Higher Education Subsidies and Human Capital Mobility

Preliminary and Incomplete

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Abstract

In the U.S. there are large differences across States in the extent to which college education is subsidized, and there are also large differences across States in the proportion of college graduates in the labor force. State subsidies are apparently motivated in part by the perceived benefits of having a more educated workforce. The paper uses the migration model of Kennan and Walker (2009) to analyze how geographical variation in college education subsidies affects the migration decisions of college graduates. The model is estimated using NLSY data, and used the quantify the sensitivity of migration decisions to differences in expected net lifetime income. The estimates suggest that State subsidies have little effect on the geographical distribution of college graduates.

1 Introduction

There are substantial differences in subsidies for higher education across States. Are these differences related to the proportion of college graduates in each State? If so, why? Do the subsidies change decisions about whether or where to go to college?

Recent work on migration has emphasized that migration involves a sequence of reversible decisions that respond to migration incentives in the face of potentially large migration costs.[1]

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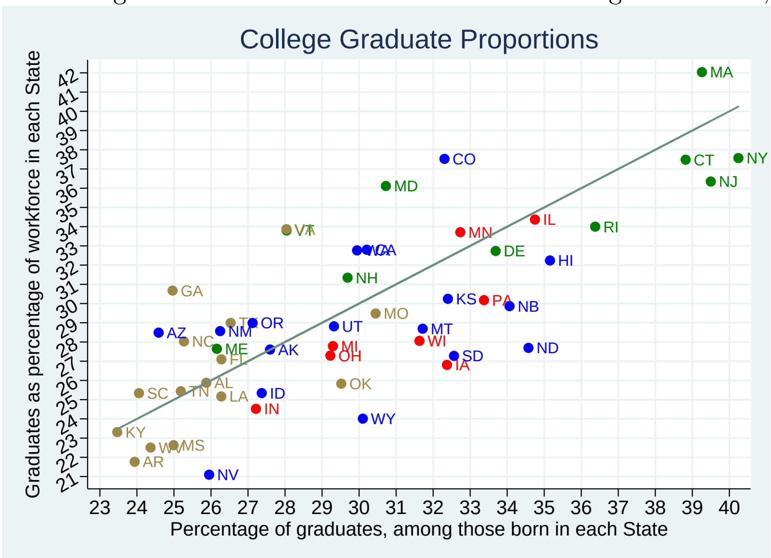
[1] See [Kennan & Walker, 2009], [Gemici, 2008] and [Bishop, 2008].

Figure 1: Birth and Work Locations of College Graduates, 2000



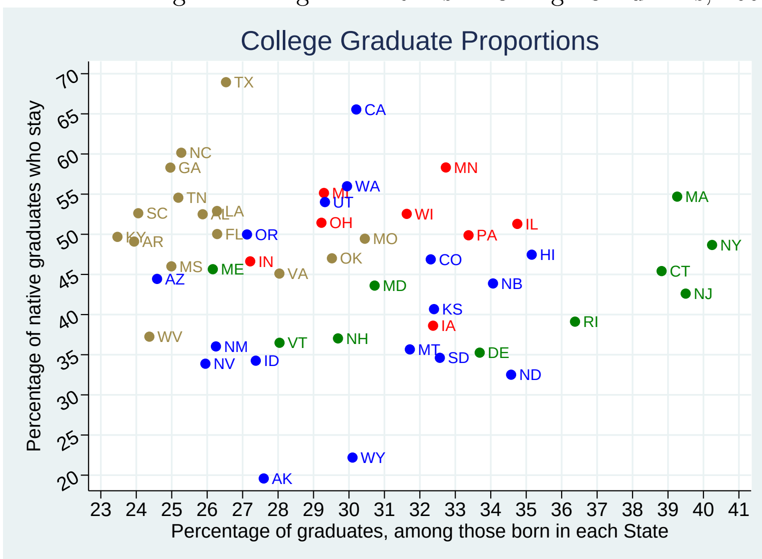
2 Geographical Distribution of College Graduates

There are big differences across States in the proportion of college graduates who are born in each State, and in the proportion of college graduates among those working in the State. Figure 1 shows the distribution of college graduates aged 25-50 in the 2000 Census, as a proportion of the number of people in this age group working in each State, and as a proportion of the number of workers in this age group who were born in each State. For example, someone who was born in New York is almost twice as likely to be a college graduate as someone born in Kentucky, and someone working in Massachusetts is twice as likely to be a college graduate as someone working in Nevada. Generally, the proportion of college graduates is high in the Northeast, and low in the South.

