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Parental Job Loss, Income Shocks and the Education Enrolment of Youth

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Abstract

Parental job loss from layoffs and business failures that occur when youth complete high school completion are found to be negatively correlated with enrolment at university and community college. Estimates from a year-to-year education transition model using longitudinal data on youth and their parents are employed to identify both immediate and lagged effects of parental job loss on education transitions. It is argued that these results can be interpreted as evidence of a potential causal effect of parental income on youth education attainment, as job losses are likely to have persistent and exogenous negative effects on parental income.

JEL classifications: I29, J63, I39

Keywords: Education, human capital, job loss, income shocks, causal effect.

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1. Introduction

There is overwhelming evidence that educational attainment is positively correlated with parental income. If certain characteristics unobservable to researchers affect both parental income and education outcomes of children, any observed correlation between these two outcomes may not reflect causality. These characteristics may include genetic ability, diligence, culture and preferences. Policies intended to alter the financial resources of youth or their parents may not have the desired effect on education outcomes if the effect of parental income is not causal. In this paper, I attempt to identify whether there is a causal effect of parental income on the subsequent education enrolment outcomes of youth.

Although studies of the relationship between family background and education are numerous, only a few attempt to identify causal effects. Acemoglu and Pischke (2001) find a significant causal parental income effect on education outcomes employing changes in the wage distribution over time. Several other studies, however, have concluded that the causal effect of parental income is small or even zero (Mayer, 1997; Blau, 1999; Levy and Duncan, 2000; Blanden and Gregg, 2004; Shea, 2000). A variety of techniques were employed to identify causal effects, with many relying on changes in income over time within families for identification. The majority of such income changes may, however, only be temporary or chosen by parents, hampering the ability of such techniques to estimate significant causal effects. Families can often smooth consumption over time, by borrowing or running down savings in response to temporary reductions in income.

In this paper, I attempt to identify parental income shocks that are most likely to be persistent and exogenous, and examine whether these particular shocks have significant effects on youth education outcomes. Parental job loss is employed to indicate such shocks. Job loss is identified as job ends due to permanent layoff (redundancy) and employer business failure. Jacobson et al (1993), Stevens (1997) and Oreopoulos et al (2005), among others, have identified the persistent

negative effect that job loss can have on income.

The Canadian Survey of Labour and Income Dynamics is employed in this analysis. The advantage of this data is the ability to measure parental income shocks, and then to analyze the subsequent annual education outcomes of youth. I focus on shocks that occur at the time of normal high school completion, when youth are 16 to 18 years old. Education enrolment outcomes of youth are analyzed from age 16 until age 19 or 20. At age 16, the vast majority of youth are still in high school. The majority of individuals who undertake university study in Canada have begun their studies by age 19 or 20.

The analysis begins with estimation of standard discrete choice models of post-secondary education enrolment. I find that parental job losses correspond with significant reductions in the probability of university and community college enrolment, after controlling for initial parental income levels, parental education and other demographic characteristics.

In addition to standard discrete choice models, I estimate a model of the complete set of annual education attendance outcomes for youth from age 16 to age 19 or 20. Analysis of the full set of education transitions allow us to identify whether parental job loss leads to immediate high school dropout behavior or to lagged effects on university or community college enrolment only. The transitions are analyzed using the framework employed by Cameron and Heckman (2001). I extend their analysis by including parental job loss as indicators of potentially persistent and exogenous negative parental income shocks.

One potential concern with the identification strategy employed is that job loss itself may reflect unobserved characteristics of parents that also affect the education enrolment of youth. The education transition model provides one particular test of the exogeneity of parental job loss. The effect of job loss shocks that occur after an education attendance outcome has occurred are estimated. Such future shocks should have no actual effect, but may have an estimated effect if job losses reflect unobserved heterogeneity. These future job loss indicators were found not

to be statistically significant, providing some comfort that causal effects are being estimated.

Finally, a loss in income related to job loss is estimated to have a large negative effect on university enrolment, while losses in income unrelated to job loss bore no relationship with education outcomes. This result implies that persistent exogenous changes in parental income can have a large effect on university entry, while other potentially temporary income losses have no effect. It is argued that the income loss associated with job loss is having a significant effect on youth education outcomes, not just the job loss experience itself.

This analysis is closest in spirit to the works of Shea (2000), Oreopoulos et al (2005) and Bratberg et al (2008). Shea (2000) attempted to estimate the causal effect of parental income on years of schooling completed by 25 year olds using information from the US Panel Study of Income Dynamics (PSID). Job loss of fathers, along with occupation type and union status, were employed as instruments for long run income levels. Oreopoulos et al. (2005) estimate the effect of Canadian father job loss due to firm closures when youth are aged 12 to 14 on three main economic outcomes measured when the youth is 13 to 18 years older. The three outcomes were: five year average earnings, unemployment benefit receipt and social assistance receipt. Significant and large effects in the hypothesized directions were found, which were interpreted as evidence of causal intergenerational income effects. Bratberg et al (2008) analyze the effect of Norwegian father job loss when youth are aged 12 to 14 on the earnings of the youth when they are aged in their late twenties. In contrast to Oreopoulos et al. (2005), the authors find no discernible effect of father job loss on child earnings in Norway.

The outline of the paper is as follows. A brief description of the Canadian post-secondary education system is provided in Section 2. The SLID longitudinal data set is described in Section 3. Standard model estimates of the effect of parental job loss on post-secondary education enrolment outcomes are presented in Section 4. Estimates from the education transition model are presented in Section 5. Estimates of the effect of parental income shocks on education

outcomes are provided in Section 6, while Section 7 concludes.

2. Canadian post-secondary education system

The majority of universities and community colleges in Canada are financed and regulated by provincial governments. University is the Canadian equivalent of four year college study in the US. In 2002/03, university tuition for arts undergraduate programs ranged from a low of $1,668 to a high of $5,000 per year across Canadian provinces, with tuition increasing considerably in many provinces over the preceding ten years. Tuition is thus comparable with levels charged by public four year colleges in the US. Entrance to university in Canada requires twelve years of study at elementary and high school in most provinces. In the province of Quebec, however, youth must complete two years of study at a community college (collège d'enseignement général et professionel or *CEGEP*) after grade eleven to enter universities in that province. The majority of universities in Ontario required a thirteenth year of high school study for university entrance over the vast majority of the period analyzed. This thirteenth year of study was dropped for the cohort entering university in 2002/03, resulting in the "double cohort" of grade 12 and grade 13 completers both entering university during the same academic year.

Community college and trade school are denoted as "other" post-secondary education in this analysis, which is a lower level of education than a university bachelor degree. Entry into these institutions do not necessarily require completion of high school. Canadian community colleges provide both vocational courses and academic courses for potential transfer to university, thus are similar to two year colleges in the US. Community college tuition ranged from a low of zero to a high of $2,500 per year across Canadian provinces during 2002/03.

Only students from lower income backgrounds can access government-guaranteed loans to assist in funding their studies. The main sources of these loans are the Canadian Student Loan Program and Québec's Aide financière aux études program. The Quebec program provides

some funds as non-repayable grants, but only to the most needy students. Between 40 and 50 per cent of post-secondary graduates have student debts at the end of their studies (Finnie, 2001). The amount a student can borrow under these systems is determined by a quite complex calculation. The amount is firstly a function of study costs: tuition, ancilliary fees, books, travel, and a living allowance that depends on whether the student must leave the parental home to study. The amount is also a function of assumed parental contributions, which are based on parental income and the number of dependent children. There are also maximum weekly or annual loan limits that may override the calculated loan eligibility amount. These limits were around $9,000 to $10,000 for a standard academic year of study during the period under analysis. The majority of loan eligibility amounts for youth still living with their parents are lower than these limits.

