Credit Constraints and Education: Models and Analysis

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Drawing on various sources:
Heckman and Mosso (2014)
and
Lochner and Monge-Naranjo (2011, 2012, 2015)

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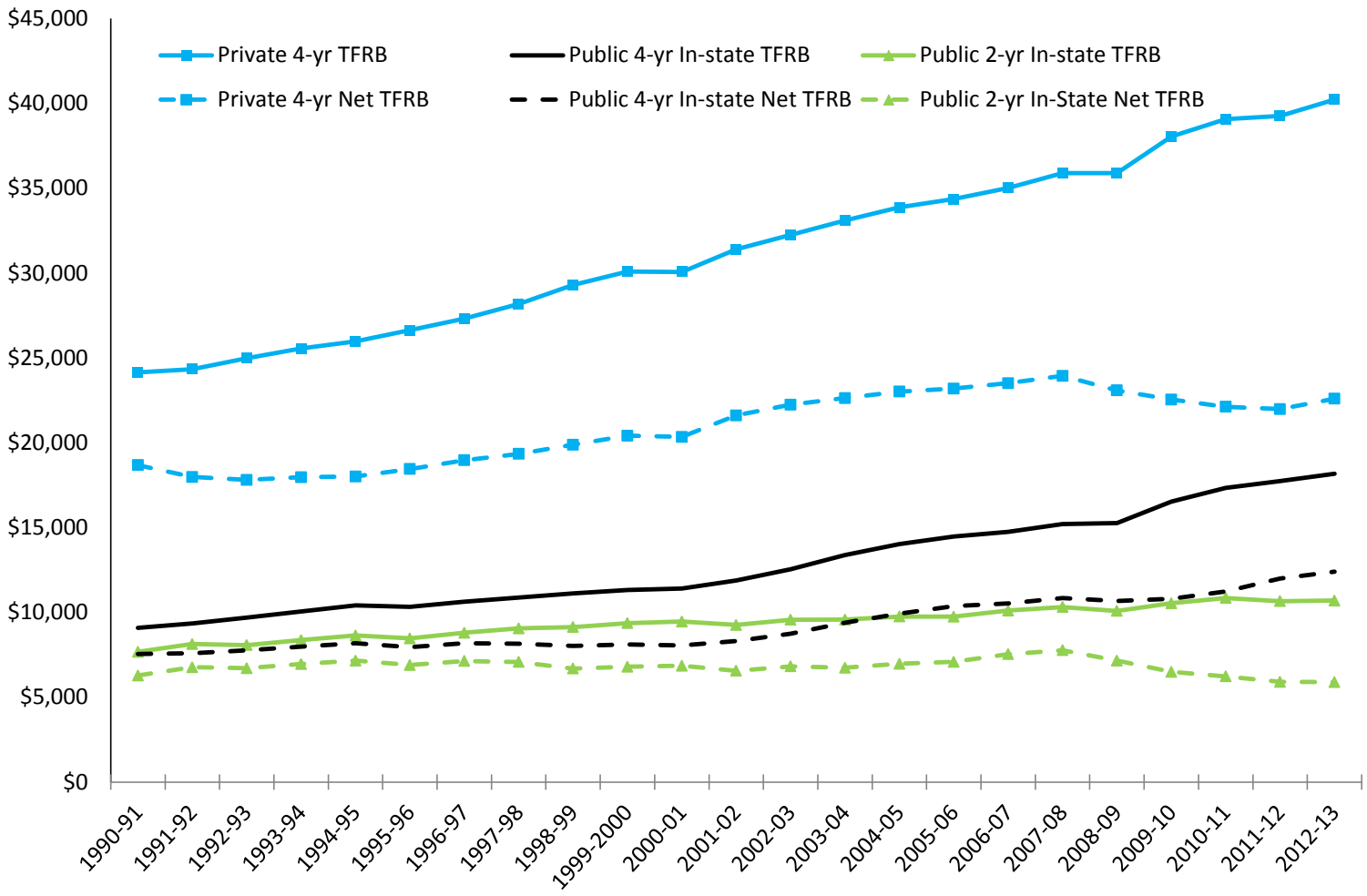
- Integration of the human capital market with the credit market

Context: Some Important Economic Trends

- Costs of college have increased markedly

Figure 1: Evolution of Average Tuition, Fees, Room & Board in the U.S. (2013 $)



Source: College Board (Online Tables 7 and 8), *Trends in College Pricing*, 2013.

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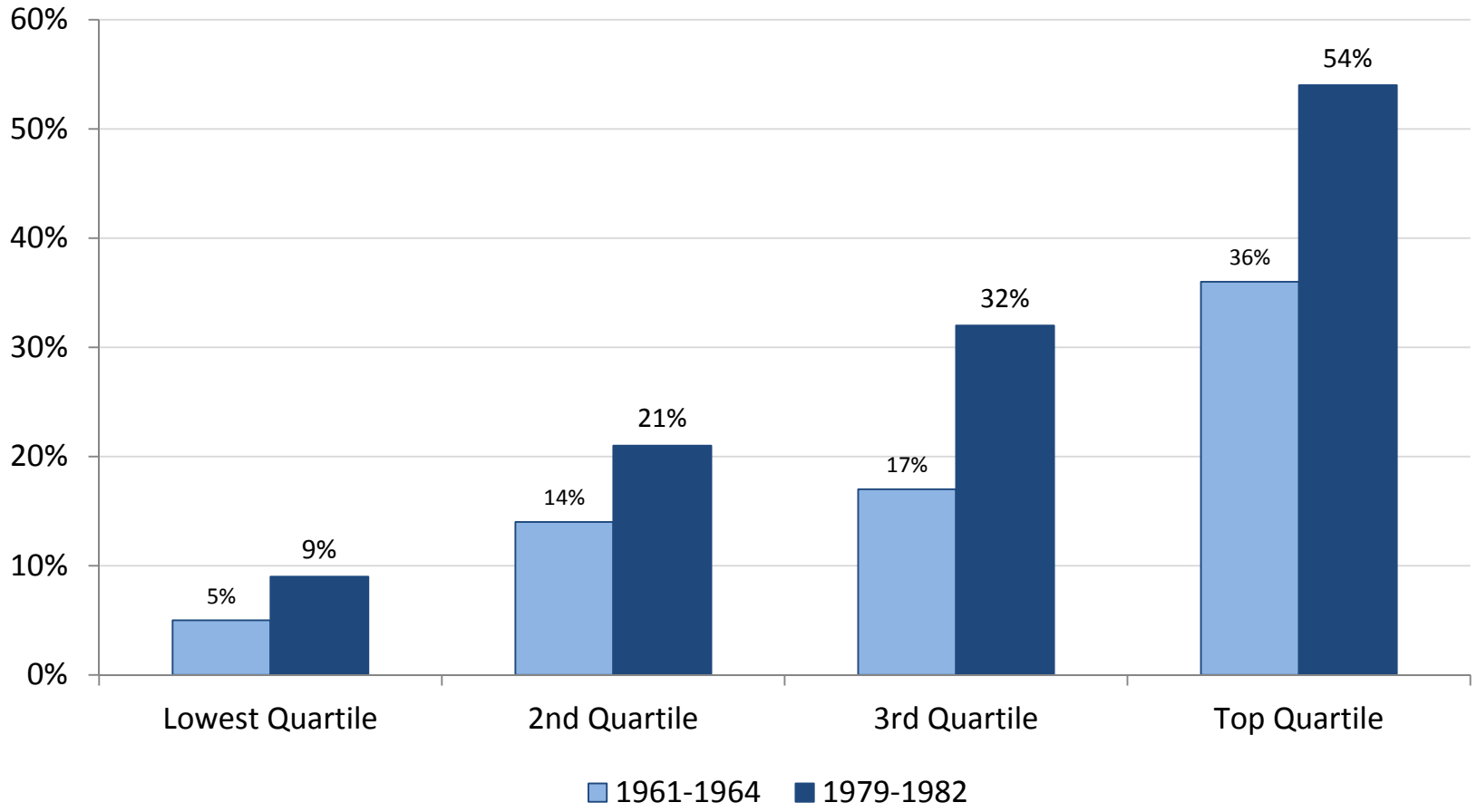
- Dramatic increase in average (net) returns to education in labor market beginning in early 1980s
  - Autor, Katz & Kearney (2008), Heckman, Lochner & Todd (2008), Avery & Turner (2012)
- Sizeable increase in uncertainty and risk in labor market, especially in Great Recession
  - Cunha, Heckman and Navarro (2005)
  - Gottschalk & Moffitt (2009, 2012), Lochner & Shin (2014)
  - Elsby, Hobijn & Sahin (2010), Hoynes, Miller & Schaller (2012)
  - Cunha and Heckman (2016)

- Growth in student debt (switch from grants to loans)
- Family income gradients in college attendance

Figure 2: Fraction of Students Completing BA Degree by Age 25, by Income Quartile and Year of Birth



Source: Recreated from Bailey and Dynarsky (2011).

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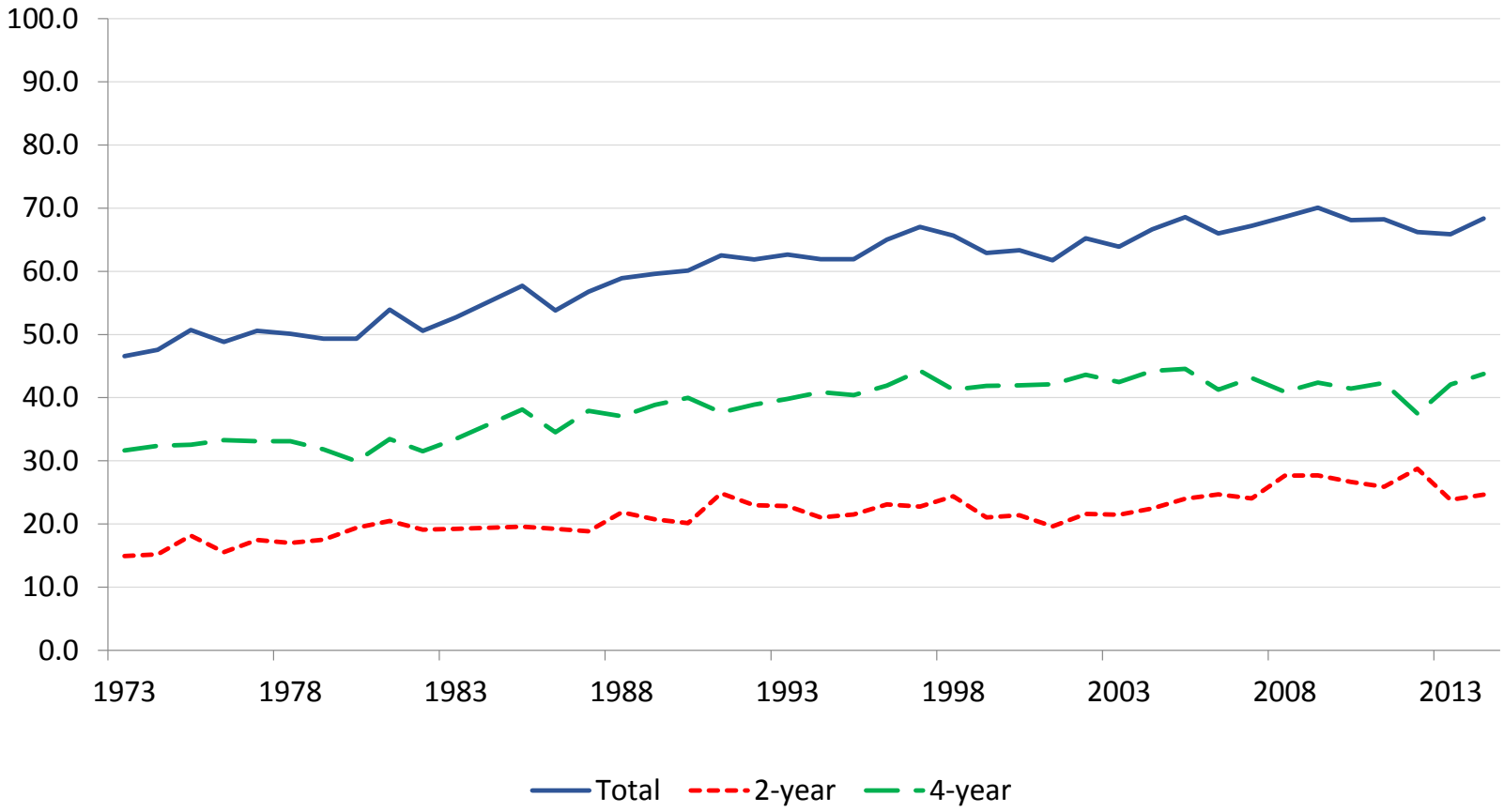
Trends in Education Sector

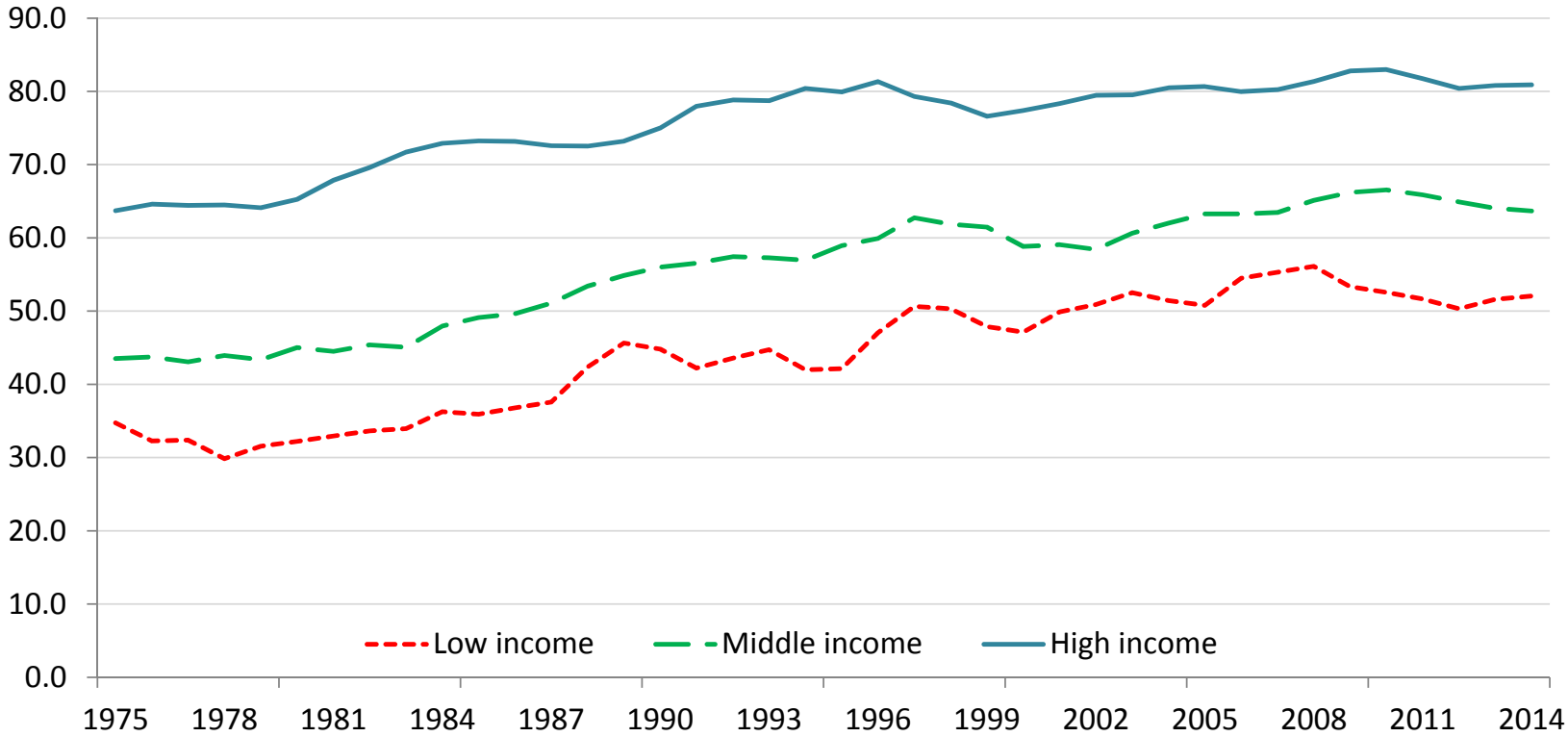
- Enrolment rates have increased substantially
  - by 25 percentage points between cohorts born in '61 to '88 (Bailey & Dynarski 2011)