There are also big differences in the proportion of college graduates who stay in the State where they were born. Figure 2 shows the proportion of college graduates who work in their birth State. On average, about 45% of all college graduates aged 25-50 work in the State where they were born, but this figure is above 65% for Texas and California, and it is below 25% for Alaksa and Wyoming.

States spend substantial amounts of money on higher education, and there are large and persistent differences in these expenditures across States. Figure 3 shows the variation in per capita expenditures across States in 1991 and 2004, using data from the Census of Governments. The magnitude of these expenditures indicates that a more highly educated workforce is a major goal of State

Figure 2: Migration Rates of College Graduates, 2000



economic policies, perhaps because of human capital externalities. Thus it is natural to ask whether differences in higher education expenditures help explain the differences in labor force outcomes shown in Figures 1 and 2.

Figure 3: Higher Education Expenditures

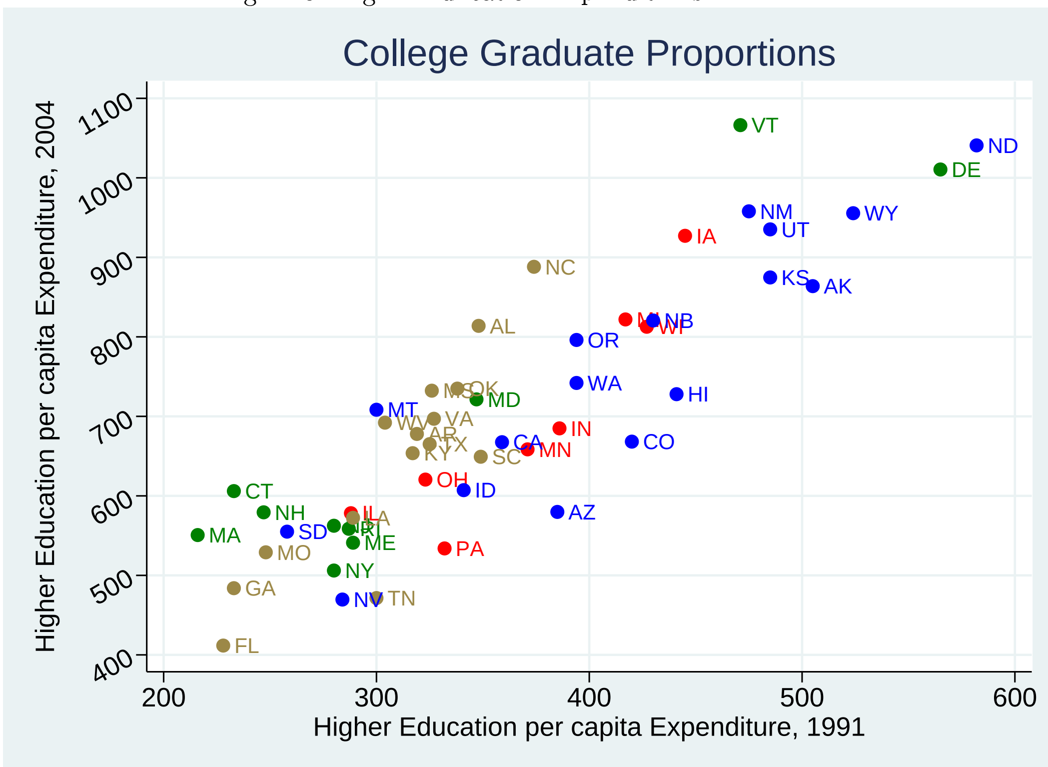
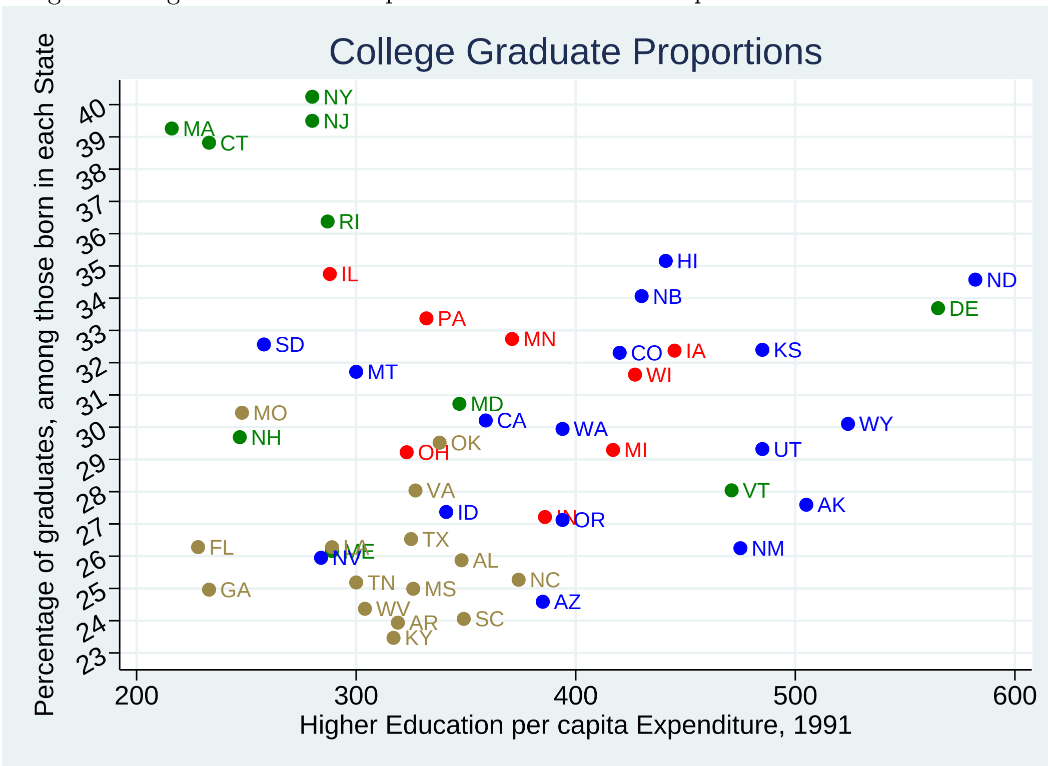