These student loans are subsidized by the provincial and federal governments, as no interest is payable until the student leaves full-time study. There are also provisions for loans or loan interest to be written off in the case of severe financial hardship. Note also that many universities also provide small scholarships and bursaries directly to students. This type of student support has increased in the 1990s as tuition has increased. The federal government now also provides some scholarships ($1,000 to $5,000) to students who are both from low income backgrounds and perform well in the first year of university study, under the Canadian Millennium Scholarship Fund program. This program started disbursing funds to students in 2000.

3. Data

3.1 *Survey of Labour and Income Dynamics (SLID)*

The Survey of Labour and Income Dynamics (SLID) is a longitudinal survey of Canadian households. Approximately 15,000 households are sampled for inclusion every three years. Once a household is chosen, all its original members are interviewed annually for six years,

even if some members leave the household. This survey feature is especially important here as youth completing high school may leave the parental home to either work or study. Youth who leave the household are tracked to their new residence and continue to be surveyed annually. The second major advantage of the SLID is the availability of information on the income and labor market outcomes of parents for each year. Having annual measures of both parental outcomes and the education enrolment of youth is a particular advantage of this data over the major representative micro data sets employed to analyze US education outcomes.[1]

The first longitudinal panel of the SLID runs from 1993 to 1998, the second from 1996 to 2001, and the third from 1999 to 2004. I employ information on youth from these first three panels in the analysis. Youth are first observed at age 16 and still in high school, prior to making their own decisions on education attendance. At this age, 98 per cent of youth still live with at least one parent. Thus accurate parental information is obtained for almost all youth.

Education enrolment outcomes of youth are observed from age 16 until 19 or 20. Youth have had the opportunity to obtain the pre-requisites for university and community college entry by these ages. The majority of individuals who attend university and community college begin by these ages, with initial entry falling considerably at older ages. I follow youth from Ontario and Quebec one additional year (to age 20) as it takes one more year of study to obtain the pre-requisites for university entry in those provinces, as described above. As a result, Quebec and Ontario youth aged 15 or 16 at the start of each panel, and youth aged 14, 15 or 16 in the remaining eight Canadian provinces, are included in the analysis. After exclusion of observations with missing information due to panel attrition and missing data (non-response), the final sample covers 1,837 individual youth from a potential sample size of 4,247. See Appendix A for details of sample construction.

[1]The PSID does not contain detailed yearly education enrolment information for youth. The NLSY does not collect annual parental income and labor market outcomes for youth who leave the parental home.

Table 1: Post-secondary education enrolment of youth by institution type and parental income

		Parental Income		
	All Youth	Low	Middle	High
University	0.32	0.21	0.31	0.42
Other post-secondary	0.36	0.34	0.38	0.36
Neither	0.32	0.45	0.31	0.22

Notes: 1,837 Observations. Proportions of youth with any attendance up to 2nd year after high school (age 20 in Quebec and Ontario, age 19 in remaining 8 provinces) from first three panels of SLID. Parental income groups constructed using average real parental income over three years when youth aged 16 through 18. See Appendix B for further details.

3.2 *Post-secondary enrolment*

Post-secondary education enrolment rates for youth are presented in the first column of Table 1. Overall, 32 per cent of youth were enrolled in university and 36 per cent were enrolled in other post-secondary education (primarily community college). Enrolment is defined as any amount of attendance from age 16 to age 19 or 20, so it identifies entry into post-secondary education. The next three columns of Table 1 present enrolment rates for youth from low, middle and high parental income backgrounds separately. Note the strong relationship between parental income level and university enrolment, but little relationship with other post-secondary enrolment. This is consistent with the findings of previous research using Canadian data.

3.3 *Parental job loss*

Parental job loss is defined as a main job ending during the year due to: (a) redundancy or permanent layoff, or (b) employer going out of business. Survey respondents could identify any of twenty five reasons for job ends, including retirement, finding another job, seasonal job

ends, dismissal, and the end of a temporary contract job. Job loss is identified for both the main income earner and the spouse in each family. Main income earner status was self reported by households. For two parent families, three quarters of main income earners were male, while only a quarter of lone parents were male. Lone parent families comprised 15 per cent of the sample.

Significant proportions of parents suffered job losses over the period under analysis. Among main income earners, 8.3 per cent suffered at least one job loss during the three years when the youth was aged 16 through 18. For spouses, the corresponding figure is 8.5 per cent. In the analysis to follow, it is main income earner rather than spousal job loss that is particularly important in having both persistent negative effects on parental income and large negative effects on the education outcomes of youth.

The persistent negative effect that main income earner job loss has on parental income is illustrated in Figure 1. The depicted income levels are total annual real after tax parental income (2001 Canadian dollars).[2] If the main income earner parent suffers a job loss when the youth is aged 16, a significant and persistent decline in parental income is observed (line denoted "job losers"). Parental income remained over $10,000 (19 per cent) lower than pre job loss levels four years after the initial job loss. Main income earner parent income fell by $12,000 itself due to the main income earner job loss, while spousal income offset this decline marginally. Where the main income earner parent does not suffer any job losses over these five years, real parental income grew by around 8 per cent (line denoted "non-job losers").

The effect of job loss on the income levels of spouses, rather than main income earners, was much less significant. Annual spousal after tax income was on average only $1,500 lower four years after an initial job loss. This more muted response to job loss can mostly be attributed

[2]This figure shows averages for a sub-sample of the sample employed in the main analysis, as it includes only those parents where a full five years of income data is observed.

to the average starting level of spousal income being much lower than that for main income earners, averaging only $15,000 per year.

4. Parental job loss and youth enrolment

The objective in this section is to estimate the effect of parental job loss on the post-secondary education enrolment of youth, employing a simple estimation strategy. The estimated effects are also broken down by certain parental characteristics such as education levels.

4.1 *Estimated model*

Standard multinomial logit is employed to investigate the post-secondary enrolment of youth among the following three outcomes: (a) attend university (4 year college), (b) attend other post-secondary education only (primarily community college), and (c) not attend post-secondary education at all. The estimates can be interpreted within a framework of youth choosing the education option that maximizes their net expected lifetime utility. This utility is a function of the expected benefits of education, such as higher wages and perhaps direct utility (or dis-utility) from studying. The costs of education include direct costs such as tuition, and indirect costs such as the opportunity cost of time spent studying. Transfers from parents can assist youth directly to finance their educational pursuits. The choice between university and other post-secondary education is a function of the higher wage premia paid to university graduates, and perhaps higher prestige. It is also a function of the higher costs of obtaining a university degree, including higher tuition each year, more years of study, and perhaps more effort required to pass courses.

A list of covariates included in the estimated models is provided in Table 2, along with sample summary statistics for both the sample employed and the observations that could not be used (see Appendix A). These covariates include measures of parental education, number of children in the family, gender, and indicators of distance to the closest university and com-

munity college. I also include a flexible three section spline function of real after tax parental income when the youth is aged 16. The function has five elements: income in levels, indicators of parental income quantile (low and high - middle income is the missing category), plus interactions of income in levels and these two income quantile indicators. Direct utility from education attendance is a function of the individual abilities and preferences of youth. This direct utility is proxied by many of the individual and parental characteristics listed in Table 2. These characteristics may also proxy any individual specific component of wage premia expectations. Usher (2005) finds that youth expectations of the costs and benefits of post-secondary education differ significantly by parental income and education in Canada. Year indicators are included to account for any changes in the average expected university and community college wage premia over time.[3] The opportunity cost of time while studying is proxied by provincial youth unemployment rates, which reflect the probability of youth obtaining employment. Beaudry et al (2000) found that education attendance is counter-cyclical in Canada. Province indicators are also included to control for differences in education and welfare systems across Canada.

