ONLINE APPENDIX

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Online Appendix for “Parental Support, Savings and Student Loan Repayment” by Lance Lochner, Todd Stinebrickner, and Utku Suleymanoglu.

Appendix A Serious Repayment Problems

The outcome variable used in the text is an indicator that includes a comprehensive list of repayment problems. The Tables A1-A4 reproduce Tables 2-5 using an outcome indicator that includes only the more serious repayment problems of delinquency or default; Figure A1 reproduces Figure 2.

Appendix B Default and Full Repayment Following Consolidation

In this appendix, we consider the implications of the CSS sampling scheme, which did not include borrowers who had fully repaid their loans or had defaulted as of the date the samples were drawn (a few months before each CSS). This may raise some concerns if a sizeable fraction of the sample is systematically excluded.

We first examine when borrowers first enter default or repay their loans in full relative to the date of consolidation. To do this, we use the 2010 and 2011 CSS, since we have follow-up administrative loan records for these individuals that continue for a few years. To ensure that we do not lose any borrowers due to full repayment or default, we consider a sample consisting only of borrowers who had not yet consolidated their loans at the time of the CSS. Specifically, we limit our sample to those who consolidated their loans from the month of the CSS up to nine months after the CSS. In Figure B1, we include those borrowers who we observe for at least 12 months after consolidation, while Figure B2 includes a more limited sample of borrowers who we observe for at least 24 months after consolidation. Both figures report the fraction of borrowers that had entered default or fully repaid their loans by months since consolidation. Figure B1 includes 248 borrowers, while Figure B2 includes 115 borrowers.

Not surprisingly, we observe no defaults until month 11. Borrowers are not considered in default until they have missed nine consecutive payments, and the timing is such that this does not get recorded as a default until month 11 in our data. Figures B1 and B2 suggest that about 5% of borrowers never make any initial payments and enter default as early as possible. Over the next few years, another 3-4% enter default. In the paper, we include individuals who were administered the CSS within the first 24 months after consolidation. Averaging across all potential months, our sample excludes less than 5% of the population who would have been in default at the time the sample was drawn. Limiting the sample to those administered the CSS within the first twelve months after consolidation would exclude a negligible population in default. (Indeed, since the samples were drawn 2-3 months prior to the CSS, we are unlikely to be missing anyone due to default when limiting our sample to those taking the CSS within 12 months of consolidation.)

Figures B1 and B2 suggest that our samples are more likely to exclude borrowers who fully repaid their loans, since 3-4% repay their loans prior to or at the time of consolidation, while another 10% repays their loans over the course of the first year after consolidation. Averaging across all potential months within the first 24 months after consolidation suggests that our main sample is missing slightly more than 10% of the population who had fully repaid their loans. Limiting our sample to those taking the CSS within the first year after consolidation would reduce this exclusion to a little under 10%.

Altogether, our main sample is missing roughly 5% of the population who defaulted fairly quickly and another 10-15% who paid off their loans quickly. By limiting the sample to those administered the CSS within one year of consolidation, we would no longer miss anyone who defaulted and would miss around 7-8% of those who fully repaid their loans shortly after leaving school. Most of the full repayment exclusions would be due to borrowers who fully repaid their loans before any payments were actually due. In this case, we could simply re-interpret our results to apply to borrowers who do not fully repay their loans immediately after leaving school.

To see whether these omissions affect our results, Table B1 reports results analogous to those of Table 3 in the paper using the more restricted set of borrowers who consolidated their loans no more than one year (rather than two years as in the paper) prior to the CSS. While the results are less precise due to the smaller sample, the estimated coefficients are quite similar to those reported in column 4 of Table 3 and column 4 of Table A2 . These results suggest that the (odd) sampling scheme of the CSS does not have important implications for our main results.