Figure 4 shows no apparent relationship between State spending and the proportion of college graduates among those born in each State. There are big variations across States in each of these variables, but these variations are essentially unrelated. A more formal analysis of these data is presented in the next section.

Figure 4: Higher Education Expenditures and Human Capital Distribution



3 A Two-Period Model

Consider a high school graduate who decides whether to go to college, and also where to work (either as a high school graduate or as a college graduate). Let ℓ_0, ℓ_1 denote the birth location and the work location. The objective is to maximize the present value of earnings, net of education costs and moving costs, and adjusted for location preferences. The payoff is given by

$$\widetilde{v}\left(d, \ell_1; \ell_0\right) \quad = \quad d\left[\alpha Y_c\left(\ell_1\right) - c\left(\ell_0\right) + \zeta_c\left(\ell_1\right)\right] + (1-d)\left[\alpha Y_h\left(\ell_1\right) + \zeta_h\left(\ell_1\right)\right] - \Delta\left(\ell_0, \ell_1\right)$$

where d is a college indicator, $c\left(\ell_0\right)$ is the cost of schooling in the birth location, $\Delta\left(\ell_0, \ell_1\right)$ is the cost of moving from ℓ_0 to ℓ_1, and $\zeta_h\left(\ell_1\right), \zeta_c\left(\ell_1\right)$ are payoff shocks. The choice problem is

$$V\left(\ell_0\right) = \max_{d, \ell_1} \tilde{v}\left(d, \ell_1; \ell_0\right)$$

This yields a (highly simplified) multinomial logit model for the choice of whether to go to college, and where to work. It is assumed for the moment that going to college means going to college in the birth location.

