and significantly different from 1. So after accepting a first job, an individual will find that more jobs become accessible. Bowlus et al. (2001) find that the probability of receiving a job offer is lower for an employed individual than for an unemployed individual. However, we find that this is mainly the case because employed workers search less, due to much higher search costs. The parameter ψ_c capturing the difference in the search cost function is also always significantly different from 1, and in the same order of magnitude as ψ_{λ}. The wage-offer distribution does not change after an individual becomes employed; ψ_{μ} is never significantly different from 1. This suggests that there are no true returns of early work experience. Since wages between the first- and second-job increase by about 16–19 percent,

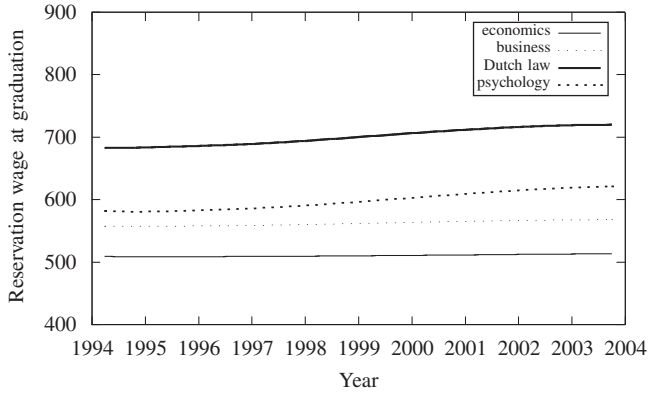

Fig. 6. Changes in the reservation wage (ϕ) at the moment of graduation over calendar time.

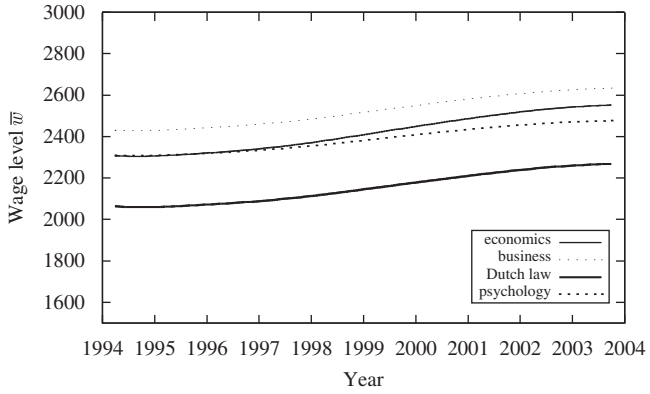

Fig. 7. Changes in lowest wage at which individuals do not search on the job ($\bar{w}$) over calendar time.

Table 7
Observed and predicted distribution of number of jobs at the moment of the survey and employment rate and grades at graduation.

	Economics		Business		Dutch law		Psychology	
	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.
Number of jobs at survey date								
No jobs	4.6	0.3	3.8	0.1	3.8	0.7	2.9	2.4
One job	48.9	62.5	46.2	55.3	46.2	53.5	40.4	39.2
Two or more jobs	46.6	37.1	50.0	44.6	50.0	45.8	56.7	58.4
Employment rate at graduation (%)	44.7	44.3	42.8	42.6	32.6	34.6	35.3	34.6
Obtained high grades (%)	24.8	25.6	27.2	28.0	29.7	31.1	40.1	40.4

labor market frictions are very important in the beginning of a career. This coincides with Topel and Ward (1992), who mention that young workers are searching for good matches.

6.2. Fit of the model

To gain some insight into the performance of the model, we report in Table 7 the observed and predicted number of jobs until the survey date, the employment rate at graduation and the grades obtained at university. Our model performs well with respect to the employment rate at graduation and grades. The employment rate at graduation and the fraction of individuals obtaining high grades are for all groups estimated very close to the observed values. Also formal χ^2-tests show similarity for all groups. The number of individuals without a job and with two or more jobs is somewhat overestimated for all groups (except for psychology graduates). This also leads the χ^2-tests for economics, business and Dutch law graduates

Table 8
Simulated policy effects.