Finally, and most importantly, I include parental job loss in the estimated models. These indicators may capture the effect of unexpected reductions in parental income on attendance. If these reductions in income are expected to be persistent, or if parents cannot access funds to smooth over temporary income declines, reductions in transfers to children may result. This in turn may lower university and other post-secondary education enrolment. Analysis and further discussion of interpreting the effect of parental job loss on youth education enrolment as reflecting parental income effects is provided in Section 6.

4.2 *Enrolment model results*

Average marginal effects from the multinomial logit estimation are presented in Table 3.

[3] Direct measures of wage premia showed no significant variation in Canada over the period.

Table 2: Summary statistics for regressors in estimated models and in sample not used

	Sample Used		Sample Not Used	
Variable	mean	s.d.	mean	s.d.
Female	0.488		0.490	
French-speaking	0.195		0.182	
Aboriginal descent	0.025		0.031	
Visible minority	0.086		0.117	
Immigrant parent	0.235		0.236	
Lone parent	0.163		0.204	
Parents less than high school	0.108		0.157	
Parents other post-secondary only	0.433		0.401	
Parent completed university	0.206		0.183	
Parental income when youth aged 16[1]	\$66,472	\$47,500	\$66,057	\$58,074
Dependent children	2.75	1.47	2.77	1.41
University $>$ 80 km away[2]	0.204		0.181	
Community College $>$ 40 km away[2]	0.135		0.126	
University tuition[1,2]	\$3,010	\$840	\$3,003	\$892
Community College tuition[1,2]	\$1,347	\$739	\$1,299	\$791
University financial aid (per student)[1,2]	\$766	\$330	\$794	\$346
Observations	1,837		2,410[3]	

Notes: 1. These variables measured in real 2001 Canadian dollars. 2. Sources provided in Appendix B. 3. Lone parent status and parental income only identified for 2,316 observations, parental education for 2,303 observations, and dependent children for 2,224 observations.

The effects represent the effect of each variable on the probability of attending university (column 1), other post-secondary education (column 2), and any post-secondary (column 3) respectively. These effects are generally in line with previous research. Females are much more likely to enrol in university than males. Youth of aboriginal descent are much less likely to enrol in university, while visible minorities and youth with an immigrant parent are more likely. Visible minority youth are predominantly from Asian backgrounds in Canada. Youth from lone parent families are less likely to attend university, even controlling for parental income. Parental education is strongly positively related to the probability of university enrolment. Parental income levels have less significant effects, but parental education may reflect permanent income more accurately than this single year income measure. Prior research has also found that long-run income measures are more closely related to child and youth education outcomes than single year measures (Mayer, 1997; Blau, 1999). University tuition has a significant negative effect on university enrolment, while living further than eighty kilometers (50 miles) from the nearest university had a statistically insignificant effect. Frenette (2004) found significant negative effects of distance on attendance using SLID data but in more parsimonious models.

These results illustrate clearly that university enrolment in Canada is not equal, an outcome mirrored in many countries. Youth from more advantaged backgrounds (higher parental income and highly educated parents) are much more likely to attend university. The covariates have much less significant effects on other post-secondary enrolment (column 2 of Table 3). In particular, parental education and income have economically small effects.

The final row of Table 3 reports the estimated effect of parental job loss on youth enrolment. It is the effect of any job loss by the main income earner (MIE) parent during the three years when the youth is aged 16 through 18. There is a significant negative effect of such job losses on the overall post-secondary education enrolment of youth (column 3), although the estimated effects on university and other post-secondary separately are not statistically significant. The

Table 3: Multinomial Logit average marginal effects on enrolment

Variable	University	Other Post-secondary	Any Post-secondary
Female	17.4***	-3.3	14.1***
	(3.5)	(2.3)	(2.6)
French-speaking	-16.5***	12.9	-3.6
	(5.5)	(8.3)	(5.1)
Aboriginal descent	-16.2**	3.7	-12.5
	(6.8)	(8.9)	(10.1)
Visible minority	19.5***	-1.7	17.8***
	(5.8)	(6.6)	(5.9)
Immigrant parent	8.8***	-4.9	3.9
	(3.4)	(4.8)	(4.7)
Lone parent	-8.7*	1.7	-7.0
	(5.3)	(4.2)	(4.2)
Parents less than high school	-10.2*	-7.2	-17.4***
	(6.2)	(5.3)	(6.7)
Parents other post-secondary only	7.5***	0.2	7.7***
	(2.7)	(3.4)	(3.3)
Parent completed university	26.5***	-4.8	21.6***
	(5.0)	(3.4)	(3.8)
Low parental income[a]	-1.6	-7.5	-9.1***
	(5.0)	(4.7)	(3.3)
High parental income[a]	5.6**	-1.4	4.2
	(2.3)	(2.9)	(3.5)
Dependent children [+1]	-1.1	0.9	-0.2
	(1.1)	(0.8)	(0.8)
University $>$ 80 km away	0.8	-4.6	-3.8
	(3.3)	(3.0)	(3.7)
University tuition [+$1,000]	-6.4*	-0.1	-6.5
	(3.3)	(4.8)	(5.1)
Job loss of MIE	-8.6	-4.7	-13.3**
	(5.5)	(7.0)	(5.4)

Notes for Table 3 on next page.

Notes: 1,837 observations. Effects denote change in probability from turning indicator variables from 0 to 1 and increasing continuous variables by amount in brackets. Clustered standard errors (by province and year) in parentheses. 1, 2 and 3 *'s denote significance at the 10, 5 and 1 per cent levels respectively. Tuition difference, provincial unemployment rates, university financial aid, plus city, rural, time, province, community college $>$ 40 km away and Ontarian double cohort indicators also included.

a. Parental income when youth was aged 16 was controlled for using a flexible three section spline. Marginal effects for these parental income indicators reflect a change in income from median income in the middle income quantile ($47,250) to median income in the low ($26,700) and high ($73,200) income quantiles respectively.

point estimates suggest a larger negative effect on university than on other post-secondary enrolment, but the estimates are not significantly different from each other.

Several additional models of enrolment that included alternative measures of parental job loss were also estimated. Marginal effects from these additional models are gathered in Table 4 for ease of comparison. Note that the full set of covariates employed in the model of Table 3 were included in each of the estimated models. The marginal effects for job loss by the main income earner (MIE) are taken directly from the bottom row of Table 3, and reproduced in Panel A. In contrast to MIE job loss, spousal job losses have no significant effect on enrolment (Panel B). This difference in effects most likely reflects the larger income declines suffered by main income earners post job loss. As noted above, spousal job losses had much smaller negative effects on parental income levels than main income earner job losses.

A potential concern with the estimation strategy here is that parental job loss may not be exogenous. If a company is losing money, management may be able to lay off the least able and motivated (least productive) workers first. Job losses due to business failure do not have this particular feature. All workers in the firm lose their jobs when the firm goes out of business.