If the payoff shocks are drawn independently for the Type-1 extreme value distribution, the probability that a person born in ℓ_0 chooses to be a college graduate in ℓ_1 is

$$
\begin{aligned}
p_c(\ell_0,\ell_1) &= \frac{exp\left(v_c(\ell_0,\ell_1)\right)}{\sum_{k=1}^{J}\left[exp\left(v_h(\ell_0,k)\right)+exp\left(v_c(\ell_0,k)\right)\right]} \\
&= \frac{exp\left(\alpha Y_c(\ell_1)\right)}{\sum_{k=1}^{J} exp\left(\Delta(\ell_0,\ell_1)-\Delta(\ell_0,k)\right)\left[exp\left(\alpha Y_h(k)+c(\ell_0)\right)+exp\left(\alpha Y_c(k)\right)\right]}
\end{aligned}
$$

and the probability of ending up as a high school graduate in $\ell_1$is

$$
\begin{aligned}
p_h(\ell_0,\ell_1) &= \frac{exp\left(v_h(\ell_0,\ell_1)\right)}{\sum_{k=1}^{J}\left[exp\left(v_h(\ell_0,k)\right)+exp\left(v_c(\ell_0,k)\right)\right]} \\
&= \frac{exp\left(\alpha Y_h(\ell_1)\right)}{\sum_{k=1}^{J} exp\left(\Delta(\ell_0,\ell_1)-\Delta(\ell_0,k)\right)\left[exp\left(\alpha Y_h(k)\right)+exp\left(\alpha Y_c(k)-c(\ell_0)\right)\right]}
\end{aligned}
$$

where

$$
\begin{aligned}
v_c(\ell_0,\ell_1) &= \alpha Y_c(\ell_1)-c(\ell_0)-\Delta(\ell_0,\ell_1) \\
v_h(\ell_0,\ell_1) &= \alpha Y_h(\ell_1)-\Delta(\ell_0,\ell_1)
\end{aligned}
$$

and where $Y_h(\ell_1), Y_c(\ell_1)$ denote the present values of net lifetime earnings for high school and college graduates.

Following [Kennan & Walker, 2009], the moving cost is specified as

$$
\Delta(\ell_0,\ell_1) = \left(\gamma_0+\gamma_1 D(\ell_0,\ell_1)-\gamma_2 D^0(\ell_0,\ell_1)-\gamma_3 n(\ell_1)\right)\chi\left(\ell_1\neq\ell^0\right)
$$

where $D(\ell_0,\ell_1)$ is the distance from ℓ_0 to ℓ_1, $D^0(\ell_0,\ell_1)$ is a dummy variable indicating whether ℓ_1 is adjacent to ℓ^0 (where States are adjacent if they share a border), and $n(\ell_1)$ is the population of location ℓ_1.

The cost of college is specified as

$$
c(\ell) = \delta_0 - \delta_1 S(\ell) - \delta_2 Y(\ell),
$$

where $S(\ell)$ measures the extent to which college costs are subsidized in State ℓ, and $Y(\ell)$ denotes the average income in State ℓ.

In this model, a reduction in the cost of education in State j implies an increase in the proportion of college graduates among those born in State j, and also an increase in the number of college graduates in the labor force in the State. The question is whether differences in State spending have a substantial effect, given the distribution of earnings for high school and college graduates. For example, there are big moving costs, so even if college is cheap in a particular State, going to college is not so attractive if the college premium is not very high in that State.

The model can be estimated using data on the number of people born in each State, the number who end up as college graduates and as high school

Table 1: **Human Capital Mobility**

	$\hat{\theta}$	$\hat{\sigma}_\theta$
Utility and Cost		
Disutility of Moving (γ_0)	5.329	0.0091
Distance (γ_1) (1000 miles)	0.215	0.0059
Adjacent Location (γ_2)	1.269	0.0089
Population (γ_5) (millions)	0.952	0.0057
Cooling (α_1) (1000 degree-days)	0.275	0.0031
Income (α_0)	0.066	0.0015
College Cost (δ_0)	1.477	0.0230
College Subsidy(δ_1)	-0.175	0.0412
Median Income(δ_2)	0.288	0.0037
Loglikelihood	-625048	
There are 255,184 observations.		

graduates in each State (ignoring those who don't finish high school),the earnings of high school graduates and of college graduates by State, and the costs of going to college in different States (measured here by State expenditures on higher education, per person of college age, by State).