Figure 3: Percentage of High School Completers Who Were Enrolled in 2- or 4- Year Colleges by the October Immediately Following High School Completion: 1973–2014



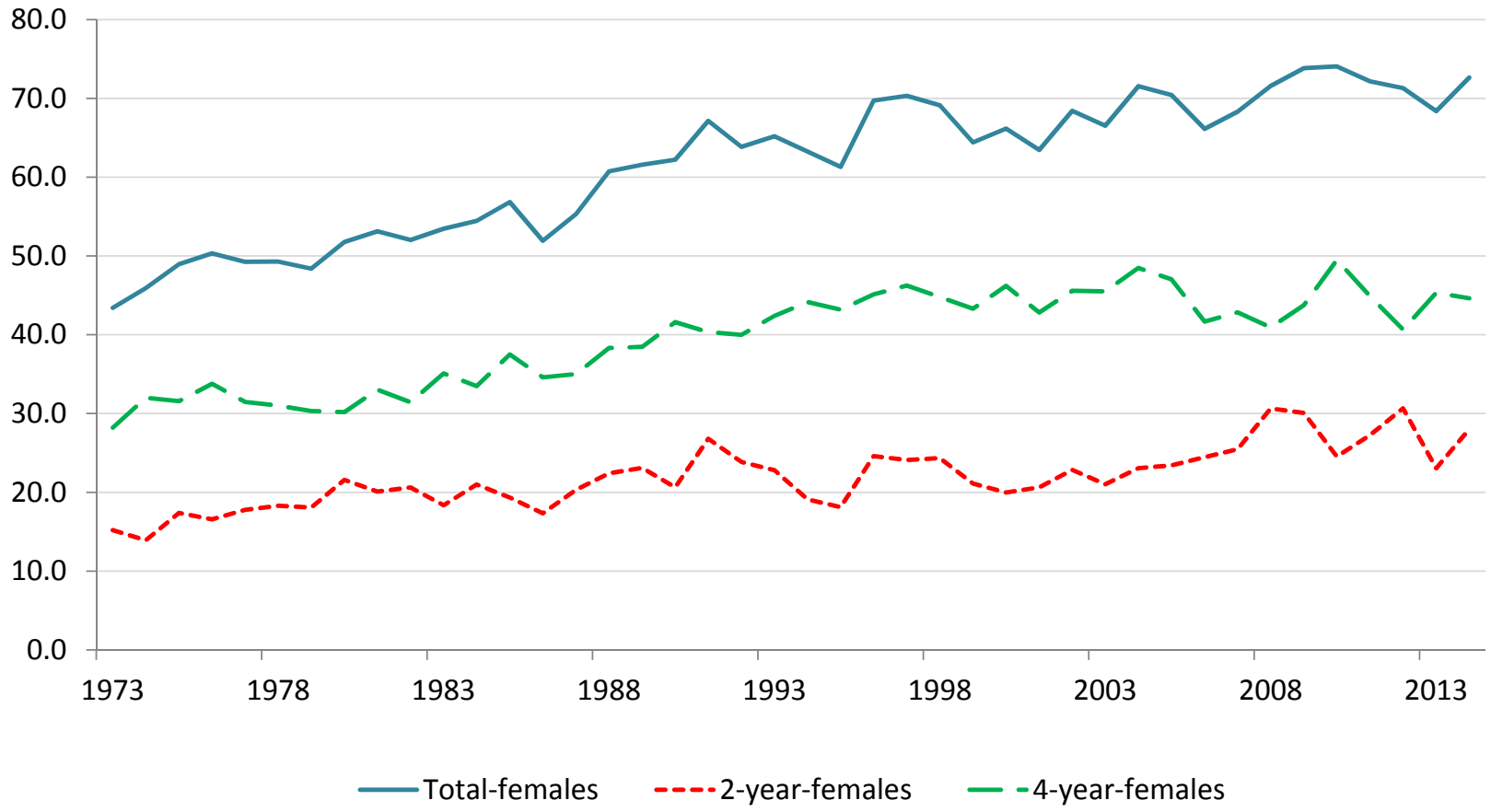
Source: Digest of Education Statistics 2015, Table 302.10.

Figure 4: Percentage of High School Completers who were Enrolled in 2- or 4-year Colleges by the October Immediately Following High School Completion, by Family Income



Source: Digest of Education Statistics 2015, Table 302.30
Note: A 3-year moving average is a weighted average of the year indicated, the year immediately preceding, and the year immediately following. For 1975 and 2014, a 2-year moving average is used: The moving average for income groups in 1975 reflects an average of 1975 and 1976, and the moving average for 2014 reflects an average of 2013 and 2014. Moving averages are used to produce more stable estimates.

Figure 5: Percentage of High School Completers who were Enrolled in 2- or 4- year Colleges by the October Immediately Following High School Completion: Females



Source: Digest of Education Statistics 2015, Table 302.10.

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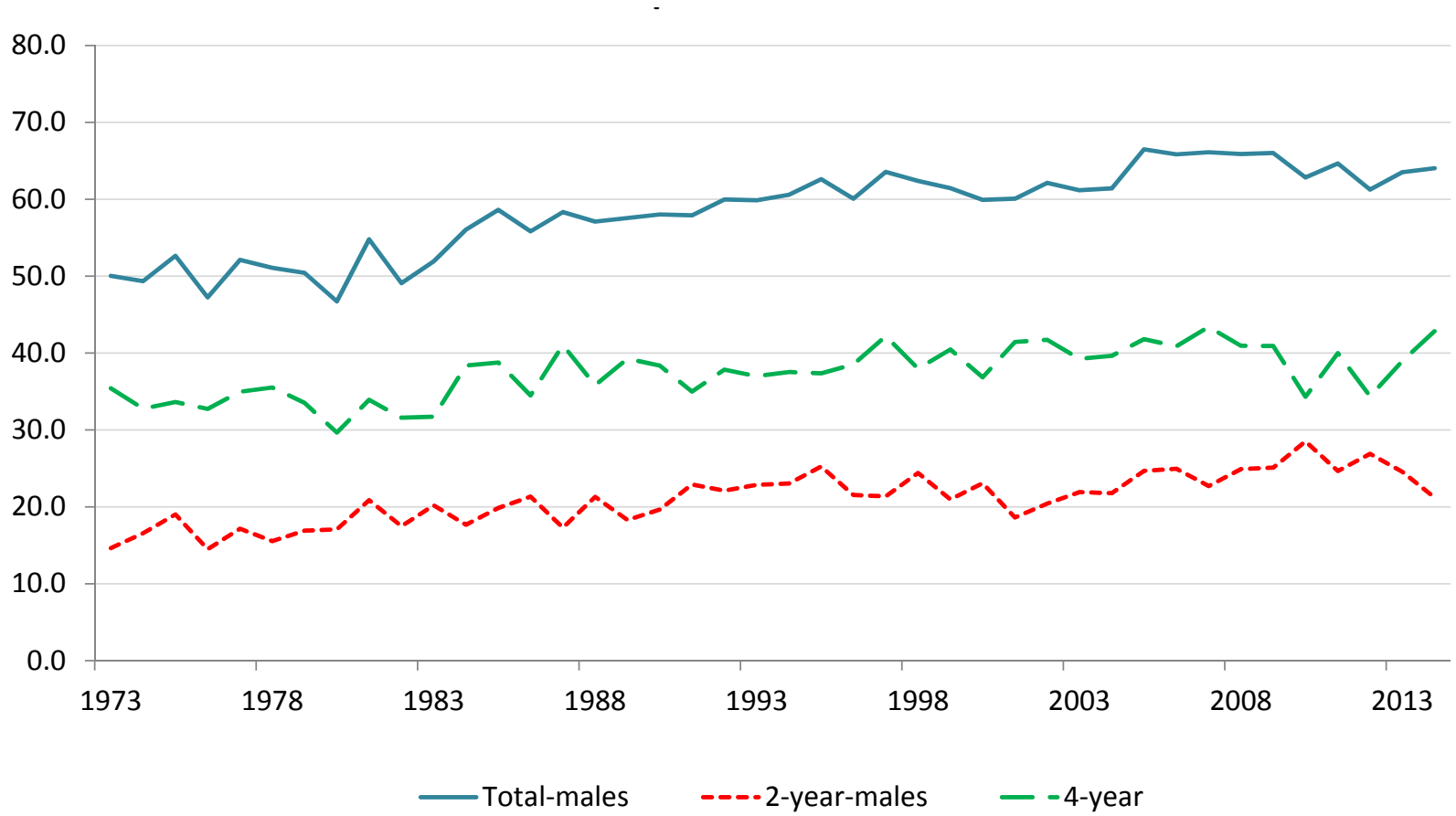
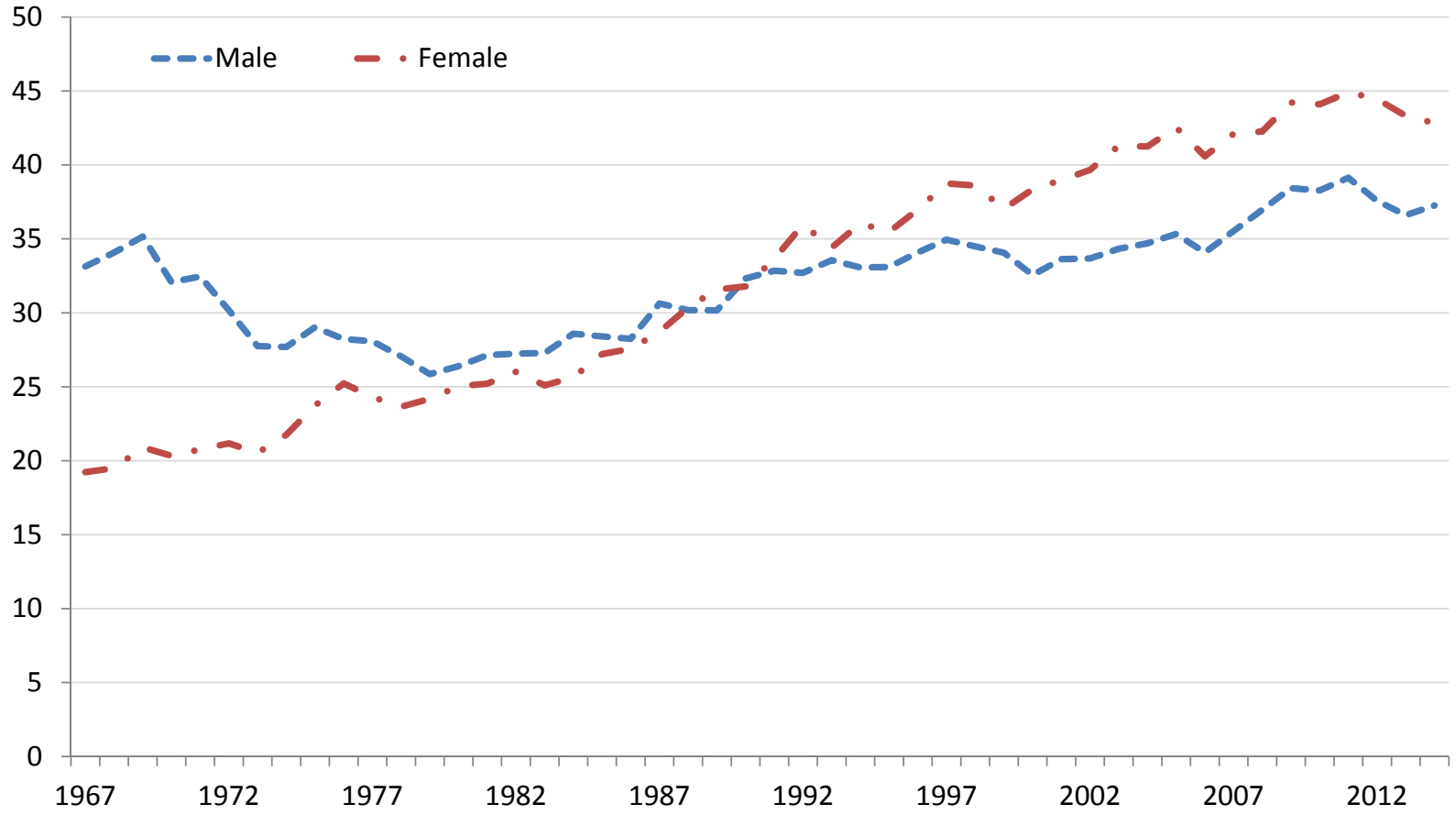
Figure 6: Percentage of High School Completers who were Enrolled in 2- or 4- year Colleges by the October Immediately Following High School Completion: Males



Source: Digest of Education Statistics 2015, Table 302.10.

Figure 7: Enrollment rates of 18–24 years old in degree-granting institutions (as a percent of all same age high school completers)



Source: Digest of Education Statistics 2014, Table 302.60.

- Substantial increase in demand for student loans & rising student debt levels
  - borrowing increased at intensive and extensive margins (Akers & Chingos 2014, Bleemer et al. 2014, Hershbein & Hollenbeck 2014)
  - government student loan limits declined 50% in value from '93 to '08
  - increasing fraction of students 'maxing out' federal student loans (Berkner 2000, Wei & Berkner 2008)
  - shift to private student loans, peaking around 25% in '07-'08 (College Board 2011)

Figure 8: Summary of Current Federal Student Loan Programs (U.S.)

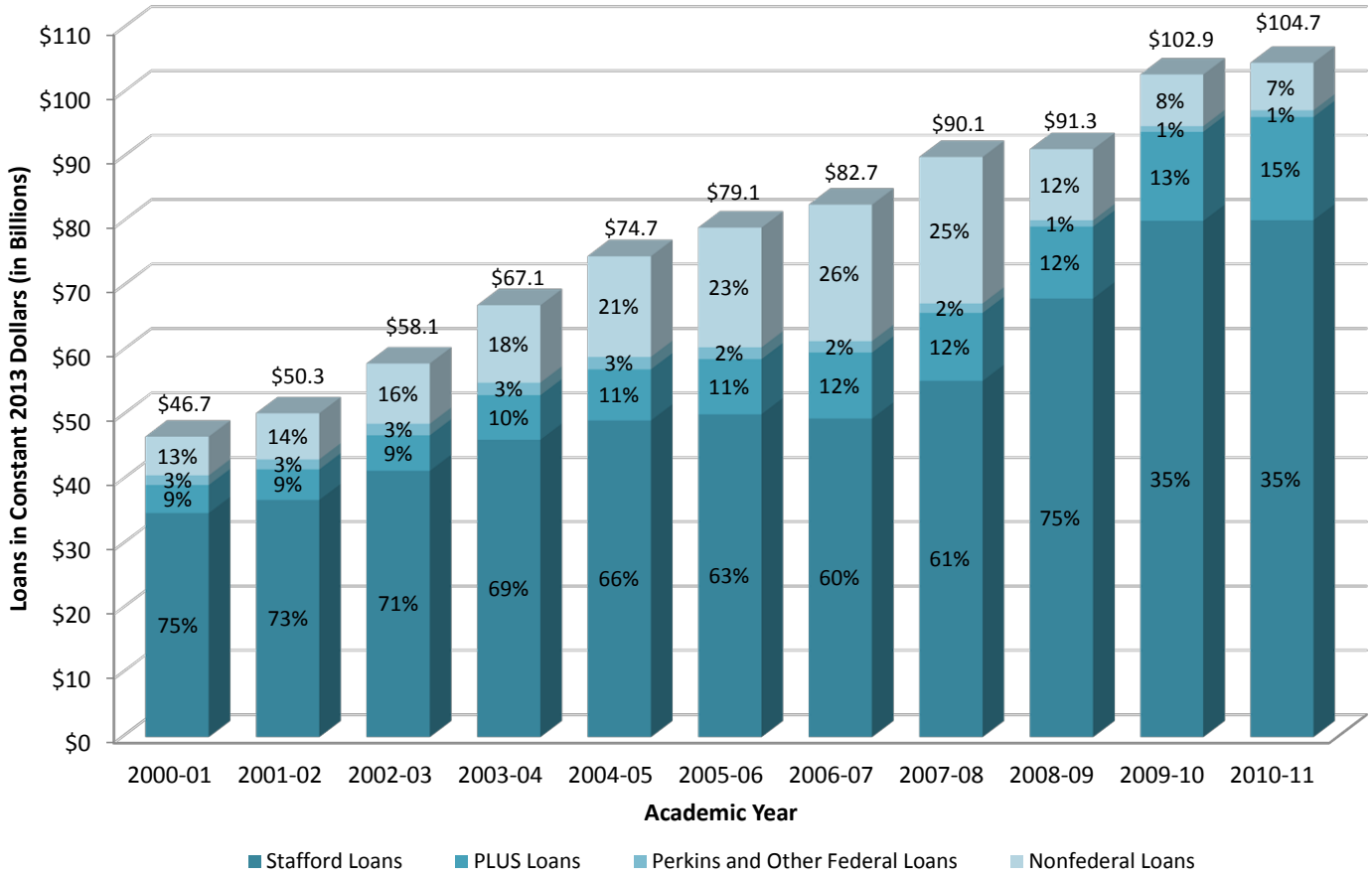
	Stafford		Perkins	PLUS
	Dependent Students	Independent Students*		& GradPLUS
Recipient	Students	Students	Students	PLUS: Parents GradPLUS: Grad. Students
Eligibility	Subsidized: Undergrad., Financial Need** Unsubsidized: All Students		Financial Need	No Adverse Credit History or cosigner required
Undergrad. Limits:				
Year 1	$5,500	$9,500	$5,500	All Need
Year 2	$6,500	$10,500	$5,500	All Need
Years 3+	$7,500	$12,500	$5,500	All Need
Cum. Total	$31,000	$57,500	$27,500	All Need
Graduate Limits:				
Annual		$20,500	$8,000	All Need
Cum. Total***		$138,500	$60,000	All Need
Interest Rate	Undergrad.: Variable, $\leq$8.25% Grad.: Variable, $\leq$9.5%		5%	Variable, 10.5% Limit
Fees		1.07%	None	4.3%
Grace Period		6 Months	9 Months	up to 6 Months

Notes:

* Students whose parents do not qualify for PLUS loans can borrow up to independent student limits from the Stafford program.
* Subsidized Stafford loan amounts cannot exceed $3,500 in year 1, $4,500 in year 2, $5,500 in years 3+, and $23,000 cumulative.
* Cumulative graduate loan limits include loans from undergraduate loans.