Table 4: Average marginal effects of alternative parental job loss measures on enrolment

	University	Other post-secondary	Any post-secondary
		Panel A	
Job loss of MIE	-8.6	-4.7	-13.3**
	(5.5)	(7.0)	(5.4)
		Panel B	
Job loss of Spouse	-1.1	6.0	4.9
	(7.8)	(7.9)	(4.6)
		Panel C	
Business failure job loss (MIE)	-12.0	-2.9	-14.9*
	(9.9)	(12.0)	(9.1)
Permanent layoff job loss (MIE)	-7.3	-4.7	-11.9**
	(5.5)	(5.9)	(6.1)
		Panel D	
Parent high school or less $\times$ MIE job loss	-7.8	-13.6**	-21.4**
	(9.8)	(7.0)	(9.0)
Parent post-secondary $\times$ MIE job loss	-9.1*	2.9	-6.1
	(5.3)	(9.8)	(7.8)

Notes: 1,837 observations. Marginal effects denote percentage point change in probability of enrolment resulting from each job loss shock. Clustered standard errors (by province and year) in parentheses. 1, 2 and 3 *'s denote significance at 10, 5 and 1 per cent levels respectively. Full set of covariates (as in Table 3) also included in estimated models.

Oreopoulos et al. (2005) chose to focus exclusively on worker displacement due to firm closures in their analysis. Estimates of the effect of job loss separated by reason (permanent layoff versus business failure) are presented in Panel C of Table 4. The two estimated effects are essentially of the same magnitude.

Moving now to Panel D of Table 4, the negative effect of MIE parental job loss on other post-secondary attendance is confined to parents with a high school education or less, while there are similar sized negative effects of job loss on university attendance for both parent education groups. There is thus a much larger effect of job loss on the overall post-secondary enrolment of youth with less educated parents. More educated parents may find it easier to obtain another well paying job after a job loss. The income decline over the three years after a job loss suffered by parents with only a high school diploma or less was found to be larger than the decline suffered by parents with a completed post-secondary education. In addition, more educated workers may have earned more prior to the job loss, resulting in higher savings to smooth spending more easily.

I analyzed several more breakdowns of the effect of parental job loss on post-secondary enrolment. Job loss effects were not more negative in provinces with higher university and community college tuition levels, nor for youth living a long distance from education institutions. The negative effect of job loss was no larger in families with more children. The effect of job loss was also not related to local unemployment rates. There is no asset or wealth information in the SLID, but there is an indicator of whether the house the family lives in is owned by a household member. The effect of job loss was found to be less negative for parents who owned their own home versus those who rented. The results of these additional breakdowns are available upon request.

To interpret the estimated effect of parental job loss on youth education outcomes as a causal effect requires job losses to be unrelated to unobservable characteristics of parents that may di-

Table 5: Linear probability model estimation of the probability of parental job loss

	Coefficient	Standard error
French-speaking	-0.043	0.070
Aboriginal Descent	-0.001	0.055
Visible minority	0.080	0.052
Immigrant parent	-0.031	0.024
Lone parent	0.053	0.036
Parents less than high school	-0.074**	0.032
Parents other post-secondary only	-0.041	0.032
Parent completed university	-0.104**	0.040
Parental income level when youth aged 16 [+$1,000]	0.000	0.000

Notes: 1,837 observations. Clustered standard errors (by province and year) in parentheses. 2 *'s denote significance at 5% level. Time, province, city & rural indicators also included.

rectly affect the education outcomes of their children. The results of a simple linear probability model estimation of the probability of parental job loss are presented in Table 5. Job loss was more prevalent for parents with a high school education only (the missing or base parental education category). Conditional on education, however, there is no relationship between initial parental income levels and job loss. The estimated effect is both statistically insignificant and economically small. Finding that job loss is unrelated to initial income provides some support for the claim that families subject to job loss are similar to those not subject to such loss. In other words, the treatment and control groups in this estimation are roughly comparable. This is obviously not proof of the exogeneity of job loss, but it is comforting. Note that the implementation of a particular test of the exogeneity of parental job loss is discussed in Section 5.

Parental income for those parents who subsequently lose their job may already be on a downward path prior to the job loss. Jacobson et al (1993) and Stevens (1997) both estimated a downward trend for the wages of workers who subsequently lost their job in the US. Bratberg et al (2008) also found such a downward trend using Norwegian data. As a result, initial income levels may not be an adequate control for unobserved family effects in estimates of the effect of job loss on youth education outcomes. Oreopoulos et al (2005), on the other hand, found no such downward trend in their analysis using Canadian data. Consistent with this Canadian research, I found no downward trend in income for subsequent job losers in the year prior to an initial job loss in the SLID data. Any potential bias in the estimated results stemming from falling income profiles prior to job loss should thus be small here.

5. Education transition model

In this section, I estimate a model of the full set of annual education enrolment outcomes of youth from age 16 to age 19 or 20. This model is employed to identify both the immediate and lagged effects of parental job loss on youth education outcomes. Such identification is

particularly important when considering the timing of possible policy interventions. Using this model, I also construct one particular test of the exogeneity of these job loss indicators to provide further support for the claim that a causal effect is being estimated.

5.1 *Education transitions*

Education attendance is a sequential process. To complete high school, youth first complete grade eleven. To attend university, youth must first complete high school. I explicitly model annual education outcomes here while imposing these sequential constraints on each youth's education alternatives. Youth are first observed during the year they turn 16 and still in high school, having completed either nine or ten years of school. Youth are generally unable to leave school before they turn 16 in Canada. A school year is commonly completed in the middle of a calendar year, with the next grade or level of education beginning in September.

The first education transition observed is from age 16 to age 17. Youth who complete grade ten at age 16 can stay in school and complete grade eleven during the year they turn 17, they can attend other post-secondary education such as community college, or they can drop out of education altogether. They cannot attend university yet. Youth in grade nine at age 16 can also drop out, attend other post-secondary education or progress to grade ten.

The second transition is from age 17 to age 18. Youth who completed grade eleven during the year they turn 17 can complete grade twelve in the middle of the calendar year they turn 18 and then progress to university. They can also go on to other post-secondary education, just complete high school, or drop out prior to completion. Youth must generally complete twelve years of school to attend university. The exceptions are youth from Quebec and Ontario, as discussed in Section 2. These exceptions are modeled explicitly here. Youth in grade ten at age 17 can progress to grade eleven, attend other post-secondary education or drop out. They cannot attend university yet. Youth who dropped out of school during the first transition can

stay out, return to school, or attend other post-secondary education.

The third transition from age 18 to age 19 includes transitions for youth who have completed twelve years of school, and those attending other post-secondary education. Youth who attend university are no longer modeled, as university is the highest level obtainable. A fourth transition from age 19 to age 20 is estimated for youth from Ontario and Quebec, to give youth from those provinces the extra year they require to obtain the pre-requisites for university entrance.

5.2 *Econometric model*

The estimation strategy employed follows Cameron and Heckman (2001). Let a denote age, where $a \in \{\underline{a}, ..., \overline{a}\}$, with $\underline{a}$ being the initial age of 16 and $\overline{a}$ denoting the highest age observed (19 or 20). Schooling status at age a is j_a, and this status will determine the available schooling choices at age $a+1$. Youth with schooling level j_a make a decision about their schooling level at age $a+1$ from choice set C_{a,j_a}. Let $D_{a,j_a,c} = 1$ if choice $c \in \mathsf{C}_{a,j_a}$ is chosen by a youth aged a with schooling status j_a. Let $D_{a,j_a,c} = 0$ otherwise, that is, where some $c' \neq c$ is chosen instead, where $c' \in \mathsf{C}_{a,j_a}$ also.