Parameter estimates are shown in Table 1, using data from the 2000 Census of Population, and the 1992 Census of Governments. The main result is that State expenditures on higher education do not seem to influence human capital investment decisions; indeed, the coefficient δ_1 is negative, and significant.

4 A Life-Cycle Model of Expected Income Maximization

The results in the previous section suggest that human capital migrates across States in response to wage differences. This section analyzes the migration decisions of college graduates, using the dynamic programming model developed in [Kennan & Walker, 2009] , applied to panel data from the 1979 cohort of the National Longitudinal Survey of Youth.

Suppose there are J locations, and individual i's income y_{ij} in location j is a random variable with a known distribution. Migration decisions are made so as to maximize the present value of expected lifetime income.

Let x be the state vector (which includes the stock of human capital, wage and preference information, current location and age, as discussed below). The utility flow for someone who chooses location j is specified as $u(x,j)+\zeta_j$, where ζ_j is a random variable that is assumed to be iid across locations and across periods and independent of the state vector. It is assumed that ζ_j is drawn from the Type I extreme value distribution. Let $p(x'|x,j)$ be the transition probability from state x to state x', if location j is chosen. The decision problem can be written in recursive form as

$$V(x,\zeta) = \max_j \left(v(x,j) + \zeta_j\right)$$

where

$$v(x,j) = u(x,j) + \beta \sum_{x'} p(x'|x,j)\bar{v}(x')$$

and

$$\bar{v}(x) = E_\zeta V(x,\zeta)$$

and where β is the discount factor, and E_ζ denotes the expectation with respect to the distribution of the J-vector ζ with components ζ_j.Then, using arguments due to [McFadden, 1973] and [Rust, 1994], we have

$$\exp\left(\bar{v}(x)\right) = \exp\left(\bar{\gamma}\right) \sum_{k=1}^{J} \exp\left(v(x,k)\right)$$

where $\bar{\gamma}$ is the Euler constant. Let $\rho(x,j)$ be the probability of choosing location j, when the state is x. Then

$$\rho(x,j) = \exp\left(v(x,j) - \bar{v}(x)\right)$$

The function v is computed by value function iteration, assuming a finite horizon, T. Age is included as a state variable, with $v \equiv 0$ at age $T+1$, so that successive iterations yield the value functions for a person who is getting younger and younger.

In the first period, there is a choice of whether to go to college. Let $\bar{v}_H(x)$ denote the expected continuation value of a high school graduate, and let $\bar{v}_G(x)$ denote the expected continuation value of a high school graduate. Then if there are unobserved payoff shocks affecting this choice, drawn from the extreme value distribution, the proportion of people who go to college is

$$\rho_G(x) = \frac{\exp\left(\bar{v}_G(x)\right)}{\exp\left(\bar{v}_H(x)\right) + \exp\left(\bar{v}_G(x)\right)}$$

4.1 Wages

The wage of individual i in location j at age a in year t is specified as

$$w_{ij}(a) = \mu_j(d) + \upsilon_{ij}(d) + G(d, X_i, a, t) + \varepsilon_{ij}(d,a) + \eta_i$$

where d is a college indicator, μ_j is the mean wage in location j (for each level of schooling), υ is a permanent location match effect, $G(d, X, a, t)$ represents a (linear) time effect and the effects of observed individual characteristics, η is an individual effect that is fixed across locations, and ε is a transient effect.

We assume that η, υ and ε are independent random variables that are identically distributed across individuals and locations. We also assume that the realizations of η and υ are seen by the individual.[2]

The relationship between wages and migration decisions is governed by the difference between the quality of the match in the current location, measured by $\mu_j + \upsilon_{ij}$, and the prospect of obtaining a better match in another location k, measured by $\mu_k + \upsilon_{ik}$. The other components of wages have no bearing on migration decisions, since they are added to the wage in the same way no matter what decisions are made.