Trends in Student Borrowing

Figure 9: Growth in Student Loan Disbursements in the U.S. (in 2013 $)



Source: College Board (2011).

Trends in Education Sector

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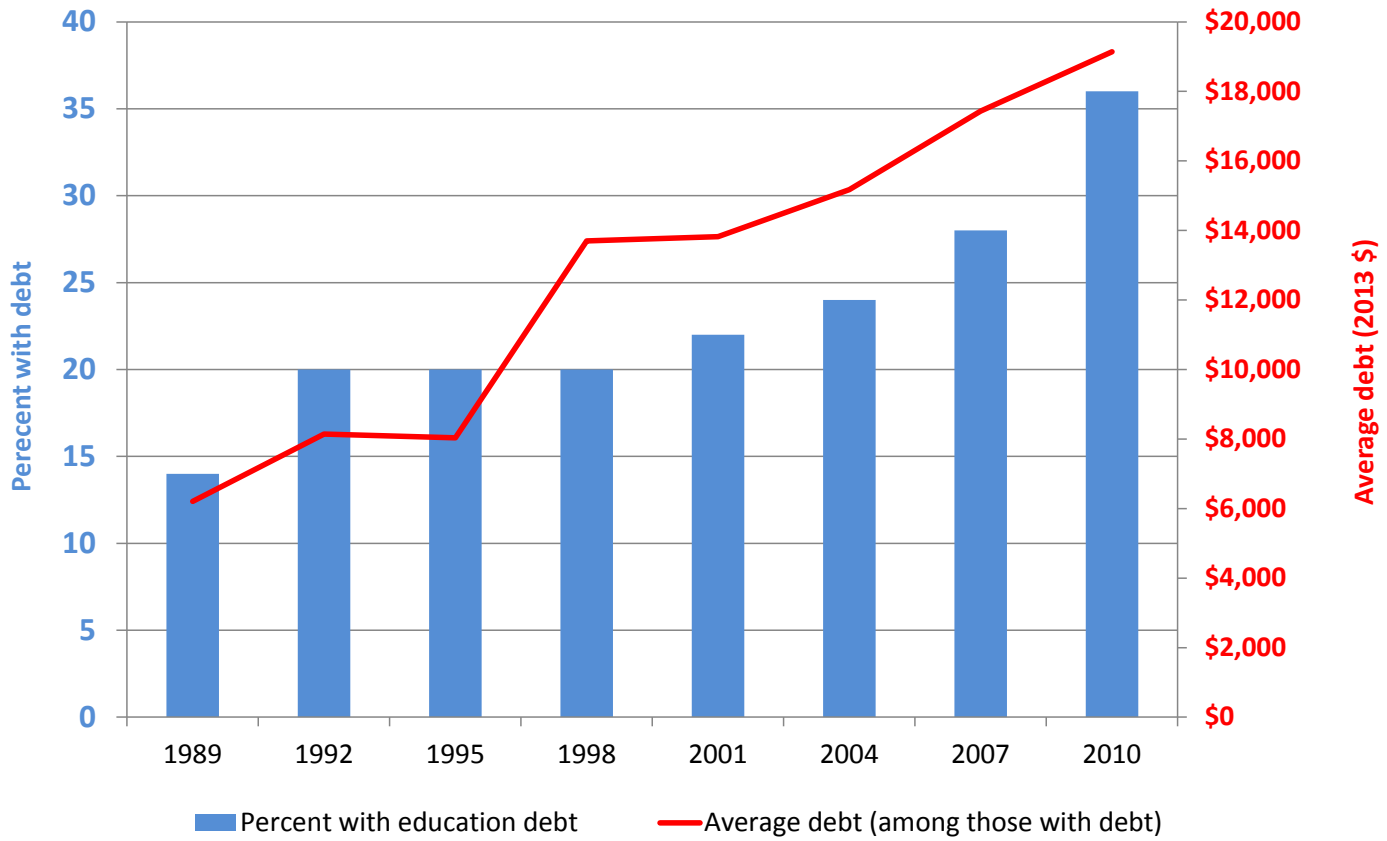
Trends in Student Debt

Figure 10: Incidence and Amount (in 2013 $) of Household Education Debt for 20-40 Year-Olds in the U.S.



Source: Table 1, Akers and Chingos (2014).

Trends in Student Debt

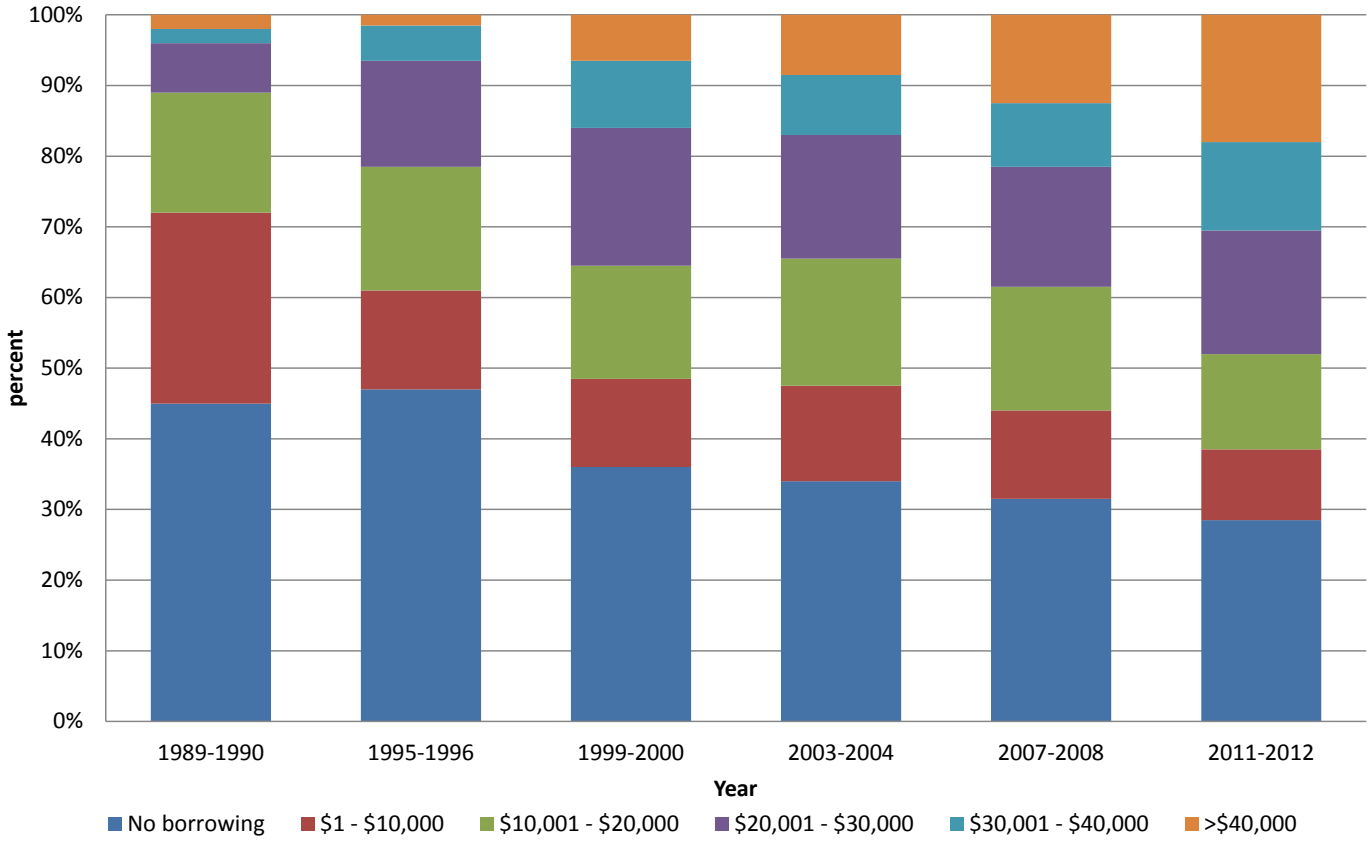
Table 1: Education Debt for Baccalaureate Degree Recipients in NPSAS (2013 $)

Year Graduating	Percent with education debt	Avg. cumulative student loan debt (per borrower)	Avg. cumulative student loan debt (per graduate)
1989-1990	55%	$7,300	$13,500
1995-1996	53%	$9,300	$17,800
1999-2000	64%	$14,600	$22,900
2003-2004	66%	$15,100	$23,000
2007-2008	68%	$17,600	$25,800
2011-2012	71%	$21,200	$29,700

Source: Hershbein & Hollenbeck (2014).

Trends in Student Debt

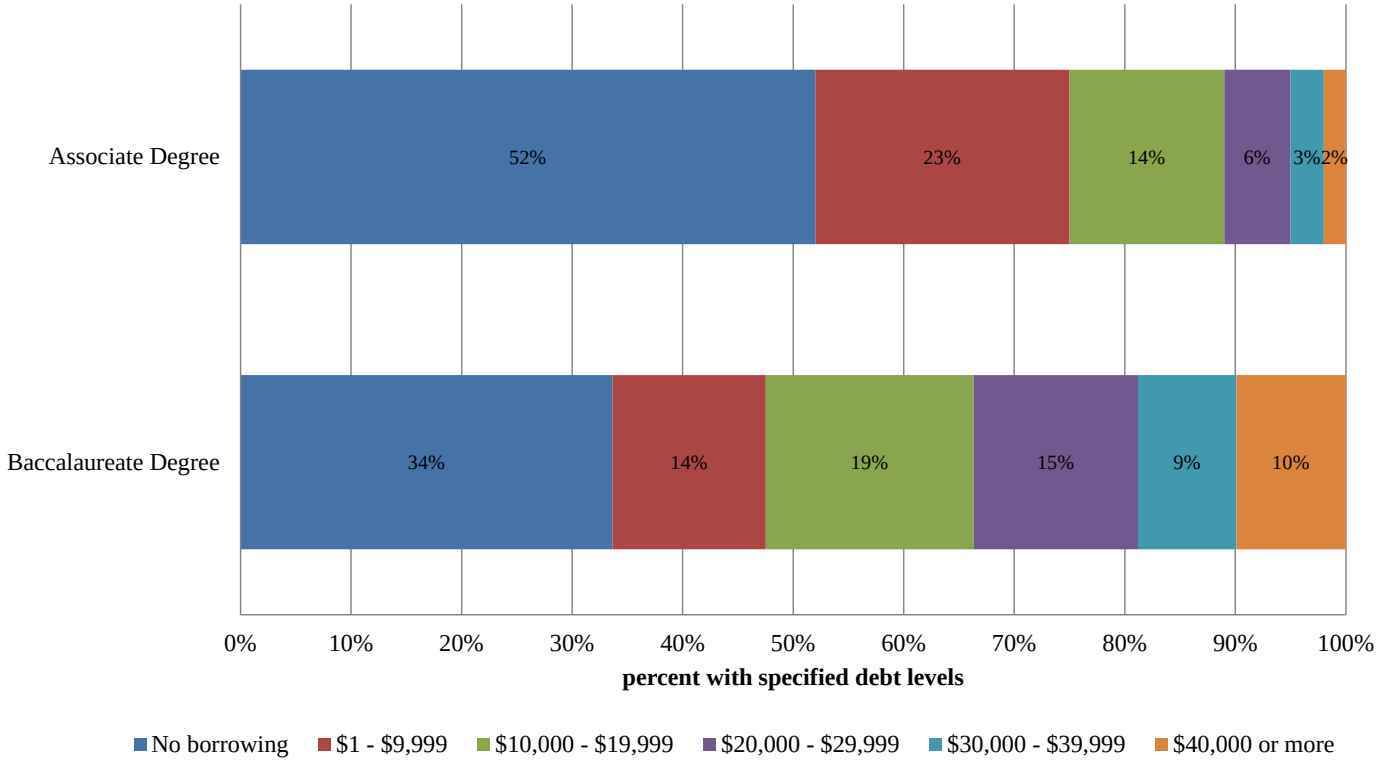
Figure 11: Distribution of Cumulative Undergraduate Debt for Baccalaureate Recipients over Time (NPSAS)



Source: Hershbein and Hollenbeck (2014).

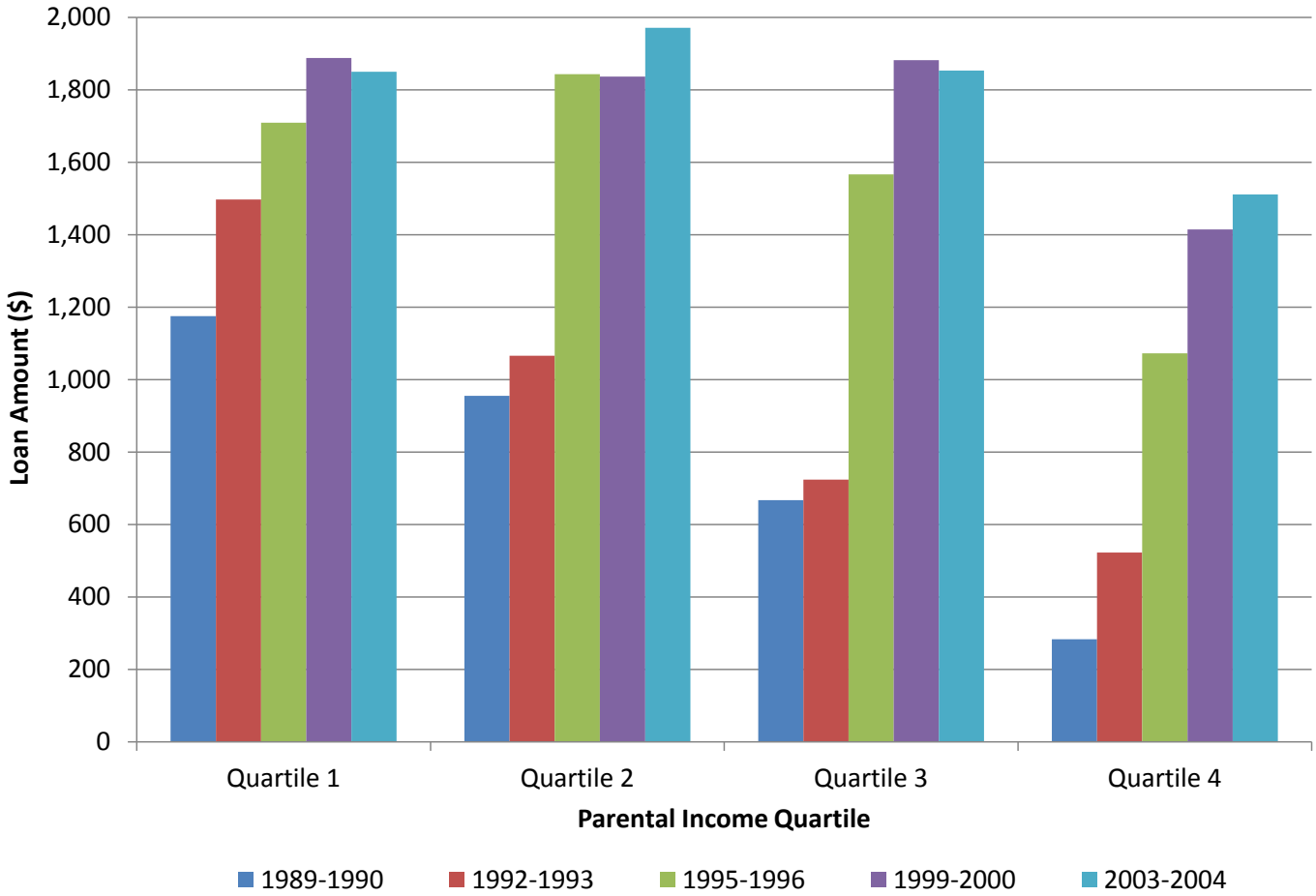
Distribution of Student Debt

Figure 12: Distribution of Cumulative Student Loan Debt By Undergraduate Degree (NPSAS 2007–08)



Source: Steele and Baum (2009).
Note: Data from 2007–08 NPSAS and includes U.S. citizens and residents. Excludes PLUS loans, loans from family/friends, and credit cards.