Each education outcome is the result of a rational decision. Youth calculate the expected utility $V_{a,j_a,c}$ from each available choice c, then choose the one that maximizes utility. This utility calculation will include the option value of further education attendance in many cases. For example, continuing in school keeps open the option of attending university. The utility of each choice is approximated by a linear equation as follows.

$$V_{a,j_a,c} = \mathbf{Z}'_{a,j_a,c}\mathbf{b}_{a,j_a,c} + \varepsilon_{a,j_a,c} \tag{1}$$

The vector $\mathbf{Z}'_{a,j_a,c}$ is a set of observable characteristics while $\varepsilon_{a,j_a,c}$ is unobservable. The unobservable is assumed to follow the following simple factor structure.

$$\varepsilon_{a,j_a,c} = \alpha_{a,j_a,c}\eta + \nu_{a,j_a,c} \tag{2}$$

Here η is a mean zero random variable that is independent of $\nu_{a,j_a,c}$. Both η and $\nu_{a,j_a,c}$ are assumed independent across youth. The random variables $\nu_{a,j_a,c}$ are assumed to follow extreme value distributions, and are assumed independent of all other $\nu_{a',j_a'',c'''}$. These assumptions produce an extension of the multinomial logit model. Conditioning on η yields the following, where the matrix $\mathbf{Z}_{a,j_a}$ denotes the set of vectors $\mathbf{Z}_{a,j_a,c}$.

$$\begin{aligned}\Pr(D_{a,j_a,c'}=1|\mathbf{Z}_{a,j_a},\eta) &= \Pr(\arg\max_c V_{a,j_a,c}=c'|\mathbf{Z}_{a,j_a},\eta) \\ &= \frac{\exp(\mathbf{Z}'_{a,j_a,c'}\mathbf{b}_{a,j_a,c'}+\alpha_{a,j_a,c'}\eta)}{\sum_{c\in\mathsf{C}_{a,j_a}}\exp(\mathbf{Z}'_{a,j_a,c}\mathbf{b}_{a,j_a,c}+\alpha_{a,j_a,c}\eta)}\end{aligned} \tag{3}$$

The main consequence to note from the assumptions of this model is that any dependence between choices $D_{a,j_a,c}$ and $D_{a',j_a'',c'''}$ ($a \neq a'$) made by an individual youth, conditional on observable characteristics, arises from η, the youth specific unobserved effect. To account for this dependence, estimation involves integrating out the η using an approximation of its distribution $F(\eta)$. The approximation employed is a discrete distribution with mass points. The estimated likelihood function is provided in Appendix C.

This estimation technique is a form of random effects estimation, and is based on the assumption that η is independent of the observable characteristics of youth. Although η is assumed independent of observable characteristics in the overall sample, it may be correlated with characteristics in any one of the particular estimated transitions ($a > \underline{a}$). This is due to the observations undertaking a particular transition beyond the initial condition being only a certain subset of the overall sample. Selection into each subset is conditional on past education outcomes. If η reflects ability, for example, it may be negatively correlated with parental income for youth remaining in school beyond age $\underline{a}$. A correlation will arise if having low parental income increases dropout behavior, so only high η youth from low income backgrounds remain in school beyond the minimum age.

5.3 *Estimation preliminaries*

Each education transition was estimated including the characteristics listed in Table 2. Provincial measures that change over time were entered at the appropriate level for that year. For example, tuition levels when a youth was aged 17 are included in the first transition. I included parental job loss indicators only in transitions that occurred after the job loss itself was suffered. An indicator of job loss when the youth was aged 16 was included in the first transition. An indicator of job loss when the youth was aged 16 or 17 was included in the second transition, and so on. Parental job losses could thus affect current and future education transitions but not past ones.

The initial condition estimates the probability of whether youth have completed nine or ten years of school by age 16. This outcome depends on whether a grade of school was repeated prior to age 16, or if the youth started school a year later than normal. This initial condition is modeled with an equation such as 3, including the set of characteristics of Table 2 plus three quarter of birth indicators. The factor loading $\alpha_{\underline{a},j_{\underline{a}},c}$ on the unobserved component η was set to one here.

For each decision among a set of choices C_{a,j_a}, one vector of parameters $\mathbf{b}_{a,j_a,c}$ must be normalized in order to identify the remaining parameters for that decision. Denote the choice c_a^* as the normalization or base case. The parameters in $\mathbf{b}_{a,j_a,c^*}$ and the factor loading α_{a,j_a,c^*} were constrained to zero within each choice set. As a result of this normalization, the remaining estimated coefficients and factor loadings are defined relative to those for the base case.

In several transitions, the number of observations undertaking a particular choice was too small to estimate the set of slope coefficients. Choices with fewer than 30 observations were estimated with a constant only. Factor loadings on the unobserved characteristic η were also set to zero for these choices. This procedure follows that employed by Cameron and Heckman (2001). Note that only three per cent of all observed transitions were estimated with constants

only.

The model was estimated both with and without controlling for unobserved heterogeneity η. In contrast to Cameron and Heckman (2001), controlling for unobserved heterogeneity did not change the coefficient estimates to any significant extent, but estimates of standard errors did increase. Only two points of support were required to adequately capture the distribution of the unobservable η. This low number is common in estimation of models such as this.

5.4 *Education transition model results*

I employ the parameter estimates of the education transition model to simulate the effect of parental job loss on the education outcomes of youth from age 17 to age 19 or 20. The simulation results are presented in Table 6. They depict an average treatment effect. Treatment effect construction involved simulating twice the estimated probability of each annual education outcome. Probabilities were simulated setting the appropriate job loss indicator to zero, then simulated again setting the indicator to one. The difference between the two simulated probabilities, averaged over all youth (with appropriate SLID weights), is the estimated effect.

Looking at Panel A of Table 6, parental job loss at age 16 has only small effects on immediate education outcomes. The probability of dropping out of high school before age 17 is essentially unchanged for youth who suffer from the parental shock. Attendance at other post-secondary education institutions increases a little, but this effect is not statistically different from zero.

Turning now to Panel B, parental job loss at ages 16 and 17 increased school dropout behavior by age 18 by a small amount, but the effect is only statistically significant at the 20 per cent level. There is a statistically significant negative effect of such shocks on other post-secondary education enrolment, but no effect on university enrolment.

In Panel C of Table 6, the effects of parental job loss on the education enrolment of youth

Table 6: Effect of parental job loss on enrolment outcomes by age, education transition model

	Age 16 shock	Age 17 shock	Age 18 shock
Age 17 Outcome		**Panel A**	
Dropout	0.4 (3.0)		
Still in high school	-2.4 (3.6)		
Other post-secondary	2.0 (1.5)		
Age 18 Outcome		**Panel B**	
Dropout	3.4 (2.4)	3.4 (2.1)	
Still in high school	0.9 (3.6)	1.9 (3.5)	
Other post-secondary	-4.3* (2.2)	-5.3** (2.4)	
University	-0.0 (2.2)	0.5 (2.2)	
Final Outcome		**Panel C**	
Dropout	2.7 (1.9)	2.7 (1.7)	-0.6 (0.8)
Still in high school / HS graduate	6.0 (4.2)	6.6 (4.4)	3.3 (3.7)
Other post-secondary	-4.8 (3.3)	-4.9 (3.2)	1.0 (3.4)
University	-3.9 (3.7)	-4.3 (3.6)	-3.6 (3.6)
Any post-secondary	-8.7*** (3.0)	-9.3*** (3.0)	-2.6 (2.3)

Notes: 1,837 Observations. Standard errors in parentheses (see Appendix C for details). 1, 2 and 3 *'s denote statistical significance of effects at 10, 5 and 1 per cent levels respectively.

by age 19 or 20 (the final age in this analysis) are presented. Job losses at ages 16 and 17 have significant negative effects on post-secondary enrolment overall, but the effects are not significant separately for university or other post-secondary education. This is consistent with the results presented in Table 4, as would be expected. The estimated effect of these age 16 and 17 shocks on school dropout behavior is positive, but again not statistically significant. Age 18 shocks have small and insignificant effects on education enrolment.