4.2 State Variables and Flow Payoffs

Let $\ell = (\ell^0, \ell^1)$ denote the current and previous location, and let ω be a vector recording wage and utility information at these locations. The state vector x consists of ℓ, ω education level, home location and age. The flow payoff may be written as

$$\tilde{u}_h(x, j) = u_h(x, j) + \zeta_j$$

where $u_h(x, j)$ represents the payoffs associated with observable states and choices, and where ζ_j, may be viewed as either a preference shock or a shock to the cost of moving. For someone who has entered the labor market, the systematic part of the flow payoff is specified as

$$u_h(x, j) = \alpha_0 w\left(d, \ell^0, \omega\right) + \sum_{k=1}^{K} \alpha_k Y_k\left(\ell^0\right) + \alpha^H \chi\left(\ell^0 = h\right) - \Delta_\tau(x, j)$$

Here the first term refers to wage income in the current location. This is augmented by the nonpecuniary variables $Y_k\left(\ell^0\right)$, representing amenity values. The parameter α^H is a premium that allows each individual to have a preference for their native location (χ_A denotes an indicator meaning that A is true). The cost of moving from ℓ^0 to ℓ^j for a person of type τ is represented by $\Delta_\tau(x, j)$.

For someone who is in college, the systematic part of the flow payoff is specified as

$$u_h(x, j) = \sum_{k=1}^{K} \alpha_k Y_k\left(\ell^0\right) + \alpha^H \chi\left(\ell^0 = h\right) - \Delta_\tau(x, j) - \gamma - \alpha_0 C\left(\ell^0\right)$$

where γ measures the disutility of the effort required to obtain a college degree (offset by the utility of life as a student), and $C\left(\ell^0\right)$ is the cost of a college degree in location ℓ^0 (which depends on State subsidies for higher education).

[2] An interesting extension of the model would allow for learning, by relaxing the assumption that agents know the realizations of η and υ. In particular, such an extension might help explain return migration, because moving reveals information about the wage components. Pessino (1991) analyzed a two-period Bayesian learning model along these lines, and applied it to migration data for Peru.

4.3 Moving Costs

Let $D\left(\ell^0, j\right)$ be the distance from the current location to location j, and let $\mathbb{A}(\ell^0)$ be the set of locations adjacent to ℓ^0 (where States are adjacent if they share a border). The moving cost is specified as

$$\Delta_\tau\left(x, j\right) = \left(\gamma_{0\tau} + \gamma_1 D\left(\ell^0, j\right) - \gamma_2 \chi\left(j \in \mathbb{A}\left(\ell^0\right)\right) - \gamma_3 \chi\left(j = \ell^1\right) + \gamma_4 a - \gamma_5 n_j\right) \chi\left(j \neq \ell^0\right)$$

This allows for unobserved heterogeneity in the cost of moving, : there are several types, indexed by τ, with differing values of the intercept γ_0. In particular, there may be a "stayer" type, meaning that there may be people who regard the cost of moving as prohibitive, in all states. The moving cost is an affine function of distance (which we measure as the great circle distance between population centroids). Moves to an adjacent location may be less costly (because it is possible to change States while remaining in the same general area). A move to a previous location may also be less costly, relative to moving to a new location. In addition, the cost of moving is allowed to depend on age, a. Finally, we allow for the possibility that it is cheaper to move to a large location, as measured by population size n_j.

4.4 Transition Probabilities

For someone who is in the labor force, the state vector can be written as $x = (\tilde{x}, a)$, where $\tilde{x} = \left(d, \ell^0, \ell^1, x_\upsilon^0, x_\upsilon^1\right)$ and where x_υ^0 indexes the realization of the location match component of wages in the current location, and similarly for the other components. The transition probabilities are as follows

$$p\left(x' \mid x, j\right) = \begin{cases} 1 & \text{if} \quad j = \ell^0, \quad \tilde{x}' = \tilde{x}, \quad a' = a + 1 \\ 1 & \text{if} \quad j = \ell^1, \quad \tilde{x}' = \left(d, \ell^1, \ell^0, x_\upsilon^1, x_\upsilon^0\right), \quad a' = a + 1 \\ \frac{1}{n} & \text{if} \quad j \notin \left\{\ell^0, \ell^1\right\}, \quad \tilde{x}' = (d, j, \ell^0, s_\upsilon, x_\upsilon^0), \\ & \qquad 1 \leq s_\upsilon \leq n_\upsilon, \quad a' = a + 1 \\ 0 & \text{otherwise} \end{cases}$$