	Economics		Business		Dutch law		Psychology	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Study effort	0.023	0.003	0.221	0.208	0.245	0.237	0.738	0.699
High grades	0.248	0.032	0.272	0.162	0.280	0.182	0.411	0.305
Search effort	1.655	1.699	1.412	1.448	1.618	1.670	1.466	1.524
Employed at graduation	0.447	0.454	0.428	0.435	0.326	0.334	0.346	0.355
Wage in first job	1348.4	1350.1	1333.7	1335.6	1237.1	1241.1	1270.7	1272.7
Expected benefit costs[a]	1785.3	0	1726.9	0	1623.5	0	1427.4	0
Expected reward costs[a]	0	0	0	0	0	0	0	0
	(3)	(4)	(3)	(4)	(3)	(4)	(3)	(4)
Study effort	0.407	0.390	0.471	0.457	0.525	0.510	1.190	1.146
High grades	0.913	0.896	0.910	0.895	0.941	0.929	0.846	0.817
Search effort	1.606	1.649	1.360	1.397	1.545	1.600	1.352	1.412
Employed at graduation	0.439	0.446	0.418	0.426	0.315	0.324	0.328	0.337
Wage in first job	1346.8	1348.3	1331.7	1333.3	1235.2	1239.2	1267.4	1268.9
Expected benefit costs[a]	1812.3	0	1756.8	0	1648.6	0	1467.8	0
Expected reward costs[a]	913.2	896.1	910.0	894.9	940.6	928.6	846.6	816.6

(1) Baseline case (no interventions).
(2) No entitlement anymore to welfare benefits.
(3) 1000 euro reward if student graduates with high grades.
(4) No welfare benefits entitlement and 1000 euro reward for high grades.
[a] Expected benefit costs and expected reward costs are per individual. Expected benefit costs are incurred until finding the first job (the model does not allow for job destruction).

to reject similarity between the data and the model predictions. Obviously, for these groups we underestimate the hazard rate of finding the first job and overestimate job-to-job transitions. This is not the case for psychology graduates.

Also the estimated variance of the measurement error can be interpreted as a measure for the goodness-of-fit of the model. The variance in the logarithm of the observed real wages equals 0.0569, 0.0521, 0.0631 and 0.0997 for economics, business, Dutch law and psychology graduates, respectively. The estimated variances of the measurement errors $\hat{\sigma}_{\varepsilon}^2$ are 0.0042, 0.0015, 0.0108, 0.0475. This implies that the model explains (for economics, business, Dutch law and psychology graduates, respectively) 92.6, 97.1, 82.9 and 52.3 percent of the variation in logarithm of observed wages. Given that our populations are very homogenous, the fit of the wages is good. Only for psychology graduates is the variation of the measurement errors substantial.

The variance in the observed number of job applications equals 0.8340, 0.9348, 1.0175 and 1.0676 for, respectively, economics, business, Dutch law and psychology graduates. Comparing these variances to the estimated variance in the measurement errors $\hat{\sigma}_s^2$ reveals that for all groups we can explain almost all variance in job applications. Overall, we can thus conclude that the model provides in most aspects a good fit of the data.

6.3. Policy simulations

During our observation period individuals had an unlimited entitlement to collecting welfare benefits after leaving school. The Dutch government recently passed a law that limits this right. In particular, as of July 2009 individuals under the age of 27 will no longer be entitled to welfare benefits. Over 70 percent of the individuals in our data set are below that age at graduation. We can simulate the consequences of this change in the law by setting the benefits level for unemployed individuals b equal to 0. Recall that the benefits level was equal to 450 euros.

Table 8 provides the results of this policy simulation. A comparison of columns (1) and (2) reveals that the employment rate at graduation increases only by less than 1 percentage-point. Also the wage in the first job increases somewhat. The slightly increased wage in the first job can be explained from more individuals collecting more job offers before graduation. Indeed, individuals have increased their job search effort before graduation. This effect dominates the effect of the reduced reservation wage. It should be noted that already with a benefits level of 450 euros almost all of the probability mass of the wage-offer distribution was above the reservation wage, so that acceptance rates of job offers are close to 1. For all groups we thus see that individuals reduce study effort and that fewer individuals graduate with high grades.

The table also reports the expected costs per individual on paying welfare benefits. These costs are incurred until the individual finds his first job. Recall, however, that our model does not allow for job destruction. These are lowest for psychology graduates and highest for economics graduates. Obviously, psychology graduates who have lower employment rates at graduation than economics and business graduates have much higher job-finding rates after graduation.