In all, 26 individual job loss indicators were estimated in the education transition model. Jointly the set of job loss indicators were highly statistically significant. A likelihood ratio test of joint significance yielded a probability value of 0.00003 when unobserved heterogeneity was ignored, and a probability value of 0.00002 when the estimator included the unobserved heterogeneity terms. [4]

5.5 *Exogeneity test*

As discussed above, a primary concern in attempting to identify a causal effect of parental job loss on youth education outcomes is the potential presence of unobservable characteristics that affect both parental job loss and youth education outcomes. The education transition model provides the basis for constructing a test of whether these job losses are indeed exogenous. The procedure involves including in estimated transitions additional indicators of new job losses that occur after the education transition has actually occurred. Such future job losses should not affect education transitions, but they may reflect unobserved heterogeneity. If such future losses are found to affect the estimates of the model, it would imply that job losses may not be exogenous.

The exogeneity test involved adding a future job loss indicator to each estimated transition equation. This indicator was set to one if the parent suffered a new job loss in any of the years up

[4] Five of these estimates were individually statistically significant at the five per cent level.

to when the youth was aged 19, but after the education transition had occurred. For example, in the first transition (age 16 to age 17), an indicator was added that denoted whether the parent of the youth suffered a new job loss at any age from when the youth was 17 to 19. These additional indicators were constructed for new job losses only. If a youth's parent had already suffered a job loss in a prior period (a multiple job loser), the new job loss indicator was set to zero. An indicator of whether parents suffered a job loss at any age of the youth from 16 through 19 were also placed in the initial condition equation (grade in school at age 16).

A likelihood ratio test of the joint statistical significance of these added future job loss indicators failed to reject the null hypothesis of insignificance. The test statistic had a probability value of 0.38 when unobserved heterogeneity was ignored, and a value of 0.46 when the model included the unobserved heterogeneity terms. Note also that none of the 18 estimated coefficients on the future job loss indicators were individually significant at the five per cent level.[5]

The insignificance of future job losses in the education transition model provides some evidence to support the view that these job losses are exogenous. In addition, including these post-transition (future) job loss indicators in the model did not alter the estimated effects of the relevant job loss shocks on education transitions to any extent. In particular, the significant negative effect of the correct job loss indicators on post-secondary education attendance remained after inclusion of these extra job loss indicators.

6. Job losses as identifying causal parental income effects

The results of the previous two sections highlight a significant negative effect of parental job loss on the post-secondary education enrolment of youth. This highlights a particularly alarming consequence of labor market displacement on the children of displaced workers. The question remains, however, of whether this finding can be interpreted as evidence of a causal

[5] In this test, 18 of 24 possible future job loss indicators could be separately estimated. The remaining 6 could not be identified as job loss was a relatively rare event.

effect of parental income on post-secondary enrolment.

Parental income may directly affect the post-secondary education outcomes of youth as transfers from parents can assist youth to fund education investments. Education attendance is costly, both from direct tuition costs, and from the opportunity cost of time spent studying. Parents may make transfers to their children given a desire for positive outcomes for their children. Such transfers will generally be a function of parental income and wealth.

According to the Permanent Income Hypothesis, if families experience a shock to income that is expected to be temporary, they may be able to smooth consumption over time, and not have to reduce transfers to children. The ability to smooth consumption will be based on past savings and the availability of credit. If parents experience a large negative shock to income that is expected to be persistent, however, parents may have to reduce transfers to children in order to maintain a desired standard of living. In addition, youth may not be willing to accept transfers from parents suffering from permanently and unexpectedly lower income levels.

To interpret the effect of parental job loss as an income effect requires that income falls as a result of the loss, and that it is the income loss that is causing the reduced post-secondary enrolment of youth rather than the job loss experience itself. We observed in Figure 1 the significant negative effect that parental job loss has on parental income. This finding is directly in line with previous research. Jacobson et al (1993) found that earnings reductions after a job loss due to mass layoff are 25 per cent even six years after the initial loss. Stevens (1997) found that displaced US workers in the PSID earn 9 per cent less six or more years after a job loss. Oreopoulos et al (2005) found that Canadian parental income reductions are a considerable 9 per cent even eight years after an initial job loss suffered by fathers due to firm closures. The father's earnings alone were 16 per cent lower. Thus job losses result on average in persistent and unexpected negative shocks to income.

In order to estimate the effect of parental income shocks on the post-secondary education

Table 7: Average marginal effects of parental shock measures on enrolment

	University	Other post-secondary	Any post-secondary
Job loss of Main income earner	-5.6	-3.2	-8.8
	(7.1)	(8.7)	(6.5)
Job loss of MIE ×	0.53**	-0.12	0.41**
income change [+$1,000]	(0.25)	(0.19)	(0.19)
No job loss ×	0.05	-0.00	0.05
income change [+$1,000]	(0.05)	(0.08)	(0.08)

Notes: 1,837 observations. Marginal effects denote percentage point change in probability of enrolment resulting from each variable. Clustered standard errors (by province and year) are in parentheses. 1, 2 and 3 *'s denote significance at 10, 5 and 1 per cent levels respectively. Full set of covariates (as in Table 3) are also included in estimated model.

enrolment outcomes of youth, an additional multinomial logit model of youth education outcomes was estimated. The basic model of Table 3 was extended by including a measure of the change in parental income over the three years from when the youth was aged 16 to aged 19 interacted with the job loss indicator, and interacted with one minus the job loss indicator. The results of this estimation are presented in Table 7. Only the marginal effects for the income change interacted with the job loss indicator and the job loss indicator itself are reported, but all the parental and individual variables that were included in the model reported in Table 3 were also included here.

This three year change in parental income should reflect a persistent and exogenous decline in income for job losers. Note the large and significant effect of income changes associated with job loss on the university attendance of youth. In contrast, an income change unrelated to job loss has essentially no effect on education outcomes. The estimated marginal effect of the job loss indicator itself is negative, as it was in Table 3, but the effect is smaller here and no longer statistically significant. Thus it is the income change related to job loss that is having a

particularly significant effect on education outcomes, not merely the job loss itself.

So why do income changes unrelated to job loss appear to have no effect on education outcomes? Such income changes may not be shocks at all, and many changes may be temporary. Some income declines may reflect large temporary increases in income in previous years, perhaps due to investment income. Some changes may reflect working decisions in the family. The results in Table 7 suggest that potentially temporary income shocks (or even chosen income changes) can be smoothed by families with little impact on the education outcomes of their children. Thus parents do not appear to be subject to binding short-term credit constraints, as these potentially temporary shocks did not affect youth education outcomes. Job loss, on the other hand, results in a persistent and most likely unexpected shock to income. It is these particularly persistent and exogenous income changes that have a marked effect on the education enrolment of youth.

The large effect of income changes associated with job loss on education outcomes may be due in part to their unexpected nature. Families on higher income levels who expect such levels to continue may make spending commitments that are difficult to alter in response to a negative income shock. The size of the effect of a shock to parental income on youth education outcomes may be larger than the size of the effect of a lower level of parental income that is expected. Lower expected levels of income may be planned for by families, with subsequently smaller effects on transfers to children and thus education outcomes. Despite this caution on interpreting the size of the effect, the results still imply a significant effect of parental income on university enrolment.