Figure 13: Growth in Average Federal Loan Amounts (Including Non-Borrowers) for Dependent Undergraduates by Parental Income Quartile



Source: Berkner (2000) and Wei and Berkner (2008).

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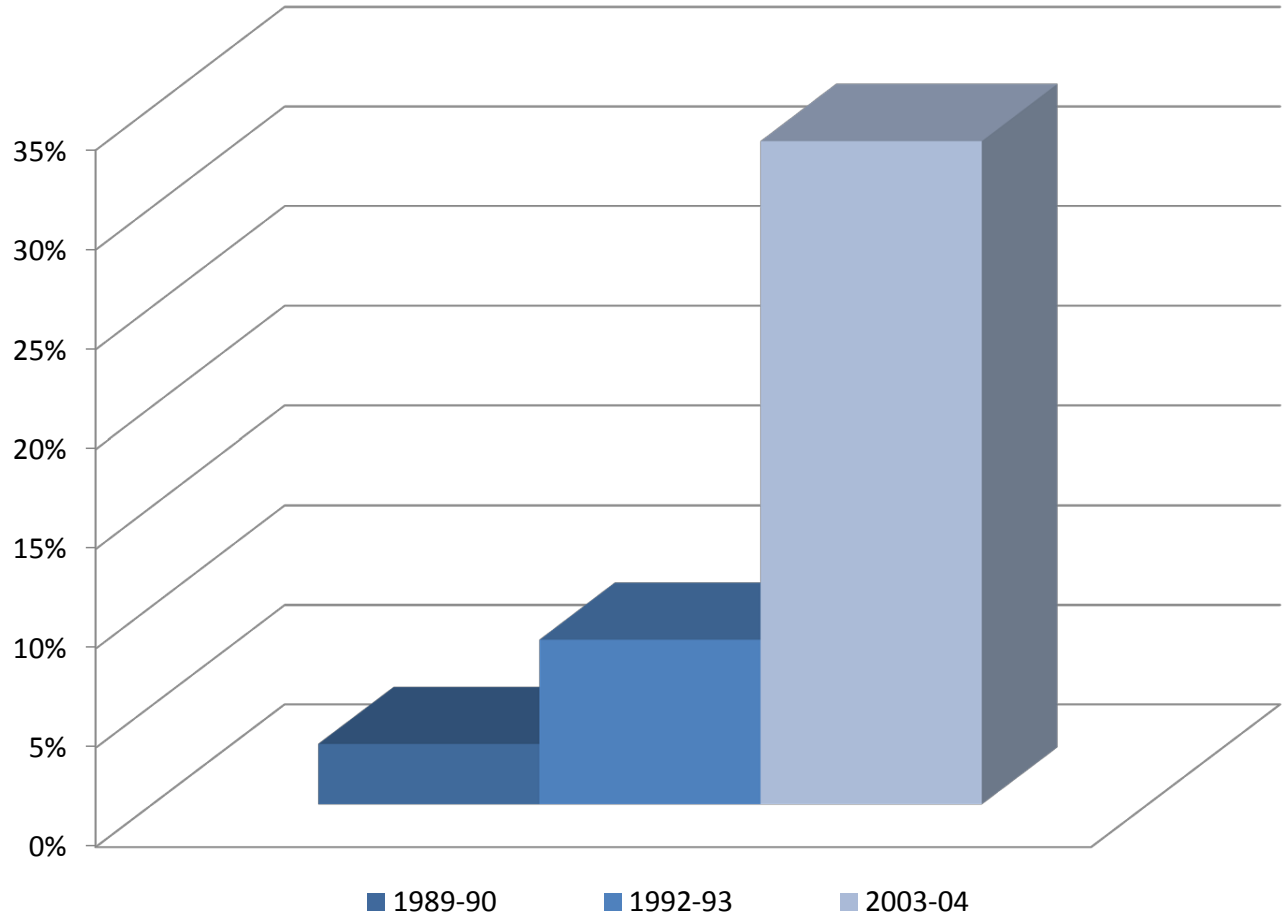
Trends in Student Borrowing

Figure 14: Fraction of FT/FY Undergraduates (Public 4-Year Institutions) who 'Max Out' their Stafford Loans

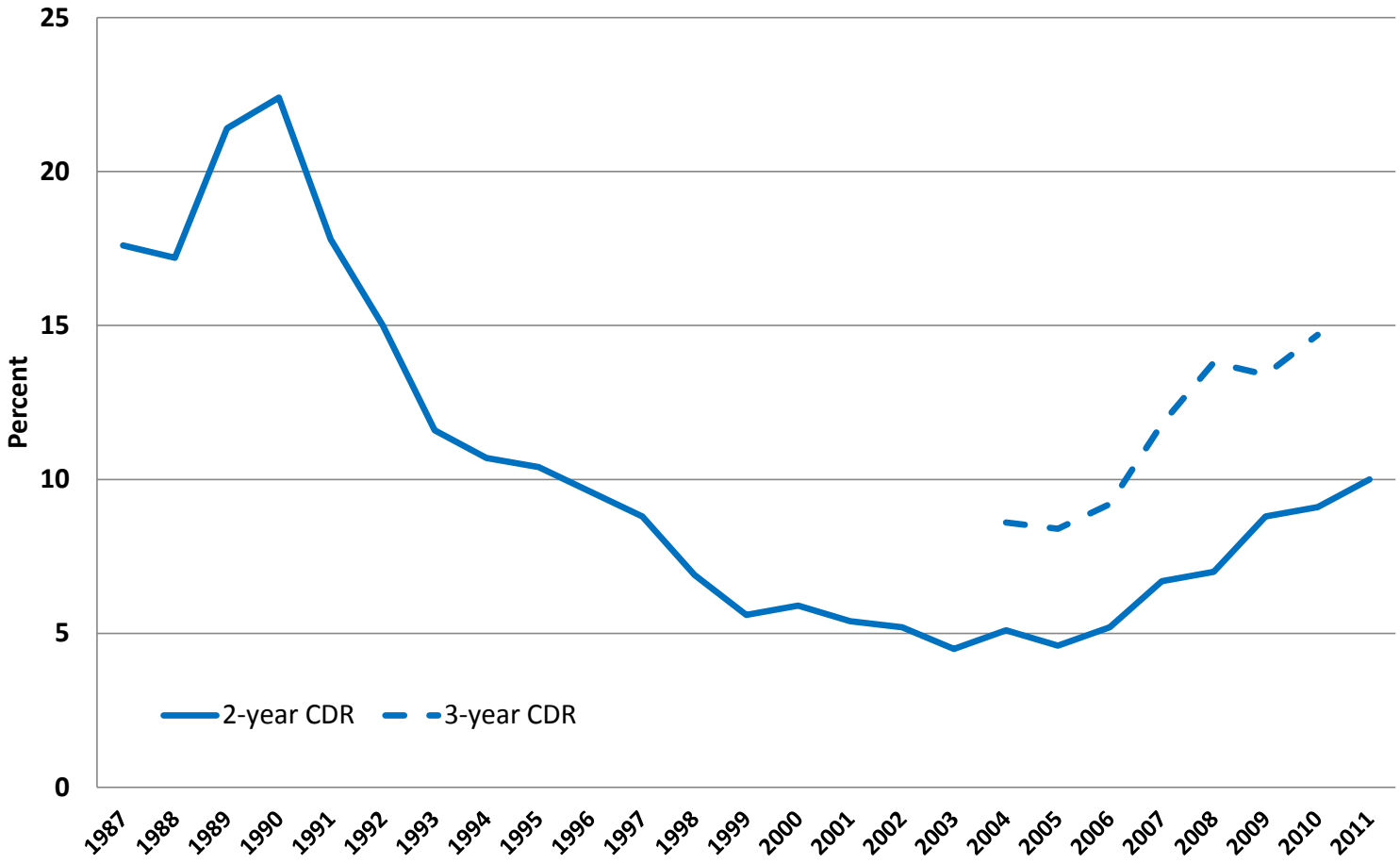


Resulting Trends in Education Sector

- **Rising delinquency & default since Great Recession**
  - 90-day delinquency rates for young borrowers in repayment rose from 20% to 35% between 2004 and 2012 (Brown et al. 2014)
  - 3-year cohort default rates at nearly 15%

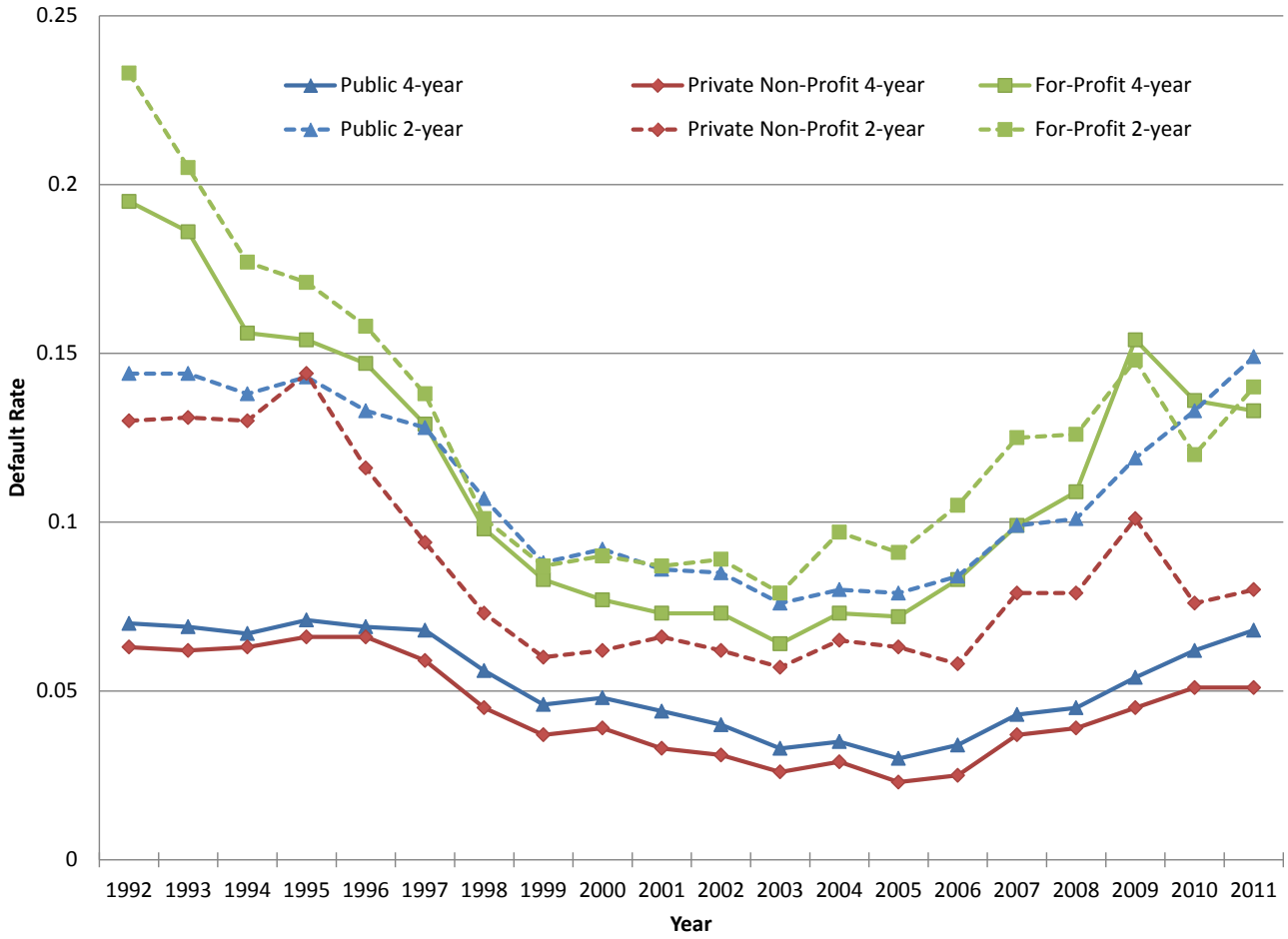
Trends in Student Loan Default

Figure 15: Trends in Federal Student Loan Cohort Default Rates



Trends in Student Loan Default

Figure 16: Trends in Federal Student Loan Two-Year Cohort Default Rates by Institution Type



In the U.S. Context:

- Rising costs of and labor market returns to college since the early 1980s, coupled with stable real government student loan limits, suggest that borrowing constraints may be more salient today
- 26% of all dependent undergraduate students at 4-year public schools borrowed the max from the Stafford Loan Program in 1999-2000, compared to under 4% in 1989-90
- Private student credit increased rapidly from virtually zero in the early 1990s to 9% of all student loan dollars distributed in 1999-2000

Two Questions

These trends raise two important concerns about student loans:

- Can students borrow enough?
  (What does "enough" mean?)
- Are some students borrowing too much?
  (What does "too much" mean?)
- How should policy address these seemingly contradictory concerns?

Insufficient Credit

Can American Students Obtain Adequate Credit?

- Little evidence that a lack of borrowing opportunities discouraged schooling 30 years ago
  - Carneiro & Heckman (2002), Cameron & Taber (2004), Keane & Wolpin (2001), Belley & Lochner (2007)
- New evidence suggests that more recent cohorts are unable to borrow as much as they would like:
  - sharp increase in fraction of students 'maxing out' their federal student loans (Berkner 2000, Berkner & Wei 2008)
  - differences in college attendance between youth from high- vs. low-income families have doubled since early 1980s (Belley & Lochner 2007)
  - most-able low-income students now work much more during school than their high-income counterparts (Belley & Lochner 2007)

Private Sector Has Jumped In

- Share of undergraduate debt from private lenders rose from virtually zero in early 1990s to 25% in 2007-08
- Private lenders scaled back considerably in 2008-09 – credit crisis
- Partially offsetting was an increase in Stafford Loan limits
- Private lenders face different incentives and offer different loan contracts
  - maximizing profits
  - target 'good investments'
  - generally charge higher interest rates, less payment flexibility
  - often require co-signor
- Important to consider response of private lenders to government policies

Labor Market Uncertainty and College Attendance

- Labor market risk can also discourage schooling and borrowing (Johnson 2013)
  - without 'insurance' against poor labor market outcomes, youth may be unwilling to take on much debt for school
  - may forego good educational opportunities altogether
- Policies that help 'insure' borrowers against downside risk encourage schooling & borrowing (Navarro 2010)

Too Much Debt?

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Student Loan Debt

- Some students do borrow a lot. Most do not
  - Only 10% of baccalaureate degree recipients in 2011-12 had borrowed more than $50,000 (Hershbein & Hollenbeck 2014)
- Default occurs across all debt levels

Recent Studies of Student Loan Repayment/Default

- Determinants of long-run repayment/non-payment outcomes and expected losses
  - Lochner & Monge-Naranjo (2014) use B&B survey to study repayment among 1992-93 BA recipients 10 years after graduation
- Default and non-payment at for-profit schools
  - Deming, Goldin & Katz (2012) and Hillman (2014) use BPS to study post-school outcomes (5 years after entry) for students entering college in 1995-96 and 2003-04
- Importance of income, parental resources & savings for repayment outcomes
  - Lochner, Stinebrickner and Suleymanoglu (2013) use Client Satisfaction Survey and CSLP administrative data for recent school-leavers in Canada

Long-Run Repayment Outcomes

Lochner & Monge-Naranjo (2014) consider the following measures 10 years after graduation:

- fraction of debt still outstanding
  - should be ≈ 0 under standard payment plan
- default
- any form of non-payment, including default, deferment, and forbearance
- fraction of debt in default
- fraction of debt in non-payment
  - closest to idea of expected losses

Student Loan Repayment for BA Recipients

Table 2: Repayment Status for 1992-93 Baccalaureate Recipients (B&B)

	Years Since Graduation	
Status	5 Years	10 Years
Fully repaid	0.27	0.64
Repaying or fully paid	0.92	0.92
Deferment or forbearance	0.04	0.03
Default	0.04	0.06

Source: Lochner & Monge-Naranjo (2014).