For someone who is in college, the transition probabilities are

$$p\left(x' \mid x, j\right) = \begin{cases} 1 & \text{if} \quad j = \ell^0, \quad \tilde{x}' = \tilde{x}, \quad a' = a + 1 \\ 1 & \text{if} \quad j = \ell^1, \quad \tilde{x}' = \left(1, \ell^1, \ell^0, 0, 0\right), \quad a' = a + 1 \\ 1 & \text{if} \quad j \notin \left\{\ell^0, \ell^1\right\}, \quad \tilde{x}' = (1, j, \ell^0, 0, 0), \quad a' = a + 1 \\ 0 & \text{otherwise} \end{cases}$$

4.5 Data

The primary data source is the National Longitudinal Survey of Youth 1979 Cohort (NLSY79); we also use data from the 1990 Census of Population are used to estimate State mean wages, and data from the Census of Governments are used to measure State subsidies for higher ecucation. The NLSY79 conducted annual interviews from 1979 through 1994, and changed to a biennial schedule in 1994. The location of each respondent is recorded at the date of each interview, and we measure migration by the change in location from one interview to the next. We use information from 1979 to 1994 so as to avoid the complications arising from the change in the frequency of interviews.

In order to obtain a relatively homogeneous sample, we consider only white non-Hispanic males, using only the years after schooling is completed. The sample includes 432 high school graduates and 440 college graduates. The high school subsample was analyzed in detail by [Kennan & Walker, 2009]. Wages are measured as total wage and salary income, plus farm and business income, adjusted for cost of living differences across States (using the ACCRA Cost of Living Index).

5 Empirical Results

As a first step, the model of [Kennan & Walker, 2009] is estimated separately for (white male) high school and college graduates.

The estimates in Table 2 show that expected income is an important determinant of migration decisions. The results for high school graduates are taken from [Kennan & Walker, 2009]; a slightly enhanced version of the model is estimated for college graduates. The overall migration rate is much higher for college graduates (an annual rate of 8.6%, compared with a rate of 2.9% for high school graduates), but the parameter estimates are quite similar for the two samples, aside from a substantially lower estimated migration cost for college graduates.

The results in Table 2 deal only with migration decisions, conditional on education level. In the model described in Section 4, on the other hand, the level of education is also a choice variable. Results for this model are shown in Table 3.

In general, the wage process for high school and college graduates could be specified as a composite of the models estimated in Table 2. But as a first step, it is useful to estimate a simple case in which only the mean (State-specific) wage depends on education level, and the other components are added in the same way for high school and college graduates, and this is what is done in Table 3. A particularly important restriction here is that ability does not interact with education in the wage process. It is obviously desirable to estimate a model without this restriction, but this means augmenting the state space, with a considerable increase in computational difficulty. Meanwhile, the restricted model is a useful way to focus on the effects of college subsidies.

The results in Table 3 reinforce the findings from the simple two-period model estimated in Section 3. Differences in expected income have a strong effect on migration decisions (as might be expected, given the results in Table 2). On the other hand there is no indication that differences in college costs associated with differences in State subsidies have any effect on educational choices.