Given this focus on shocks at ages 16 through 18, only a potential causal effect of parental income in assisting youth to finance post-secondary study can be identified here. This strategy will not identify other potential causal effects of parental income on post-secondary education attainment, such as by altering the early learning outcomes of children. Parental income may be

spent on investments at the pre-school, elementary, and secondary school levels, increasing the preparedness of youth for post-secondary study. The focus on post-secondary education entry, however, provides additional evidence to inform the ongoing debate on whether individuals face financial constraints in their post-secondary education pursuits.

Student loans were available to youth from low income backgrounds in Canada during the period, yet the above results imply that youth may face credit constraints. Many youth may, however, be unwilling to borrow to finance their own education investments, even if the expected payoff to education appears large. Individual investments in higher education are risky, and youth generally cannot insure against the individual risk of their human capital investments. There are several risks involved, including course completion risk and income return risk. Student loans overcome loan market incompleteness, but not insurance market incompleteness. Parents can assume some of the risk of a youth's education investments with transfers.

The results in Table 7 suggest that the negative effect of parental job loss on education enrolment may be due in part to the job loss itself rather than solely due to the income decline associated with it. Parental job loss and subsequent unemployment may lower the self esteem of the parent and disrupt the family environment, which in turn may directly affect the education outcomes of youth. There was no evidence in this SLID data, however, that job loss was related to reduced health or increased stress of adults. Starting in 1996, survey respondents were asked to rate their health and level of stress on five point scales. These self reports were no worse for job losers prior to the job loss than for non-losers, nor did the reports deteriorate for job losers over the five years after a loss. This suggests that such psychological explanations of the effect of parental job loss on youth education outcomes may not be particularly important here.

Parental job loss may also change a youth's expectations of the riskiness of employment and earnings. Investments in education may appear more risky to youth whose parents lose jobs. Affected youth may be more concerned that they cannot repay any student loans if they

themselves lose jobs or cannot find appropriate employment. Unemployment rates and the probability of job loss, however, are lower for the well educated, so youth should rationally surmise that higher education levels will lower employment risk. It is not possible to analyse this issue with the SLID data, however, as no measures of employment or earnings expectations are available.

The implication of this analysis that financial constraints on post-secondary education attendance may be significant contrasts with the claim of Carniero and Heckman (2002) that at most 8 per cent of the US population is subject to short-term credit constraints. This claim is based in large part on the methodology and findings of Cameron and Heckman (1998, 2001). The evidence provided to support the claim is that once achievement test scores, parental education and other demographics are controlled for, only a very small empirical relationship remains between parental income and post-secondary educational attainment. Armed Forces Qualifying Test (AFQT) scores are employed as the measure of achievement. The authors argue that these test scores reflect long-term investments in education and innate ability, and these factors are the underlying drivers of post-secondary education outcomes, not parental income. This identification procedure implicitly employs the assumption that the AFQT scores themselves are unresponsive (exogenous) to the costs of financing post-secondary education. That is, youth and their parents are not forward looking (do not anticipate future financial constraints) when making investments in education during and prior to school. This point is made by Keane and Wolpin (2001), Acemoglu and Pischke (2001), and Ellwood and Kane (2000).

An alternative estimation strategy is employed in this analysis to identify potential financial constraints on post-secondary education outcomes. I first condition on initial parental income level, parental education and demographics. Post-secondary enrolment rates are then compared between youth whose parents suffered an exogenous and persistent negative income shock (job loss) and those that did not. The strategy thus does not rely on the exogeneity of AFQT test

scores, which is hotly debated.

7. Conclusions

There remains considerable debate about whether the observed correlation between parental income and education attainment has any causal element. Apart from Acemoglu and Pischke (2001), prior research attempting to identify causal effects often found only small or no effects. Related research has also claimed that financial constraints on post-secondary education decisions are also small.

This study provides evidence implying the existence of significant causal parental income effects on youth education outcomes. Large and potentially persistent parental income shocks associated with job loss are estimated to have large negative effects on the post-secondary education enrolment of youth. The empirical strategy employed here focussed exclusively on parental shocks occurring when youth are of high school leaving age. The estimates thus imply that financial constraints on the post-secondary education choices of youth may well exist. This in turn suggests that subsidization of post-secondary education, perhaps closely targeted, may be an important component in any strategy aimed at reducing the gap in the post-secondary education enrolment between youth from low and high parental income backgrounds.

Youth who have responded to parental job loss by not attending university immediately after high school may subsequently enter university in later years, after working to save the necessary funds themselves. Youth are observed until age 19 or 20 in this analysis, so it is not possible to observe any significantly delayed entry here. Even delayed entry is costly for youth, however, as they can earn the higher wages of post-secondary graduates for fewer years.

As has been demonstrated by a number of researchers, job loss has large and persistent negative effects on family income. Such job loss may, however, have additional effects on a family, such as increased stress and household movements in search of employment. These

non-financial factors may also have contributed to the effects on youth education outcomes estimated here. Nonetheless, the results highlight alarming evidence of the intergenerational consequences of labor market displacement that has received little prior attention.

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Appendix A: Details of Sample Employed in Estimation

Of the 4,247 youth in the SLID data of the appropriate age for inclusion in this study, 1,837 were employed during estimation (43.3%). The reasons why 56.7% of potential observations could not be used are as follows. (1) Youth not observed in data at age 16 - 3.9% of all observations; (2) youth not living with any parent at age 16, so no parental information - 2.2%; (3) family attrition from SLID - 12.5%; (4) parental non-response to at least one labour outcome question - 26.9%; (5) youth attrition from SLID - 3.8%; (6) youth non-response to education questions - 2.8%; and (7) youth with invalid or highly unusual education outcomes - 4.7%.

If a sample member did not respond to the SLID questionnaire or to any variable required for the analysis in one year but did in later years, they were still excluded. Thus a full balanced panel was employed. The largest loss item was from parental non-response to the relevant parental shock measures such as job loss. Such non-response could be due to non-response to the entire questionnaire or to non-response to specific labour market outcome questions.

Youth deemed to have invalid education transitions included those youth reporting to be already at university or community college at age 16, or reporting completion of 12 or 13 years of high school by that age. A small number of youth also reported education transitions that did not accord with a normal education progression. For example, some youth reported completion of grade nine at age 16, and university attendance at age 17.

Summary statistics for both the sample of observations employed and the remainder of the sample that could not be employed are presented in Table 2. There are some differences in parental and youth characteristics between the two samples: visible minority, lone parent, parents with less than high school education, and parents with other post-secondary education but no higher.

Appendix B: Variable Construction Methods and Alternative Sources

The majority of information employed in the analysis was taken from the Canadian Survey of Labour and Income Dynamics (SLID). The following variables were constructed using information both from the SLID and from alternative sources. Information from alternative sources was attached to SLID respondents using province of residence, house location, and year in sample.

1. Parental income quantiles were constructed separately by cohort to deal with real wage growth over time.

2. Indicators of distance to closest university and community college were constructed using latitude and longitude of residence of each youth at age 16. Latitude and longitude of institutions were constructed using postal codes (data compiled by Frenette, 2004). Postal codes were transformed into latitude and longitude using Statistics Canada's Postal Code Conversion File (PCCF). Straight line distances were constructed as follows:

$$\text{D} = 6,370.997 * \cos^{-1}[\sin(lt_y) * \sin(lt_i) + \cos(lt_y) * \cos(lt_i) * \cos(lg_y - lg_i)]$$

Latitude (lt) and longitude (lg) were measured in radians by dividing degrees and decimals by 57.29578. Subscripts y and i refer to locations of youth and education institutions respectively.