Estimating Determinants of Expected Losses

Estimate effects of these factors:

- personal/family characteristics
- institutional characteristics
- college major
- student debt levels
- post-school earnings
- state/division fixed effects

Main Results

- Losses due to non-payment are high for blacks
  - not explained by differences in major, institution type/quality, debt, or post-school earnings
- Other demographic factors (including SAT/ACT) are relatively unimportant
- Modest differences in repayment patterns by college major
- Institutional characteristics generally have insignificant effects
- Post-school earnings reduce non-payment, while debt levels increase non-payment
  - an extra \$1,000 in debt is generally offset by about \$10,000 in earnings

Significant Effects Only for All Repayment/Non-Payment Outcomes using Specification 6

(includes state/district fixed effects)

Variable	Share of UG Debt Still Owed	Fraction in Default	Fraction Not Paying	Default x Share of Debt Still Owed	Not Paying x Share of Debt Still Owed
black	**0.216**	**0.055**	**0.085**	**0.108**	**0.158**
asian	0.107	**0.072**	**0.089**	0.003	0.008
SAT/ACT Q4	0.029	0.006	0.006	0.022	**0.041**
mom some college	**-0.047**	0.022	0.008	0.001	-0.014
mom BA+	**-0.062**	0.003	-0.007	-0.018	-0.013
business	-0.020	**-0.081**	-0.051	-0.023	-0.010
engineering	**-0.090**	-0.018	-0.021	-0.016	-0.008
health	-0.007	-0.047	-0.019	**-0.042**	-0.027
social science	**0.078**	-0.022	-0.014	-0.008	0.008
humanities	**0.083**	0.001	0.023	0.030	**0.081**
HBCU	0.041	-0.005	-0.040	-0.060	**-0.117**
1997 earnings ($1,000)	**-0.0010**	-0.0001	-0.0003	-0.0005	-0.0004
2002 earnings ($1,000)	-0.0004	**-0.0008**	**-0.001**	-0.0001	**-0.0004**
UG loan amount ($1,000)	**0.013**	**0.003**	**0.004**	**0.003**	**0.003**

Some Open Questions

- What explains the large differences in national cohort default rates across institution types?
  - probably need to include dropouts and two-year college students
- What explains the poor payment records for blacks?
  - Do black families provide less financial assistance to their children after college?

For-Profit Institutions

Based on the BPS cohort of students entering college in 2003-04 (following them 5 years later)

- Deming, Goldin & Katz (2012) account for a broad set of individual and school factors, estimating that students attending for-profits
  - experience higher levels of post-school unemployment and lower post-school earnings
  - leave school with more debt
  - have higher default rates (7-8 pp)
- Hillman (2014) reaches similar conclusions regarding default
- Caveat with both studies: students attending college for 4+ years just entered repayment by last survey date

Importance of Post-School Income, Family Support, and Savings

- Lochner, Stinebrickner & Suleymanoglu (2013) use administrative and 2011-12 survey data from Canada Student Loan Program (CSLP)
- Examine non-payment during first few years after school
  - 11% experience 'serious repayment problems' (delinquency, default, bankruptcy)
  - 25% experience 'any/some repayment problems' (above + repayment assistance)

Main Findings

- **Borrower income has a very strong effect on repayment**
  - changes in income are also important for returning to good standing after entering default
- **Savings and family support are important sources of insurance against unemployment & adverse income shocks**
  - among low-income borrowers, access to savings and/or family assistance has important effects on repayment problems
  - income has relatively weak effects on repayment for borrowers with access to savings and/or family assistance

Importance of Savings and Family Assistance

Table 6: Repayment Problems in CSS by Income and Additional Financial Resources

	Both Savings & Family Assistance	Either Savings or Family Assistance	Neither Savings nor Family Assistance
A: Any Repayment Problem			
Income < $20,000	0.037	0.263	0.585
	(0.020)	(0.067)	(0.060)
	6.64%	*15.08%*	*26.70%*
Income ≥ $20,000	0.045	0.072	0.307
	(0.024)	(0.023)	(0.079)
	11.94%	*29.01%*	*10.60%*
B: Serious Repayment Problem			
Income < $20,000	0.011	0.075	0.250
	(0.009)	(0.030)	(0.044)
	6.64%	*15.08%*	*26.70%*
Income ≥ $20,000	0.024	0.026	0.100
	(0.020)	(0.013)	(0.029)
	11.94%	*29.01%*	*10.60%*

Note: 'Savings' implies savings ≥ $1,000. 'Family Assistance' implies expected family transfers ≥ $2,500.

General Lessons

- Enforcement mechanisms seem to be effective – only those without any resources fail to repay
- Family is still quite important in years immediately after college
  - may help explain high default rates for blacks in U.S.
- More than 1/2 of borrowers with low post-school income have little self- or family-insurance

Default isn't Always Bad!

- Of course, some students may borrow 'too much' or may walk away from their debts too easily
- But, some defaults are to be expected (and desirable) in an uncertain labor market
  - default acts as an implicit form of loan forgiveness/insurance

Are there better ways to provide this insurance?

Models

Overview:

- Study a two-period canonical model to examine frequently tested implications of constraints for schooling
- Discuss U.S.-based evidence on the impacts of credit constraints on college-going, as well as consumption and work during college
- Discuss models with richer, more realistic forms of credit constraints:
  - GSL programs
  - Private lending with incentive problems
  - Consider implications of uncertainty
- Discussion draws on Lochner and Monge-Naranjo (2012, 2016)

Human Capital with Exogenous Borrowing Constraints

Review: A Basic Model (From Lochner and Monge-Naranjo, 2012, *ARE*)

- Consider two-period-lived individuals who invest in schooling in the first period and work in the second
- Preferences are

$$U = u(c_0) + \beta u(c_1), \tag{1}$$

  - c_t is consumption in periods $t \in \{0, 1\}$
  - $\beta > 0$ is a discount factor
  - $u(\cdot)$ is strictly increasing & concave
- Investments increase future earnings but provide no additional utility benefits/costs
- Abstract from the choice of leisure time

- Each person is endowed with financial assets $W \geq 0$ and ability $a > 0$
- During the schooling period, individuals make human capital investments h that increase post-school labor earnings

$$y = w_1 a f(h) \tag{2}$$

  - w_1 is the price of human capital
  - $f(\cdot)$ is positive, strictly increasing and concave
  - Higher ability a increases total and marginal returns to investment
- Each unit of h entails
  - Foregone wages $w_0 \geq 0$
  - Tuition costs $\tau > 0$

- Young individuals can borrow d (or save) at a gross repayment rate; $R > 1 \quad (R = (1 + r)$; r is interest rate)
- Consumption levels in each period are

$$c_0 = W + w_0(1 - h) - \tau h + d \tag{3}$$

$$c_1 = w_1 af\,(h) - Rd \tag{4}$$

- d is what person gets from the bank in loans.

Where does family enter?

- W (assets); ability a; inputs for f; R borrowing rate

Unrestricted optimum:

- In the absence of credit market frictions, individuals maximize utility U subject to (3) and (4)
- Problem can be solved in two stages:
  - Choose h to maximize PDV lifetime income
  - Choose d to smooth consumption
- "Separation Theorem:" wealth maximization followed by consumption choices
- Human capital investment equates its marginal return with that on financial assets:

$$\frac{w_1 a f'\left[h^U(a)\right]}{w_0 + \tau} = R \tag{5}$$

(Assume feasible; might have a corner solution $\geq$)

- Optimal unrestricted investment $h^U(a)$ is strictly increasing in ability a and independent of initial assets W

- Unconstrained optimal borrowing $d^U(a, w)$ smooths consumption over time, satisfying the Euler equation:

$$u'\left[W + w_0 + d^U(a, W) - (w_0 + \tau)h^U(a)\right] = \beta R u'\left[w_1 a f\left[h^U(a)\right] - R d^U(a, W)\right]$$

- Unconstrained borrowing is strictly decreasing in wealth and increasing in ability
- Greater ability increases borrowing for two distinct reasons:
  i. More able individuals wish to finance more investment; and
  ii. Given any level of investment, more able individuals earn higher net lifetime income and wish to consume more in the first period.

Borrowing Constraints:

- Consider an exogenously specified upper limit on the amount of debt that individuals can accumulate:

$$d \leq \bar{d}, \tag{6}$$

- The equation $d^U(a, W) = \bar{d}$ implicitly defines a threshold level of assets $W_{\min}(a)$ determining who is
  - Constrained: $W < W_{\min}(a)$
  - Unconstrained: $W \geq W_{\min}(a)$
- Constrained persons have high ability relative to their wealth: $W_{\min}(a)$ is increasing in ability
- Importantly, being 'unconstrained' may require greater wealth W than is necessary to cover tuition, since individuals also borrow to smooth consumption
- Thus
  $W + w_0 > \tau h$ does not ensure that $d^U(a, W) < \bar{d}$

- Optimal constrained investment h^X satisfies

$$(w_0 + \tau)u'\left[W + w_0 - (w_0 + \tau)h^X + \bar{d}\right] = \beta u'\left[w_1 af\left(h^X\right) - R\bar{d}\right] w_1 af'\left(h^X\right)$$

- $u'(0) \geq u'(1)$
- $h^X(a, W)$ strikes a balance between increasing lifetime earnings and smoothing consumption

Empirical Predictions (assume borrowing constraint binds for h^X):

1. Constrained individuals under-invest in their human capital: $h^X(a, W) < h^U(a)$
2. $h^U(a)$ is independent of wealth W, while $h^X(a, W)$ is strictly increasing in wealth and the borrowing limit $\bar{d}$
3. The marginal return on human capital $MR(h) \equiv \frac{w_1 a f'[h]}{w_0 + \tau}$ is equal to the return on savings R for unconstrained individuals and is strictly greater than R and strictly decreasing in wealth W for constrained individuals
4. $h^X(a, W)$ decreases more with an increase in direct costs, τ, than with an equal increase in opportunity costs, w_0 (i.e., $-\partial h^X/\partial w_0 \geq -\partial h^X/\partial \tau$); $h^U(a)$ responds equally to both costs (i.e., $\partial h^U/\partial w_0 = \partial h^U/\partial \tau$)

- The first three results are well-known since Becker (1967)
  - They derive from the fact that the marginal cost of investment is higher for constrained individuals, since they cannot borrow to smooth consumption over time
  - This causes constrained individuals to invest less, stopping school when the marginal return is still relatively high
- The fourth implication is derived by Cameron and Taber (2004)
  - An increase in opportunity costs w_0 also raises 'full wealth' levels, while an increase in direct costs does not

- Relationship between ability and constrained investment is shaped by two opposing forces:
  i. More able individuals earn a higher return on human capital investment, so they would like to invest more
  ii. More able individuals have higher lifetime earnings, so they would like to consume more at all ages
- The second discourages investment, since constrained borrowers can only increase early consumption by lowering investment
- With empirically relevant preferences for intertemporal consumption smoothing, the second effect can dominate and constrained investments should be *decreasing* in ability

Incorporating Tastes for Schooling

- To introduce non-pecuniary benefits/costs of education ξ to the previous model, augment utility.
- $U = u(c_0) + \beta u(c_1) + \xi h$
- The introduction of non-pecuniary benefits ($\xi > 0$) or costs ($\xi < 0$) implies that unconstrained investment is not generally independent of wealth W
  - If $\xi > 0$, then $\frac{\partial h^U}{\partial W} > 0$ and $MR(h^U) < R$
  - If $\xi < 0$, then $\frac{\partial h^U}{\partial W} < 0$ and $MR(h^U) > R$

- Results 2 and 3 no longer imply simple 'tests' for borrowing constraints
- Low-wealth individuals may acquire low levels of schooling (and have a high marginal return to investment), because they are more likely to be constrained or because schooling offers non-pecuniary benefits
- Result 4 is robust to the inclusion of non-pecuniary tastes
- *Question:* Prove this claim.

- Belley & Lochner (2007): in the absence of borrowing constraints, the relationship between family resources and college attendance depends on $Corr(\xi, W)$ and the net financial returns to college
- Absent borrowing constraints, the correlation between family resources and the probability of attendance (conditional on ability) should weaken (or become negative) as the net financial returns to college increase
    - An increase in the return to college raises the relative value of college less for individuals with high wealth due to diminishing marginal utility of consumption
- This need not be true when borrowing constraints limit the consumption of low-wealth individuals
    - Constrained youth may benefit little from an increase in future labor market returns to school

Other Margins: Consumption, Leisure, and School Quality

Constrained youth:

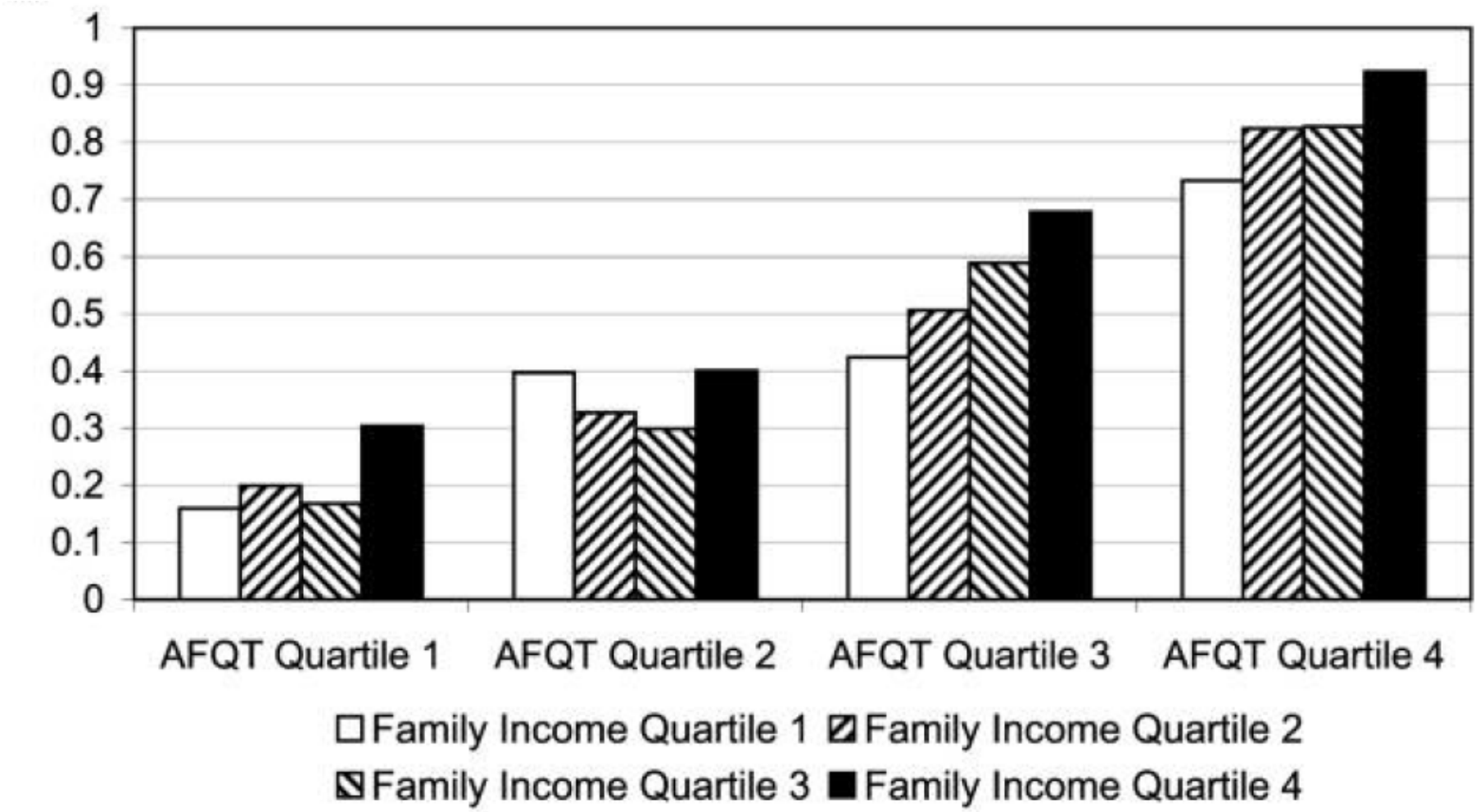
- Are likely to have low levels of consumption during school
- May substitute leisure for work to alleviate the negative impacts of constraints on consumption and investment
- May delay college entry (and its labor market rewards) to accumulate savings
- May adjust on the school quality margin given any level of attendance
  - Re-interpreting h as the quality of school conditional on school attendance, constrained youth should attend lower quality institutions, with quality increasing in wealth and the borrowing limit
  - Implies that wage returns from college attendance should be lower for constrained youth