In the Netherlands, students are often criticized for their lack of ambition to get high grades. Politicians, university administrators and teachers have recently all suggested that students devote just enough effort to pass courses rather than having the ambition to get the highest possible grade. Policymakers have even suggested that a lack of excellent students may harm innovation in the Dutch economy. Given the low labor market returns to high grades that were found in our model, this study behavior seems rational. The low labor market returns to good academic achievement might not be typical for the Netherlands. Colonna (2007) finds that the college premium is substantially lower in Italy than in the US.

In the second policy simulation we investigate the extent to which study effort can be influenced. We investigate this issue by promising financial rewards for students graduating with high grades. In particular, in our policy experiment students receive 1000 euros at graduation if they have obtained high grades. Recall from Section 2 that at the end of the 1990s annual tuition fees were about 1250 euros. Furthermore, from our structural model we estimate the average total costs of studying and job search before graduation, which we can only do for the joint costs because of the nonseparability of these efforts in the cost function. Total costs of effort before graduation are 898 euros for economics students, 822 euros for business students, and 543 euros for both Dutch law and psychology students. The financial rewards for obtaining high grades are thus quite substantial. Column (3) of Table 8 presents the results from this policy experiment. The financial reward had, for all groups, a substantially positive effect on study effort. Also the fraction of students who graduate with high grades is shown to increase to about 85 percent for psychology graduates and over 90 percent for other groups. At the same time, all students slightly reduce their job-search effort. This latter effect dominates the effect of higher grades in labor market outcomes. Therefore, due to promising rewards for high grades, employment rates at graduation decreases slightly—as does the average wage in the first job. The policy is thus costly because most individuals receive the rewards and the expected costs of welfare benefit payments increase.

It should be noted that the effects of promising rewards for high grades are quite large. In fact, the effects are much larger than what is found in the social experiment conducted by Leuven et al. (2009). They find that financial rewards have a positive effect on study achievement only for high-ability students. The main reason why our model generates such large effects is that, due to negligible labor market returns to high grades, the model can only explain the fact that some students graduate with high grades from the very low costs of studying. If study costs are low, then students can almost freely increase study effort and thus obtain high grades when being promised a financial reward.

Finally, column (4) reports the simulation results from combining both policies. Compared to their counterparts in column (1), individuals in all groups increase study effort and reduce job search effort. This implies that students obtain better grades, but that labor market outcomes remain relatively unaffected. Only for psychology graduates do we see a small reduction in both the employment rate at graduation and the first wage. Furthermore, the expected costs on reward payments per individual in column (4) are much lower than the expected costs on welfare benefit payments per individual in column (1).

The main conclusion from the policy simulations is that financial rewards have a substantial influence study behavior and thereby grades. Changing students' job-search behavior is much more difficult. Both the employment rate at graduation and the average wage in the first job are scarcely affected by changing entitlement to unemployment benefits.

7. Conclusion

This paper developed a model that describes the labor market behavior of individuals around the time of graduation. Shortly before graduation individuals divide their effort between studying and job search. Study effort generates higher grades, while search effort increases the probability that an individual starts working immediately after graduation. Furthermore, our model allows for on-the-job search. We estimate our model in four samples of university graduates who are finishing an undergraduate education in economics, business, Dutch law and psychology. The estimated model provides a very good fit of the data.

The estimation results show that the labor market returns to high grades are low. Therefore, most students devote little effort to studying. This is well recognized in the public debate, which criticizes students for a lack of ambition to perform well in university. Policy simulations show that financial rewards for graduating with high grades can increase study effort substantially. However, because students substitute effort from job search to studying, and the labor market returns to high grades are low, such a policy does not improve labor market outcomes.

In a second policy experiment we investigate the effects of reducing unemployment benefits for school leavers. The Dutch government just passed an act that abolishes welfare benefits for individuals under the age of 27, which affects most of our sample. Policy simulations show that reducing benefit entitlement will only very modestly improve labor market outcomes. However, most students will reduce their study effort, and overall academic performance will drop substantially.

The data describe a relatively long observation period, which allows us to investigate the importance of business-cycle variation on labor market prospects. The empirical results indicate that the business cycle is important. During recessions, average wage offers decrease, which has a substantial impact on the labor market prospects of students. It should, however, be noted that the optimal level of job search remains relatively unaffected by changes in the business cycle.

We find that labor market frictions are very important at the beginning of an individual's career. On average, wages increase between 16 and 19 percent between the first- and second job. This wage increase cannot, however, be explained

from differences in the wage-offer distribution faced by employed and nonemployed job seekers. We do not find evidence for substantial returns to early work experience.

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