Table 2: **Interstate Migration, White Male High School and College Graduates**

	High School		College			
	$\hat{\theta}$	$\hat{\sigma}_\theta$	$\hat{\theta}$	$\hat{\sigma}_\theta$	$\hat{\theta}$	$\hat{\sigma}_\theta$
Utility and Cost						
Disutility of Moving (γ_0)	4.794	0.565	3.598	0.707	3.570	0.687
Distance (γ_1) (1000 miles)	0.267	0.181	0.464	0.129	0.482	0.131
Adjacent Location (γ_2)	0.807	0.214	0.869	0.129	0.852	0.131
Home Premium (α^H)	0.331	0.041	0.170	0.019	0.167	0.019
Previous Location (γ_3)	2.757	0.357	2.383	0.185	2.382	0.179
Age (γ_4)	0.055	0.020	0.083	0.025	0.085	0.024
Population (γ_5) (millions)	0.654	0.179	0.608	0.120	0.678	0.118
Stayer Probability	0.510	0.078	0.196	0.060	0.227	0.057
Cooling (α_1) (1000 degree-days)	0.055	0.019	-0.003	0.012	0.001	0.011
Income (α_0)	0.314	0.100	0.245	0.040	0.172	0.030
Wages						
Wage intercept	-5.133	0.245	-6.401	0.517	-6.054	0.505
Time trend	-0.034	0.008	0.082	0.008	0.065	0.008
Age effect (linear)	7.841	0.356	8.196	0.682	7.936	0.667
Age effect (quadratic)	-2.362	0.129	-2.800	0.223	-2.739	0.220
Ability (AFQT)	0.011	0.065	-0.024	0.156	-0.254	0.167
Interaction(Age,AFQT)	0.144	0.040	0.162	0.107	0.522	0.114
Transient s.d. 1	0.217	0.007	0.207	0.007	0.188	0.687
Transient s.d. 2	0.375	0.015	0.399	0.016	0.331	0.131
Transient s.d. 3	0.546	0.017	0.866	0.025	0.460	0.131
Transient s.d. 4	1.306	0.028	3.358	0.051	0.921	0.019
Transient s.d. 5					3.153	0.179
Fixed Effect 1	0.113	0.036	0.323	0.020	0.205	0.022
Fixed Effect 2	0.296	0.035	0.599	0.021	0.722	0.023
Fixed Effect 3	0.933	0.016	1.562	0.030	1.081	0.025
Wage match (τ_v)	0.384	0.017	0.517	0.014	0.634	0.016
Loglikelihood	-4214.160		-4925.596		-4876.957	
	4274 observations		3114 observations			
	432 men,124 moves		440 men, 267 moves			

Table 3: **College Choice and Migration, White Males**

	$\hat{\theta}$	$\hat{\sigma}_\theta$
Utility and Cost		
Disutility of Moving (γ_0)	6.128	0.518
Distance (γ_1) (1000 miles)	0.205	0.098
Adjacent Location (γ_2)	0.916	0.103
Home Premium $\left(\alpha^H\right)$	0.434	0.024
Previous Location (γ_3)	2.706	0.151
Age (γ_4)	-0.021	0.018
Population (γ_5) (millions)	0.356	0.097
Stayer Probability	0.689	0.018
Cooling (α_1) (1000 degree-days)	—	—
Income (α_0)	0.591	0.041
College Subsidy(δ_1)	-1.280	0.649
College Cost (δ_0)	2.951	0.353
Wages		
Wage intercept, high school	-2.496	0.186
Wage intercept, college	-2.712	0.186
Time trend	0.031	0.005
Age effect (linear)	4.079	0.272
Age effect (quadratic)	-1.518	0.095
Ability (AFQT)	-0.657	0.050
Interaction(Age,AFQT)	0.733	0.033
Transient s.d. 1	0.204	0.006
Transient s.d. 2	0.366	0.015
Transient s.d. 3	0.450	0.019
Transient s.d. 4	0.764	0.020
Transient s.d. 5	2.216	0.014
Fixed Effect 1	0.202	0.016
Fixed Effect 2	0.576	0.016
Fixed Effect 3	0.940	0.013
Wage match (τ_v)	0.618	0.010
Loglikelihood		
The results in this Table are approximate.		

6 Conclusion

The data indicate that there are strong economic incentives to migrate from low-wage to high-wage locations. Using a dynamic programming model of expecting income maximization to quantify these incentives, it is found that they do in fact generate sizable supply responses in NLSY data. There are also big differences across States in the extent to which higher education is subsidized, and these State subsidies are apparently motivated to a large extent by a perceived interest in having a highly educated labor force. Given the finding that workers respond to migration incentives, it might be expected that State subsidies would have the intended effect, in the sense that States that provide more generous subsidies induce more people to go to college, so that even if some of these people subsequently move elsewhere, the costs of migration are such that most people will choose to stay, so that subsidies increase the level of human capital in the local labor force. But the empirical findings do not support this prediction. Indeed to the extent that State subsidies for higher education are motivated by a desire to enhance the level of human capital within the State, the results provide no evidence that the subsidies have beneficial effects.

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