US Evidence on Borrowing Constraints and College

Differences in Schooling Decisions by Family Income/Wealth

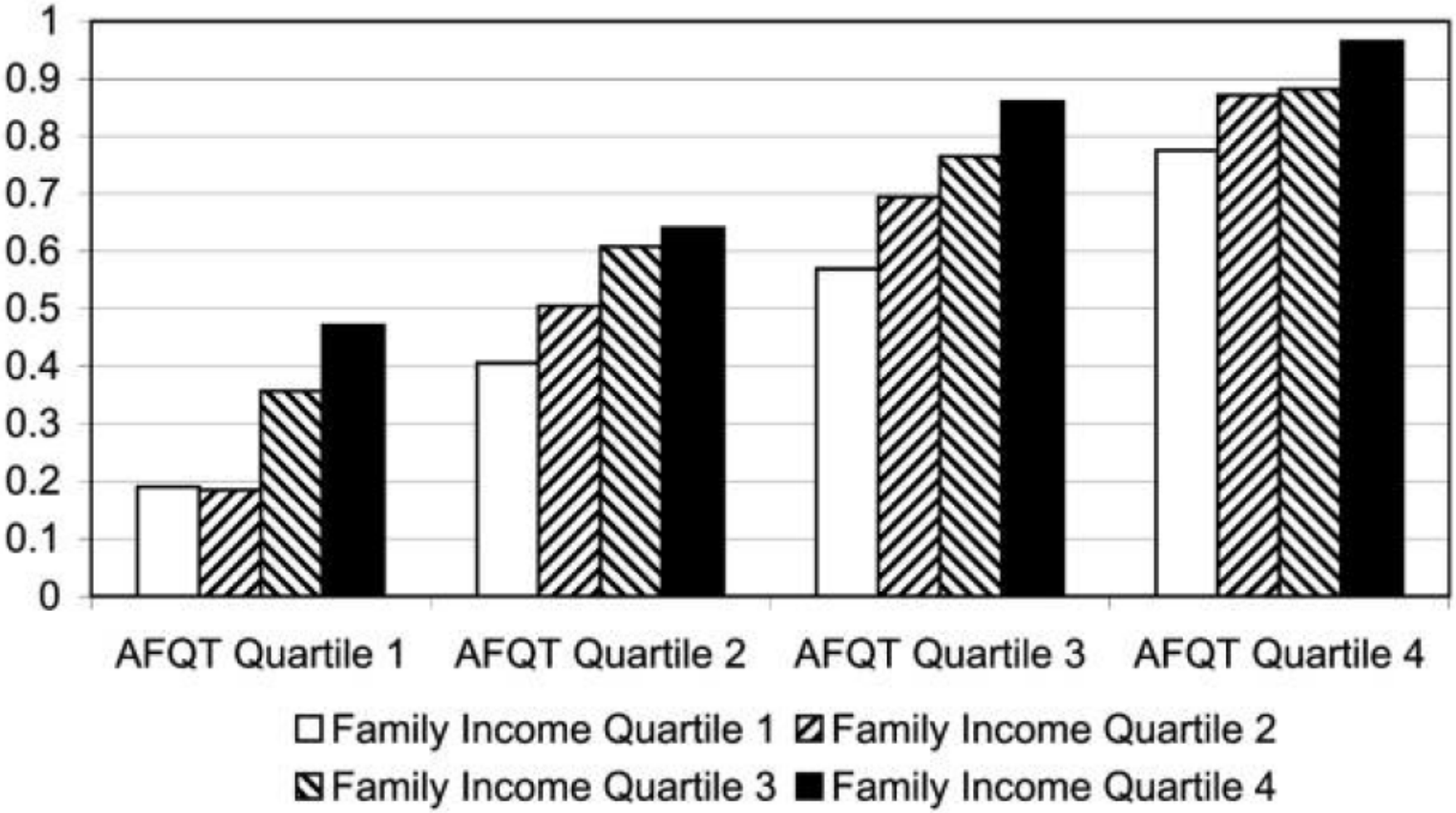
- In the early 1980s (NLSY79), family income played little role in college attendance decisions after controlling for adolescent ability and family background (Cameron & Heckman 1998, 1999, Carneiro & Heckman 2002)
- Comparing the NLSY79 with the NLSY97, Belley and Lochner (2007) find that family income is a much more important determinant of college attendance in the early 2000s
  - Youth from high income families in the NLSY97 are 16 percentage points more likely to attend college than are youth from low income families conditional on adolescent cognitive achievement and family background
  - Roughly twice the effect observed in the NLSY79
- In the NLSY97, the combined effects of family income and wealth on college attendance are roughly double the effects of income alone

Figure 17: College attendance by AFQT and Family Income Quartiles (1979)



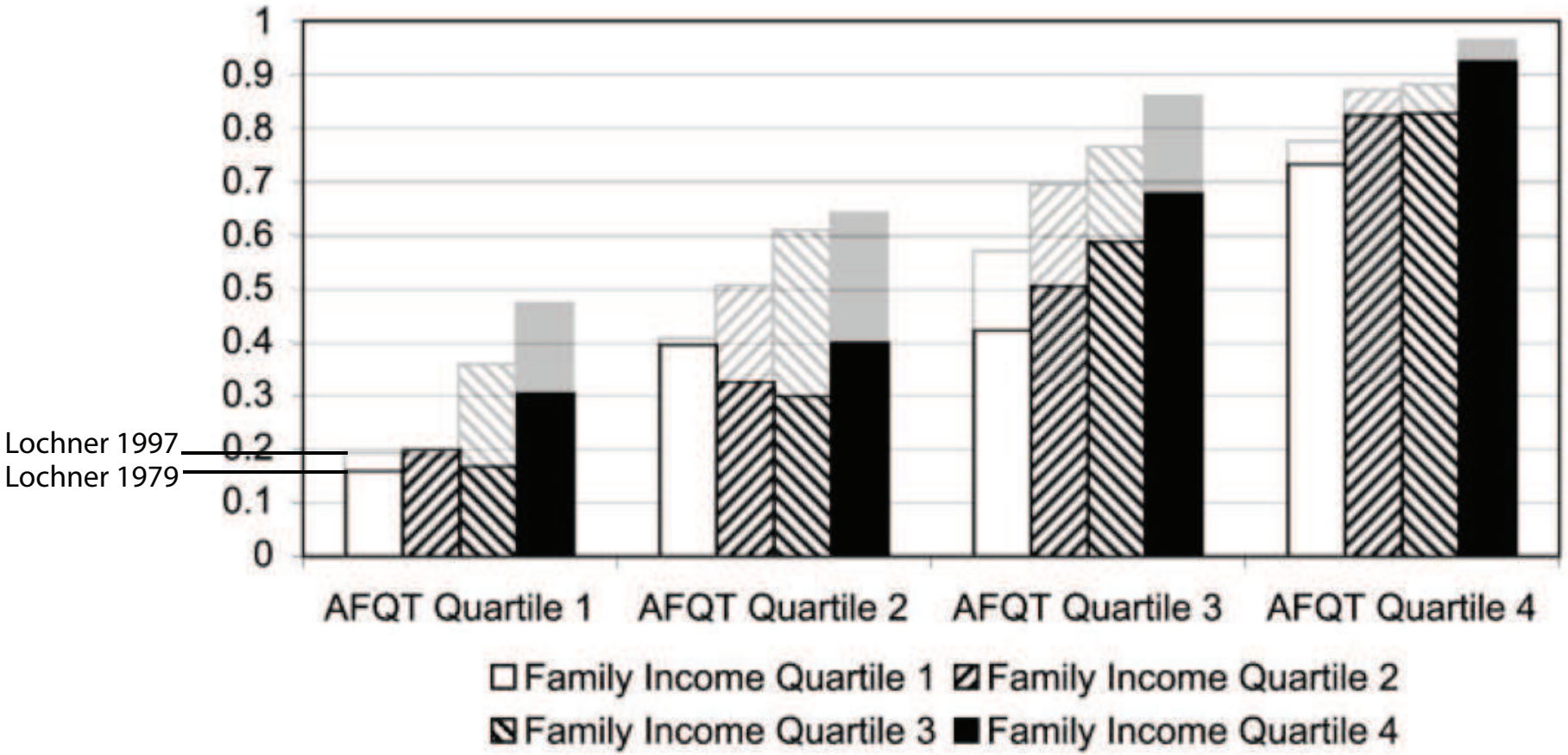
Source: Belley and Lochner (2007).

Figure 18: College attendance by AFQT and Family Income Quartiles (1997)



Source: Belley and Lochner (2007).

Figure 19: College attendance by AFQT and Family Income Quartiles (1979 and 1997 on one graph)



Source: Belley and Lochner (2007).

Lovenheim (2011):

- Uses the PSID to estimate the impacts of exogenous changes in housing wealth (driven by local housing booms and busts) on post-secondary enrollment decisions
- His estimates suggest that an additional $10,000 in housing equity raises college enrollment by 0.7 percentage points, with much larger effects among lower income families
- Impacts of housing wealth have become more important in the 2000s
    - Increased liquidity of housing wealth or a general increase in the effect of family resources on schooling?

Work and college entry delay (Belley & Lochner 2007):

- Among lower ability groups, weak effects of income on work (during the school year) for both NLSY cohorts
- Among the most able, effects of income on work increase substantially over time
- In the NLSY97, the most able youth from low-income families work more weeks and nearly twice as many hours per week during the school year than their higher family income counterparts
- Estimated effects of family income on college entry delay are weak for both NLSY cohorts

College Type/Quality:

- In NLSY79, family income had little effect on the choice of 2-year vs. 4-year institutions
- Belley & Lochner (2007) estimate that moving from the bottom to top income quartile increased the probability of attending a 4-year college by 11 pp. in the NLSY97
- Relationship between family income and attendance at selective high quality institutions has weakened
  - Kinsler & Pavan (2010) estimate that moving from the bottom to top income quartile increased the probability of attending a top quality college by about 25 pp. in the NLSY79 and 16 pp. in the NLSY97
  - Among top (often private) schools, both tuition and need-based fellowships increased dramatically
  - This effectively increased the price of college quality more for high-income students

Role of tastes for college:

- One explanation for the observed positive relationship between family income and schooling is that higher income families place greater value on education
- Not clear why this relationship would have strengthened so much since the early 1980s
- Increase in net returns to schooling should have *weakened* the income – attendance relationship in the absence of borrowing constraints (if the relationship between 'tastes' for college and family income had remained stable)

Differential (Marginal) Returns to Schooling

- Card (1999) notes that many IV estimates of the wage return to schooling exceed OLS estimates by 20-30%
- Based on the LATE interpretation, Lang (1993) and Card (1995, 1999) argue that borrowing constraints may explain this
  - Typical instruments largely impact the decisions of low-income and potentially constrained youth
  - IV estimates *may* reflect relatively high returns for constrained youth
  - OLS estimates *may* more closely reflect average pop. returns
- Carneiro & Heckman (2002) show that this is not generally true with heterogeneous returns and self-selection
- We previously discussed this
- Marginal costs and returns to schooling may differ for reasons other than borrowing constraints
- Difficult to draw any conclusions from this literature

Cameron & Taber (2004):

- Examine returns to schooling, basing their analysis on results 3 and 4
- Argue that the set of individuals whose college-going is affected by a change in direct costs (college in county) should disproportionately include more credit constrained youth than the set of individuals affected by a change in opportunity costs (local low-skill wage rates)
- IV estimates of the return to schooling using 'college in county' as an instrument should exceed those using 'local low-skill wages' if borrowing constraints are important
  - Ignores differences in college quality
- No evidence in support of credit constraints for NLSY79 men
- Recall, however, our discussion in *Building Bridges* about multiple instruments.

Structural Models

- Recent studies estimate dynamic life cycle schooling models
- Exploit data on schooling choices, earnings, and in some cases, assets and family transfers, to identify the role of borrowing constraints
- Approach facilitates evaluation of a wide range of potential policies

Cameron & Taber (2004):

- Estimate a life cycle model with a discrete set of schooling options
- Test whether individuals face different interest rates when making their schooling decisions
- Evidence that some individuals face high interest rates relative to others would imply that borrowing constraints distort their education decisions
- Main source of identification is potential asymmetry in impacts of opportunity costs and direct costs
- Finding: no heterogeneity in "interest rates" (borrowing costs/costs of schooling) (NLSY79 men)

Keane & Wolpin (2001):

- Estimate a dynamic model of schooling, work, and consumption
- Incorporate borrowing constraints and (exogenous) parental transfers
- Panel data on schooling and work (full-time and part-time), wages, and assets (white males, NLSY79)
- Allow for unobserved heterogeneity in the ability to acquire human capital, tastes for work and school, and borrowing limits

Keane & Wolpin (2001) findings:

- Estimated borrowing limits are very tight (ranging from \$600 to \$1000 across individuals, in 1987 dollars)
  - Less than 1/3 the estimated cost of a single semester of school (about \$3,700)
- Important role for parental transfers and part-time work in enabling school attendance
  - Parents provide between \$3,300 and \$10,000 in transfers while enrolled in school
  - Transfers increasing in parental education
  - Transfers are substantially lower when students are not enrolled in school
  - Transfers act as a subsidy for education (larger for children with more educated parents)
  - A model of parental paternalism, not of altruism: children confront a price schedule

Keane & Wolpin (2001) conclusions:

- Conclude that nearly all of the (sizeable) differences in educational attainment by parental education are accounted for by
  - Higher enrollment-contingent parental transfers from educated parents
  - Unobserved heterogeneity
- Increases in available credit
  - Have negligible effects on schooling
  - Reduces work during school
  - Increases consumption during school
- Hope Scholarship Program study found similar effects

Johnson (2011):

- Estimates a model similar to Keane & Wolpin
- Some key differences:
  - Recent male high school graduates in the NLSY97
  - Explicitly models government student loan programs and a private credit limit
  - Allows for differences in tuition across states
  - Incorporates need- and merit-based grants
  - Allows for exogenous unemployment
  - Exploits additional data on avg. tuition by state, self-reported grant aid and parental transfers
- Enables him to infer consumption during and after school, helping identify who is constrained

Johnson (2011) findings:

- Parental transfers (esp. that schooling-contingent transfers are greater for higher-income families) and unobserved heterogeneity are important determinants of schooling
- Slope of transfers with income increasing in income
- Estimated borrowing limits are modest relative to college costs; substantially greater than those of Keane & Wolpin
- Estimates a modest impact of increasing loan limits
  - An additional $1,500 in credit per year in school would increase college completion rates by 4.5%
  - Allowing students to borrow up to the total costs of schooling would increase completion rates by nearly 8%
  - Greater impact than an increase in education subsidies costing the same amount

- Borrowing constraints have small to modest impacts on schooling choices in these two studies for very different reasons
- Estimates from Keane & Wolpin suggest that most students are constrained but that consumption and leisure are distorted rather than schooling
  - Lack of effects on schooling consistent with other NLSY79 studies
- Johnson estimates that few youth borrow up to their limit
  - Risk aversion, coupled with the possibility of very low income (associated with post-school unemployment), prevents individuals from taking on much debt
  - His estimates suggest that very few would choose to borrow more than $6,000

Navarro (2010):

- Explores importance of heterogeneity, uncertainty, and borrowing constraints as determinants of college attendance in a life cycle framework
- Uses schooling and earnings data from the NLSY79 and PSID
- At each age, borrowing constraints are given by the lowest possible discounted future income ('natural' limit of Aiyagari (1994))
- Applies Cunha et al. (2005) and Cunha and Heckman (2010) to distinguish *ex ante* heterogeneity in abilities (and tastes for college) separately from uncertainty about future income

Navarro (2010) findings:

- Because individuals would never choose to borrow more than the 'natural' limit, relaxing this constraint by itself would have no effect on behavior in his framework
- Eliminating uncertainty would substantially change who attends college but would have little impact on the aggregate attendance rate
- Simultaneously removing uncertainty and borrowing constraints would lead to sizeable increases college attendance
- Highlights an important interaction between borrowing constraints and risk/uncertainty

Some Comments on Uncertainty and Borrowing Constraints:

- Assumptions about minimal income (or consumption) levels are crucial for the importance of borrowing limits in life cycle schooling models with uncertainty
- Demand for credit may be much higher with explicit insurance mechanisms or implicit ones (e.g. bankruptcy, default, deferment and forgiveness)
- Private credit offerings may increase in response to any reductions in risk
- Need to think about insurance and credit together

Interpreting Keane & Wolpin (2001) and Johnson (2011):

- Results suggest that many youth would not attend college without schooling-contingent transfers from their parents even if credit were abundant
- Why do wealthier parents effectively subsidize so much schooling if their children are not willing to pay for it themselves?
- Suggests that many parents (at the time of the decision) must value their children's education more than their children do

- Three potential explanations for the strong positive relationship between parental income/education and schooling-contingent subsidies:
  1. All parents have similar tastes for schooling, but poor parents may be constrained in what they can afford to give their children
  2. All parents have similar tastes for schooling, but wealthier parents buy more of it like they do other normal goods
  3. Wealthier parents have a stronger preference for schooling than poor parents
- These explanations mirror the earlier discussion of the wealth – schooling relationship, only for parents rather than for students themselves

- While the results of Keane & Wolpin (2001) and Johnson (2011) suggest that expansions in student loan programs are likely to have limited effects on college-going, they effectively shift the 'constrained' question up a generation
- It is not clear how these results help explain the dramatic increase in family income – attendance gaps over the past few decades
- Efforts to endogenize parental transfer decisions and family dynamics are needed

Some Other Observations:

- Adolescent 'endowments' or abilities play a central role in determining the relationship between socioeconomic background and education (and earnings) outcomes
  - Structural models: Keane & Wolpin (2001) and Johnson (2011)
  - Education gaps by family income: Cameron & Heckman 1998, Carneiro & Heckman 2002, Belley & Lochner 2007)
- Earlier studies treat these endowments as exogenous and invariant to policy
- Recent work endogenizes these endowments through early investments by families and schools
  - Cunha (2007), Cunha & Heckman (2007), Cunha, Heckman & Schennach (2010), Caucutt & Lochner (2011)
  - Constraints can have large impacts on early investments

- Empirical literature on borrowing constraints and education is almost exclusively partial equilibrium
- Heckman, Lochner & Taber (1998) and Gallipoli, Meghir & Violante (2011) show that incorporating GE effects on skill prices can considerably dampen the impacts of education policies on schooling

Other Approaches to Identifying Constraints

Stinebrickner & Stinebrickner (2008):

- Directly ask students enrolled at Berea College whether they would like to borrow more if they could (at a 'fair' interest rate)
  - Typical student at Berea College comes from a low-income family
  - Berea effectively charges zero tuition and offers large room and board subsidies
  - College dropout rates are similar to those for low-income students in the US
- While many Berea students live on a very tight budget, only about 20% reports that they would like to borrow more
- College drop out rates (by the beginning of year two) are 11-13 percentage points higher (or roughly double) for 'constrained' youth

Brown, Scholz and Seshadri (2011):

- Model intergenerational relationships and derive a new way of identifying which youth may be affected by borrowing constraints
- Assume that youth would be borrowing constrained if they did not receive help from their parents
- Parents can borrow freely, but they cannot write enforceable loan contracts with their children
- Parents may not want to transfer enough resources to satisfy their children's demand for consumption and schooling
  - parents would provide all their transfers to their children at college ages, but children would under-invest
- Unconstrained families transfer enough resources to their children to support optimal investment and make transfers after their children leave school

- Distinguish between 'constrained' and 'unconstrained' families based on post-school parental transfers
- In their framework, total human capital investment should be more sensitive to a tuition subsidy among constrained youth than among unconstrained youth
- Test this prediction using intergenerational data on educational attainment and family transfers from the HRS (US during 1970s, 1980s, and 1990s)
- Identify 'constrained' youth as those receiving no post-school family transfers
- Use sibling spacing as an instrument for student aid
- Among 'constrained' youth, an additional $3,600 in aid (i.e., 4 vs. 0 years of sibling overlap) increases average schooling by 0.2 years
- Negligible effects of additional aid on 'unconstrained' youth

Summarizing the Evidence

- Studies analyzing the NLSY79 data find little evidence that borrowing constraints affected college-going in the early 1980s
- Important changes over past few decades point to increased salience of constraints:
  - Significant increases in the share of students 'maxing out' their federal student loan opportunities
  - Doubling in family income – college attendance gradients for recent cohorts
  - Able low-income students work much more than their high-income counterparts in NLSY97

- Changes in family income – college quality relationship mixed
- Small effects on college entry delay
- Strong effects on work while in school
- Differences in parental transfers and labor market risk are also important factors, complicating interpretation of the evidence
- Family influence factors will be reexamined
- Initial conditions play a big role
- Psychic costs are substantial
- Paternalism plays a substantial role

Formal Models of Borrowing Constraints for Education (Lochner and Monge-Naranjo, ARE, 2012)

- Standard ad hoc assumptions on borrowing limits are at odds with the actual operation of public and private sources of credit for education
- More realistic assumptions about government and private lending are useful for understanding the behavior of human capital investments
- GSL programs explicitly link credit to educational expenditures, while private lenders extend credit to students based on their prospects of repayment and projected future earnings

GSL programs:

- In 1999-2000, roughly 40% of all US undergraduates received Stafford loans, borrowing almost $9,000 on average
- Most GSL programs have three salient features:
  1. Lending is directly tied to investment – students (or parents) can only borrow up to the total cost of college (including tuition, room, board, books, and other expenses directly related to schooling) less any other financial aid they receive
  2. Set upper loan limits on the total amount of credit available for each student
  3. Extended mechanisms to enforce repayment compared to other unsecured private loans

- Imply that government borrowing d_g must satisfy

$$d_g \leq \min\left\{\tau h,\ \bar{d}\right\} \tag{7}$$

- Upper limit $\bar{d}$ is specified by law
- Given their strong enforcement, assume, for simplicity throughout this analysis, that government loans must be repaid

Private Lending:

- The importance of private lending markets for schooling has skyrocketed from virtually zero in the early 1990s to over $15 billion in 2005-06, 20% of all student loan dollars distributed
- Credit cards have also become an important source of funds for students
- Useful to derive credit constraints that arise endogenously when lenders have limited mechanisms for enforcing repayment (e.g. Andalfatto & Gervais 2006, Lochner & Monge-Naranjo 2011)

- A rational borrower repays private loans if and only if repaying is less costly than defaulting
- Lenders limit credit to amounts that will be repaid
- Since penalties for default typically impose a larger cost on borrowers with higher earnings, credit is directly related to perceived future earnings
- Because expected earnings depend on schooling, private credit limits and investments are co-determined in equilibrium

- Assume that the cost of default on private loans equals a fraction $0 < \tilde{\kappa} < 1$ of labor earnings
- Borrowers will repay if and only if the payment Rd_p is less than the punishment cost $\tilde{\kappa} af(h)$
- $\tilde{\kappa}$ is set outside of the model
- Private credit is limited to a fraction of post-school earnings

$$d_p \leq \tilde{\kappa} R^{-1} af(h) \tag{8}$$

- Credit is increasing in both ability and investment

Total GSL and private credit limits:

$$d = d_g + d_p \leq \min\left\{\tau h,\ \bar{d}\right\} + \tilde{\kappa} R^{-1} a f(h) \tag{9}$$

- Assuming GSL repayments are fully enforced, government credit does not crowd-out private credit here (if $\bar{d} < \tau h$, otherwise τ affects h and private loans)
- Similar constraint holds in a life cycle model that includes both temporary exclusion from credit markets and wage garnishments as punishments for default
  - Partial crowd-out arises even if GSL credit is fully enforceable
- In general, some crowd-out is expected because increases in total debt reduce incentives to repay private debt

Empirical Implications (Lochner and Monge-Naranjo 2011):

- Framework can explain college attendance and financing patterns as equilibrium responses to the increased returns to and costs of college observed since the early 1980s, given stable GSL limits
  - In the early 1980s, the GSL provided adequate credit to most students and only a few would have needed private funding
  - College attendance was, therefore, largely independent of family resources
  - Rising college costs and returns have encouraged more recent cohorts to invest and borrow more, those exhausting GSL credit turning to private lenders
  - Private lenders have responded by endogenously raising their credit limits, though not enough to ensure efficient investment for everyone

- Distortionary effects of credit constraints are shifted onto consumption and away from investment
  - Due to the link of GSL and private credit to investment
  - Consistent with Keane & Wolpin (2001), Stinebrickner & Stinebrickner (2008), and Johnson (2011)
- Constrained individuals may not under-invest at all, since additional investments (at the margin) can be financed with additional government or private loans

- The endogenous nature of private and GSL credit also accommodates greater investment among the most able, since total credit is increasing in both investment and ability
- Constrained investment is more likely to be increasing in ability than when credit limits are exogenous

- Private credit responses to GSL programs and other government policies
  - Simulations suggest that expansions of public credit have only modest crowd-out effects on private credit
  - Increases in GSL limits lead to higher levels of total credit and raise human capital investment among constrained youth
  - Human capital investment is more sensitive to government education subsidies due to a 'credit expansion effect'
- Changes in GSL credit tend to have a relatively greater impact on investment among the least able, while changes in private loan enforcement tend to impact investment more among the most able

Uncertainty, Default and Other Incentive Problems

- Consider risky returns and the implications of imperfect insurance and private information for the provision of credit and human capital investment
- Uncertainty introduces interesting issues for policy
  - Potential for default
  - Tradeoff between enforcing repayment and providing insurance
- Incorporate ideas from literatures on
  - Optimal contracting with limited commitment
  - Private information
  - Moral hazard
- Can offer useful guidance in designing efficient policies to provide both credit and insurance for schooling in a risky environment

Extending Basic 2-Period Framework:

- Abstract from forgone wages and normalize tuition costs to one

$$w_0 = 0 \text{ and } \tau = 1$$

- Assume that the post-school price of human capital is stochastic and can take on $i = 1, ..., N$ possible realizations:

let $p_i > 0$ denote the probability of realization $w_{1,i}$ or more generally state i

- Public knowledge about p_i, a, and W
- Interest rate r (nonstochastic)

- Individuals maximize expected utility

$$U = u(c_0) + \underbrace{\beta}_{\substack{\text{time} \\ \text{preference}}} \sum_{i=1}^{N} p_i u(c_{1,i}) \quad s.t. \tag{10}$$

$$c_0 = W - h + \sum_{i=1}^{N} q_i D_i$$

$$c_{1,i} = af(h) w_{1,i} - D_i, \quad i = 1, ..., N$$

- $c_{1,i}$ is second period consumption associated with realization i
- D_i reflects the (possibly neg.) quantity a person commits to repay in the second period contingent on realization i
- q_i is the (Arrow) price of a contingent claim that pays 1 if realization i takes place and zero otherwise
- With complete markets, assume risk neutral arbitrage-free asset prices: $q_i = \frac{p_i}{(1+r)}$

Complete Markets

- Human capital investments $h^U(a)$ maximize the expected net present value of lifetime income
- Investment equates MC with the expected MR:

$$\bar{w}_1 a f'\left[h^U(a)\right] = (1+r) = R \tag{11}$$

  where $\bar{w}_1 \equiv \sum_{i=1}^{N} p_i w_{1,i}$ is the expected period 1 skill price
- Neither $u(\cdot)$ nor W affect investment
- Asset/debt holdings D_i optimally smooth consumption over time and across states: $u'(c_0) = \frac{(1+r)}{(1+\rho)} u'(c_{1,i}),\ \forall i$
- From now on, assume $r = \rho$
- $u'(c_0) = u'(c_{1,i})$

Limited Commitment with Complete Markets

- Assume that individuals can default on their debts in the second period
- 'Default' utility of $V^D(w_{1,i}, a, h)$, generally increasing in $w_{1,i}$, a, and h (from definition of $c_{1,i}$ and from possible stigma or punishment associated with default)
- 'Participation constraints':

$$u[w_{1,i}af(h) - D_i] \geq V^D(w_{1,i}, a, h), \ \forall i \tag{12}$$

  - Borrowers only repay if it offers higher utility
  - Potential for non-payment limits the credit and insurance of borrowers

- Let $\lambda_i \geq 0$ denote the (discounted) multiplier on participation constraint $i = 1, ..., N$
- Optimal debt holdings satisfy $u'(c_0) = (1 + \lambda_i) u'(c_{1,i})$
- Perfect consumption smoothing ($c_{1,i} = c_0$) for states in which the participation constraint does not bind ($\lambda_i = 0$)
- Consumption growth ($c_{1,i} > c_0$) when participation constraint binds ($\lambda_i > 0$)

- Consider case in which a defaulting borrower must forfeit a fraction $\tilde{\kappa} \in [0,1]$ of his earnings ($\tilde{\kappa}$ assumed fixed)

$$V^D(w_{1i}, a, h) = u\left[(1-\tilde{\kappa})\, w_{1i} a f(h)\right] \tag{13}$$

- This is clearly increasing in w_{1i}, a, h
- Participation constraints in this case reduce to simple 'solvency' constraints: $D_i \leq \underbrace{\tilde{\kappa} w_{1,i} a f(h)}_{\substack{\text{amount you pay} \\ \text{if you default}}}, \ \forall i$
  - Solvency constraints likely to bind for *high* realizations of $w_{1,i}$ $\Rightarrow D_i = \tilde{\kappa} w_{1i} a f'(h)$
  - Individuals cannot commit to pay back enough in *high earnings states* to enable full consumption smoothing
- *Perfect smoothing across low earnings states*
- *Only limited insurance in high earnings states*
- The able and high human capital people are constrained
- Where does $\tilde{\kappa}$ come from? (*ad hoc* assumption)

- Optimal human capital investment $h^{LC}(a, W)$ satisfies

$$\bar{w}_1 a f'\left[h^{LC}(a, W)\right]\left[\frac{\sum_{i=1}^{N} p_i w_{1,i}\left(\frac{1+\lambda_i\tilde{\kappa}}{1+\lambda_i}\right)}{\bar{w}_1}\right] = 1 + r = R \quad (14)$$

- *Question*: Prove (14).
- When all $\lambda_i = 0$, the unrestricted allocation is attained
- If any 'solvency' constraint binds, there is under-investment
- Notice $\sum_{i=1}^{N} p_i w_{1,i}\left(\frac{1+\lambda_i\tilde{\kappa}}{1+\lambda_i}\right) < \bar{w}_1$ when $0 < \tilde{\kappa} < 1$ and $\lambda_i > 0$ for some i

- Many similarities to case with full certainty:
  - constraints produce under-investment
  - *default does not occur in equilibrium, since all debt repayments are fully contingent*
  - optimal institutional arrangements would minimize the temptation of default by raising $\tilde{\kappa}$ as high as possible ($\tilde{\kappa} = 1$ produces unconstrained optimal allocations)

Limited Commitment with Incomplete Markets

- Assume no ability to write state contingent contracts
- Now, suppose second period liabilities cannot depend on the state $w_{1,i}$
- Now default may occur in equilibrium
- Assume the same punishments for default with the income forfeiture recovered by lenders
- Let $D > 0$ be the amount of debt individuals 'promise' to repay after school is finished (now no longer state-contingent)
- Individuals actually repay if and only if

$$D \leq \underbrace{\tilde{\kappa} w_{1,i} a f(h)}_{\substack{\text{amount recovered by lenders} \\ \text{from borrowers in state } i}}$$

- Assume that $\tilde{\kappa}$ is the same across all states (strong assumption)
- Weird feature: *lhs* is not state-contingent; *rhs* is
- Default if $w_{1,i} < \tilde{w}_1(D, a, h) \equiv \frac{D}{\tilde{\kappa} a f(h)}$

- Probability of default, $\Pr\left[w_{1,i} < \tilde{w}_1\left(D, a, h\right)\right] = \pi(D, a, h)$, is weakly increasing in D and decreasing in a and h
- In exchange for a 'promise' to pay $D > 0$, risk-neutral lenders extend credit (d in previous notation)

$$d(D, a, h) \equiv Q(D, a, h) = \frac{1}{1+r}\left\{D - \sum_{w_{1,i} < \tilde{w}_1} p_i\left[D - \tilde{\kappa} w_{1,i} a f\left(h\right)\right]\right\} \tag{15}$$

- *Question:* Verify (15) and interpret in terms of the break-even decision of the lender