3. Average community college tuition by province was obtained from the Manitoba Council on Post-Secondary Education.

See: "http://www.copse.mb.ca/en/ documents/statistics/index.htm".

4. University tuition by province was constructed from individual university tuition for undergraduate arts programs (within-province students). Data from 1994/95 provided by Statistics Canada's Centre for Education Statistics. Prior to 1994/95, data taken from Statistics Canada's "Tuition and living accommodation costs for full-time students at Canadian degree granting

institutions" publication. Province averages calculated using 1997/98 university full-time enrolment as weights. University enrolment obtained from Statistics Canada's Cansim cross-tabulation 580701.

5. Province unemployment rates obtained from Statistics Canada's Cansim II table 282-0002.

6. Annual aggregate university-provided financial aid data by province were provided directly by Statistics Canada's Centre for Education Statistics. These numbers were divided by aggregate full-time enrolment at universities within each province.

7. All variables that were constructed in real terms used the Canada-wide Consumer Price Index, obtained from Cansim II table 326-0001.

Appendix C: Grade Transition Model Estimation Details

Denote $d_{a,j_a,c}$ as the realized value of $D_{a,j_a,c}$. Abbreviate the initial condition to $d_{\underline{a},c}$. Schooling status at age a (denoted j_a) is equal to the choice made at age $a-1$, denoted c_{a-1}. Define a history H of education outcomes for an individual:

$$H \;=\; (D_{\underline{a},c} = d_{\underline{a},c},\; D_{\underline{a}+1,c_{\underline{a}},c} = d_{\underline{a}+1,c_{\underline{a}},c},\; ...,\; D_{\overline{a},c_{\overline{a}-1},c} = d_{\overline{a},c_{\overline{a}-1},c}) \tag{A1}$$

Conditioning on the observables $\mathbf{Z}$ and a particular value for the unobservable η_i, the probability of observing the above history can be defined as:

$$\begin{aligned}\Pr(H|\mathbf{Z},\eta_i) \;=\; &\prod_{c\in C_{\underline{a}}} [\Pr(D_{\underline{a},c} = d_{\underline{a},c}|\mathbf{Z}_{\underline{a}},\eta_i)]^{d_{\underline{a},c}} \cdot \prod_{c\in C_{\underline{a}+1},c_{\underline{a}}} [\Pr(D_{\underline{a}+1,c_{\underline{a}},c} = d_{\underline{a}+1,c_{\underline{a}},c}|\mathbf{Z}_{\underline{a}+1},\eta_i)]^{d_{\underline{a}+1,c_{\underline{a}},c}} \\ &\cdots \prod_{c\in C_{\overline{a}},c_{\overline{a}-1}} [\Pr(D_{\overline{a},c_{\overline{a}-1},c} = d_{\overline{a},c_{\overline{a}-1},c}|\mathbf{Z}_{\overline{a}},\eta_i)]^{d_{\overline{a},c_{\overline{a}-1},c}}\end{aligned} \tag{A2}$$

At each age after the initial condition ($a \in \{\underline{a}+1, ..., \overline{a}\}$) there is a separate probability product term for each schooling status c_{a-1}. The superscript variables ($d_{\underline{a},c}$, etcetera) are indicators that pick out the appropriate elements of the education history H for a particular

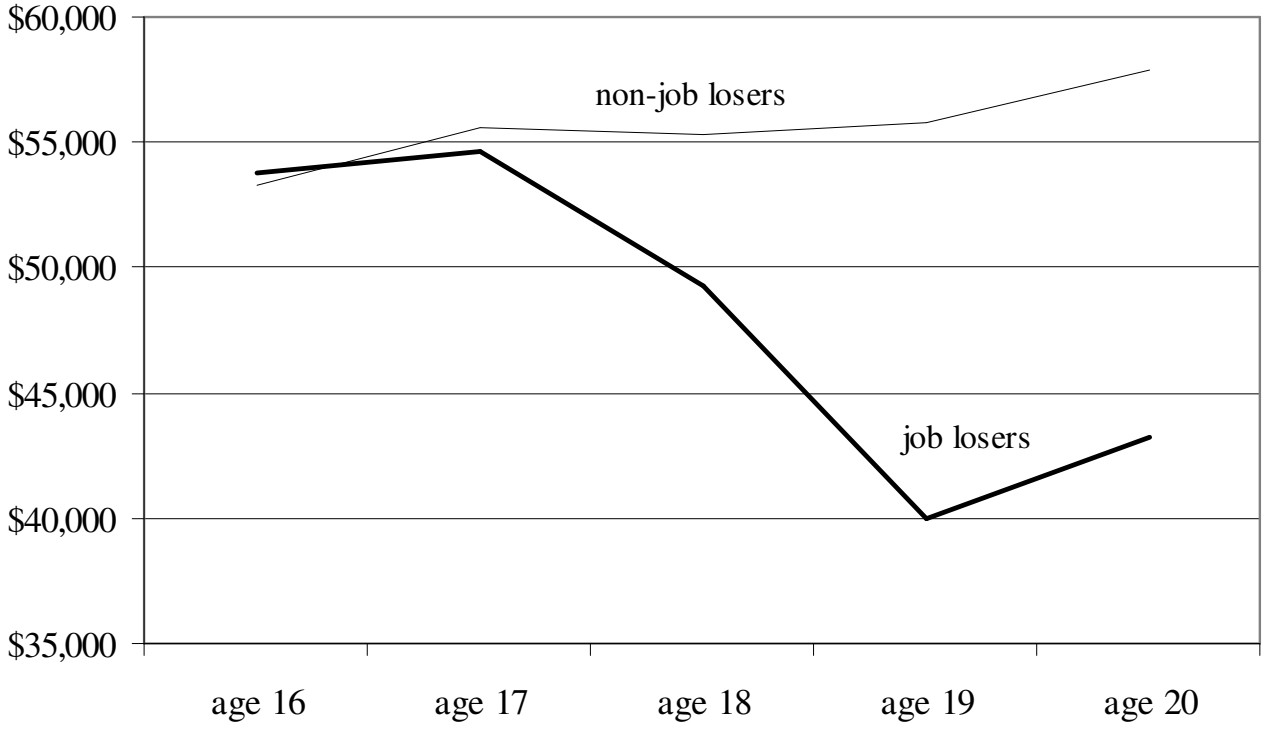
observation. The probability of each education transition and the initial condition are modeled using the functional form in equation 3. The log-likelihood function L that is maximized during estimation is:

$$L = \ln \left[\sum_{i=1}^{I} \Pr(i) \cdot \Pr(H|\mathbf{Z}, \eta_i) \right] \tag{A3}$$

Here the probability $\Pr(i) \geq 0$ is associated with mass point η_i, and where $\sum_{i=1}^{I} \Pr(i) = 1$ is imposed. Estimation revealed that two mass points ($I = 2$) were sufficient to characterize the data. The probability $\Pr(1)$ and mass point η_2 are both estimated, while $\Pr(2) = 1 - \Pr(1)$ and $\eta_1 = 0$. The distribution of η was estimated recursively, identifying $\Pr(1)$ from estimation of the initial condition at age 16.

Standard errors on the simulated effects of Table 6 were constructed by taking 500 random draws from the estimated distribution of model parameters (the estimated covariance matrix), assuming these parameter estimates are normally distributed, and simulating treatment effects using each random draw.

Figure 1: Parental Income Effects of Shocks Occurring When Youth are Aged 16



(real after tax income in 2001 Canadian dollars, job loss of main income earning parent)