- Assume $\tilde{w}_1$ falls outside the support of $w_{1,i}$ and, therefore, ignore jumps in the default probabilities
- Unlikely to be satisfied for high wage states (see Lochner and Monge-Naranjo, 2011; 2012)
- Under this assumption, marginal changes in D and h do not affect the probability of default, and the FOC for D is

$$u'(c_0) = E[u'(c_{1,i}) | w_{1,i} \geq \tilde{w}_1]. \tag{16}$$

- Consumption smoothing for the rich
- **Optimal borrowing trades-off the gains in c_0 with the costs on future consumption only in higher income states in which there is repayment**
- Reverses logic of previous case, which produced consumption smoothing for the poor

- Assuming $\tilde{w}_1$ falls outside the support of $w_{1,i}$ (i.e. ignore jumps in default probabilities), optimal h satisfies:

$$\bar{w}_1 a f'(h) \left[\frac{\sum_{i=1}^{N} p_i u'(c_{1,i}) w_{1,i} - \tilde{\kappa} \sum_{w_{1,i} < \tilde{w}_1} p_i u'(c_{1,i}) w_{1,i}}{\bar{w}_1 u'(c_0)(1 - Q_h)} \right] = 1 + r, \tag{17}$$

where $0 < Q_h < 1$ at the optimum
(Intuition: A unit expenditure on h expands credit line less than one unit per unit h)

- Three important differences compared to full insurance:
  1. Additional investment increases expected payments, thereby expanding credit ($\uparrow h$)
  2. Some benefits of investment are lost in the event of default since $0 < \tilde{\kappa} < 1$ ($\downarrow h$)
  3. Lack of insurance implies a precautionary motive for investment; however, the riskiness of human capital can also reduce investment as discussed in Krebs (2003)

- Absence of repayment contingencies has a number of important consequences
  - Default can occur in equilibrium
  - If default happens, it is for low realizations of $w_{1,i}$ when earnings and consumption are low
  - The option to default serves a positive insurance role
  - Eliminating default may be inefficient and could reduce investment
- The policy trade-offs in this model are more interesting than in previous models

- Interest rates, implicitly given by $R(D, a, h) \equiv D/Q(D, a, h) = d(D, a, h)$, contain a premium for the possibility of default
- Higher $R(\cdot)$ must cover for states in which borrowers default
- However, no red-lining or credit restrictions, as in Stiglitz and Weiss (1981, *AER*)
- That is an area that deserves exploration
- Ability directly impacts implicit interest rates and credit limits, since $Q_a > 0$
  - For the same investments h and credit amount Q, more-able individuals need to repay less (lower R)
  - Leads more-able persons to invest further in human capital
- Higher investments coupled with higher liabilities may increase the probability of default

Felicia Ionescu (2008, 2009, 2011):

- A source document for these results
- Analyzes models similar to this to study college enrollment, borrowing, and default decisions when credit is provided by GSL programs
- The degree to which contingencies can be incorporated into repayment schemes can have significant effects on schooling
  - More than hard borrowing constraints, lack of insurance can be the limiting factor for schooling decisions
  - Consistent with the quantitative analysis of Krebs (2003) and structural estimates of Johnson (2011) and Navarro (2010)

Incomplete Contracts with Incomplete Markets

Four distortions affect human capital investment:

- Returns to investment are reduced by fraction κ in default states
  (But what is the optimal $\tilde{\kappa}$?)
- Additional investment improves loan terms by reducing probability of default ('credit expansion effect')
- Imperfect insurance reduces MR on investment, since benefits cannot be spread across future states
- Imperfect intertemporal consumption smoothing reduces MR on investment, since some benefits cannot be accessed while in school

Incomplete Contracts with Incomplete Markets

Empirical implications:

- Default can occur in equilibrium for low income realizations
- Default provides a useful insurance role
- Probability of default is linked to ability and investment decisions
- Loan terms (interest rates) will depend on ability, investment and distribution of shocks

Many attractive predictions, but difficult to justify lack of any contract contingencies

Private Information and Limited Insurance

- Conceptually, the lack of insurance previously assumed could arise from imperfect information
- As such, it is natural to consider some of the lessons and modeling approaches from the vast literature on optimal contracting under private information

Ex Post Asymmetric Information

- Suppose cannot easily observe the ex-post circumstances of a borrower (that was a strong assumption)
- When outcomes can be observed at a cost, the possibility of partial insurance arises
  - Model of *costly state verification* (Townsend 1979)
  - For high realizations of $w_{1,i}$, borrowers would simply repay a fixed amount (avoiding verification costs), while an audit would take place for lower realizations
  - Observing the actual outcome (through verification), lender would provide a constant consumption level to the borrower in 'low' states of the world
  - Worst ex post outcomes would be fully insured against (as opposed to partial insurance implicit in basic income-contingent loan programs)
- See Lochner and Monge-Naranjo (2016)

Moral Hazard in Investment

- Suppose youth must exert unobservable costly effort that affects post-schooling earnings
  - Assume higher returns to effort or a higher probability of graduation for more able individuals
    (e.g. Chatterjee & Ionescu 2010)
- Well-known trade-off between incentives and insurance suggests that some individuals may not obtain adequate credit because lenders foresee (correctly) the toll of debt on effort

Post-School Moral Hazard

- Effort must be exerted to seek, keep and improve one's job after leaving school
- If these efforts are costly and unobserved by the creditor, a high debt may affect labor market outcomes as suggested by Braguinsky and Ohyama (2010)
- Foreseeing post-schooling moral hazard problems, credit is likely to be reduced in the first place
- Optimal unemployment insurance literature generally considers the welfare of workers once human capital has been formed
- Stantcheva (2015) is a recent contribution that endogenizes human capital in these models
- She uses a Diamond-Mirrlees model to show that, as long as education is an intermediate good, no taxation of educational costs is an optimal policy
- Little is known about the joint design of optimal policies that provide both credit for education and insurance against post-schooling labor market risks when moral hazard is a problem

Conclusions

- Evidence suggests that credit constraints may have become more important for higher education in the US
- The significant rise in the costs of and returns to college have increased the demand for credit well beyond the supply available from government programs
- As such, the rapid expansion in private lending over the past 15 years should not come as a surprise
- Providing credit for human capital, however, requires repayment enforceability and raises other incentive problems
- Explicitly incorporating these incentive problems in models of human capital formation can help explain observed cross-sectional patterns and shed new light on schooling responses to policies and economic changes

- The importance of credit constraints extends beyond their impacts on college-going
- Distortions in student consumption and leisure have been documented even during periods when college outcomes were not (e.g., the early 1980s)
- More importantly, recent evidence highlights the adverse impacts family borrowing constraints can have on early investments in children

- Unfortunately, most of the human capital literature has ignored the vast literature on optimal contracts with incentive constraints
- Standard results in this literature can be easily adapted to models of human capital formation, leading to new insights on the way abilities and family resources affect investments in human capital and a better understanding of how to best design government policies.

Future Issues

- Additional work is needed to measure the extent to which early family credit constraints inhibit early childhood investments and affect later educational outcomes and earnings
- Future empirical studies are needed to better understand the skill production technology, especially with respect to the dynamic complementarity of investments from birth through early adulthood
- Given improvements in computing power, additional margins of heterogeneity and realistic life-cycle dynamics can be readily introduced in quantitative general equilibrium models of human capital

- To better understand cross-country differences in aggregate human capital, additional work is needed to consistently measure differences in access to and prices of credit for education
- Additional empirical studies are needed to better understand the extent to which different individual characteristics and choices, as well as government policies, affect repayment of government and private student loans
- Adapting well-known results from the optimal contracts literature to human capital accumulation problems should lead to interesting insights about the impacts of ability and family wealth on schooling as well as the optimal design of government lending programs

- Little is known about the impact of student debt on post-school labor market performance; future studies in this area can shed light on the importance of moral hazard in the design of optimal student loan contracts
- A promising avenue of research is integrating the optimal unemployment insurance literature with the optimal design of credit programs for human capital accumulation

Designing Optimal Student Loan Contracts
(Taken from: Lochner and Monge-Naranjo, 2016)

- Under uncertainty, want to provide credit for school and insurance against adverse labor market outcomes
- Many potential market frictions:
  - Limited commitment/enforcement
  - Unobserved actions & moral hazard
  - Costly income verification
  - Asymmetric information & adverse selection

Challenges in Designing Optimal Contracts

- Under uncertainty, want to provide credit for school and insurance against adverse labor market outcomes
- Many potential market frictions:
  - **Limited commitment/enforcement**
  - **Unobserved actions & moral hazard**
  - **Costly income verification**
  - Asymmetric information & adverse selection

Basic Environment

We consider a simple two-period human capital investment model with labor market uncertainty

- Individual choices
  - Period 0: invest h, consume c_0, and borrow/save d
  - Period 1: work/earn y, consume c_1, repay loans $D(z)$
- Individual endowments:
  - Initial family wealth W
  - Ability a
- Post-school earnings: $y = zaf(h)$ with $z \sim \phi(z)$
  - With moral hazard, $\phi(z|e)$ with FOSD for higher effort

Individuals maximize expected lifetime utility

$$u(c_0) - v(e) + \beta \int u(c_1)\phi(z|e)dz \tag{18}$$

- Lenders lend d. Borrowers pay back $D(z)$ in each state
- Lender participation, or break-even, constraint:

$$d \leq \frac{1}{1+r} \int_z D(z)\, \phi(z|e)\, dz \tag{19}$$

- Assume $\frac{1}{1+r} = \beta$ (as before)

Consumption allocations:

$$\begin{aligned} c_0 &= W + d - h \\ c_1(z) &= zaf(h) - D(z) \end{aligned}$$

First Best

In 'first best', lenders offer unrestricted borrowing with *full insurance*

$$u'(c_0) = u'(c_1(z)) \quad \Rightarrow c_0 = c_1(z), \quad \forall z \tag{20}$$

- Repayments adjust to fully offset shocks to income, eliminating all risk
- Payments increase one-for-one with income, so 'lucky' subsidize 'unlucky' *ex post*
- Can mean negative 'payments' at very low income levels

Human capital investment equates E[MR] with gross return on savings:

$$E[z|e]af'(h) = (1 + r) = R \tag{21}$$

- h is increasing in ability a
- h is independent of wealth W and time preference β

Complete Contracts with Limited Enforcement

Now, suppose lenders can default but must give up fraction $\kappa \in (0, 1)$ of their earnings, with lenders collecting nothing

- Borrower repays iff $D(z) \leq \kappa z a f(h)$
- Lenders write contracts imposing this condition on contracts to avoid default
  - **No default in equilibrium**
- Limits amounts that can be collected from borrowers in high income states
  - Prevents consumption smoothing across high incomes
  - Cannot borrow fully against high income realizations

Human capital investment now satisfies:

$$af'[h] \underbrace{E\left[z\left(\frac{1+\kappa\lambda(z)}{1+\lambda(z)}\right)\right]}_{\geq E[z]} = 1+r \tag{22}$$

- Inability to borrow fully against high earnings states effectively lowers MR on investment
- Reduces investment, especially for low W and high a youth

Incomplete Contracts with Limited Enforcement

Next, consider same potential for default, but restrict contracts so that repayments cannot depend on z

- Constant repayment D cannot provide explicit insurance
- Default provides implicit insurance
- May not be optimal to fully eliminate default
- Default occurs if

$$D > \kappa z a f(h) \quad \Leftrightarrow \quad z < \tilde{z} = \frac{D}{\kappa a f(h)} \tag{23}$$

- Lender break-even constraint requires $d \leq (\frac{1}{1+r})[1 - \Phi(\tilde{z})]D$
  - Interest rate is increasing in probability of default (and amount borrowed)

Four distortions affect human capital investment:

- Returns to investment are reduced by fraction κ in default states
- Additional investment improves loan terms by reducing probability of default ('credit expansion effect')
- Imperfect insurance reduces MR on investment, since benefits cannot be spread across future states
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Empirical implications:

- Default can occur in equilibrium for *low income* realizations
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Many attractive predictions, but difficult to justify lack of any contract contingencies

Costly State Verification

Instead of exogenously ruling out contingencies, suppose lenders must pay cost $\vartheta \geq 0$ to observe/verify a borrower's post-school income

- Contingent repayment $D(z)$ when income is verified: $z < \bar{z}$
  - Can provide full insurance/consumption smoothing across low post-school states: $c_0 = c_1(z)$
- Constant repayment $\bar{D}$ when income is not verified: $z \geq \bar{z}$
  - No contingencies/insurance in high income states
- Yields lower human capital investment due to imperfect insurance across high earnings realizations and inability to fully borrow against high earnings outcomes
- Now the rich are constrained
- Question unanswered – who gets verification?
- Would not people higher in the z distribution want verification?
- This analysis is poorly developed

Comparing CSV with incomplete markets with limited enforcement

- CSV yields endogenous form of market incompleteness
  - Only for good labor market states
- Full insurance for bad labor market states under CSV
  - Low (or even negative) payments for worst outcomes $\rightarrow c_1 > y$
  - Punishments associated with default $\rightarrow c_1 < y$ (default provides much worse insurance)

Moral Hazard

Now suppose lenders cannot observe the borrower's effort $e \in \{e_L, e_H\}$ (during or after school)

- If high effort is to be induced, contract must satisfy an *Incentive Compatibility Constraint*:

$$\beta \int_0^\infty u\left[zaf\left(h\right) - D\left(z\right)\right]\left[\phi\left(z|e_H\right) - \phi\left(z|e_L\right)\right] dz \geq v\left(e_H\right) - v\left(e_L\right) \tag{24}$$

- $c_1(z)$ is strictly increasing in z (if MLRC is satisfied)
- Contract must reward good outcomes with higher consumption to induce effort
- Limits extent of insurance that can be provided
- If low effort is efficient, then full insurance can be provided
    - E.g. high W individuals who place more value on leisure than extra consumption from investment

Educational investments:

- Conditional on effort, investment is equal to the first best level
- Investment decisions are only distorted if effort is distorted
  - Only a problem when high effort cannot be induced
  - Family wealth is irrelevant for investment as long as proper effort is induced
- With a continuum of effort levels, likely that effort (and, therefore, investment) is distorted downward for everyone

Costly Verification & Moral Hazard

Consider contracts when both information frictions co-exist

- At high income levels $z \geq \bar{z}$, verification does not take place and a fixed payment is required, $\bar{D}$
- For low income levels $z < \bar{z}$, verification will occur
  - Moral hazard limits insurance, so $c_1(z)$ is increasing in z
- No default in equilibrium
- Human capital investment will be less than in first best, especially for low W youth

Limited Enforcement & Default

Suppose we also incorporate limited enforcement

- Still have no verification and fixed payment for highest incomes
- Verification and partial insurance for low incomes
- With $\vartheta > 0$, should now think of default as a potential part of the contract
  - Both borrower and lender may prefer default
  - Default only possible, but not ensured, when $\vartheta > \kappa z a f(h)$
- Default even more attractive to lenders if they can capture some of defaulter's losses (e.g. wage garnishment)
- Verification/insurance always dominates default for lowest income realizations

Key Principles and Policy Guidance

What do Current US Student Loan Programs Look Like?

- Borrowing limits
  - Linked to years in school
  - Higher limits for graduate & professional students
- Standard plan has fixed payments for up to 15-25 years
  - Payments only depend on amount borrowed (modest risk premium)
- Forms of insurance:
  - Forbearance & deferment delay payments
  - 'Pay as You Earn'
    - High earners make standard fixed payment
    - Low earners pay up to 10% of discretionary income
    - After 20 years, remaining debt/interest is forgiven
    - Borrowers must apply & qualify
  - Default (triggers collection costs, wage garnishment)

Three Key Principles

- Borrowers should fully repay in expectation
  - Better to offer subsidies directly rather than through loan programs
  - Cross-subsidies can be undermined by private creditors
- Insurance is a central aspect in the design of efficient contracts
  - Explicit insurance best, but default also can play a role
- Incentive problems must be addressed
  - Can limit contracts at both low and high ends of income realizations
  - Also limits the amount that can be borrowed and educational investments

Optimal Structure of Repayments

General points:

- Repayment schedules should depend on student abilities as well as borrowing amounts and investment choices
- Contracts should aim to provide greatest insurance at the bottom
  - Could mean additional transfers to worst-off
  - Other social insurance programs may already do this
- Repayments of most successful can be much higher than amount borrowed plus interest (with modest risk adjustment)
  - Default incentives impose some limits on this
- Default may be efficient if verification costs are non-trivial
  - May not want to completely eliminate default

Summarizing optimal structure of repayments (given a, d, h):

- Fixed payment for highest income realizations due to costly income verification
  - Enforcement concerns may limit this payment level
- Verification and explicit income-contingent repayments for lower income realizations
  - Partial insurance due to moral hazard concerns
  - Payments increasing less than one-for-one in income
- Default can arise for low- to middle-income borrowers
  - Always dominated by explicit insurance at very bottom