Appendix C Living at Home as a Form of Parental Assistance

Recent research in other contexts (e.g. Kaplan, 2012) has recognized that financial assistance from parents often comes in the form of housing. To account for this, we modify our measure of parental assistance to incorporate this possibility. For Appendix Tables C1 and C2 (analogous to Figure 2 and column 1 of Table 4 in the text), we set the parental assistance indicator to one if any of the following are true: (1) the respondent could expect to receive $2,500 or more from parents/family in the next six months if needed, (2) the respondent could move in with parents/family if necessary, or (3) the respondent already lives with their parents. The results in Tables C1 and C2 strongly support the conclusion that savings and parental assistance are critical forms of insurance for low-earning borrowers, significantly reducing the likelihood of repayment problems.

Appendix D RAP payment amounts

In this Appendix, we describe important rules for RAP determining repayment amounts.

Consider the repayment for a borrower with debt d and family income y in some period. The standard debt-based *required payment* $p(d, i, T)$ depends on initial debt d, the interest rate i, and amortization period T:

$$p(d, i, T) = d\Big[\frac{i(1+i)^T}{(1+i)^T - 1}\Big].$$

RAP also prescribes an income-based *affordable payment* $a(y)$, which is given by the following formula for an unmarried borrower with no children (as of June 2014):

$$a(y) = \max\Big\{0, \min\Big\{0.2y, 1.5\Big(\frac{y - 1434}{25000}\Big)y\Big\}\Big\}.$$

The RAP payment $r(d, y)$ equals the lesser of the debt-based required payment $p(d, i, T)$ and the income-based affordable payment $a(y)$.[1]

In Stage 1 of RAP, the required payment $p(d, i, T)$ is based on an amortization period T of 120 months (10 years) less any months since leaving school that the borrower has paid interest (i.e. made required payments). Interest does not accumulate when the borrower pays the lesser affordable payment; however, the outstanding principal is only reduced by the payment amount.

After 60 months of making reduced affordable payments or after 120 months since leaving school, whichever is sooner, borrowers move to Stage 2 of RAP. In Stage 2, borrowers continue to pay the lesser of the required payment $p(d, i, T)$ and affordable payment $a(y)$ with two differences: (i) the required payment is based on the outstanding balance amortized over 180 months (15 years) less days since leaving school, and (ii) the outstanding principal is reduced as if the required payment were made each month. The last point means that the government effectively forgives any payment amounts that are not covered by the income-based affordable payment, with all debt forgiven after 15 years since entering repayment.

D.1 RAP calculations in CSS and SLID analyses

In all of our calculations, we assume that borrowers are unmarried and have no children, since we are primarily focusing on early years out of school. Borrowers have the option of choosing a fixed annual interest rate of prime + 5% or a floating rate of prime + 2.5%. In practice, nearly all borrowers choose the floating rate, which has been 5.5% for many years. We assume this rate unless otherwise stated.

Our CSS analysis uses the monthly formulas above to calculate RAP payments. This analysis excludes 3% of our sample that is from Manitoba, PEI or Yukon, since income-contingent RAP payments in these provinces also depended on loan amounts. RAP income-based payments were calculated based on the mid-points of reported monthly earnings categories in the CSS (0, 1-$799, $800-1599, $1600-2499, $2500-3299, $3300-4999, $5000-6699, and $6700+). The scheduled monthly payment amount is reported in administrative records. This reflects what borrowers are expected to pay (including any reductions if they are on RAP).

Since the SLID data only contain annual measures of earnings and total student debt at the end of school, this analysis uses the annual analogues for the repayment formulas above to calculate standard and RAP payments.

D.2 RAP income-based payments vs. income-based payments in Australia, the United States and United Kingdom

Figure D1 graphs the annual RAP affordable payment amount as a function of income along with similar income-based payment amounts from the (optional) PAYE program in the U.S. and repayment amounts for the Australia and U.K. (universal) income-contingent loan systems.[2] Clearly, the income-based repayment amounts are higher under RAP than in other countries. It is important to note, however, that repayments under both RAP and PAYE cannot exceed

[1] This formula assumes unmarried borrowers with no children. More generally, the affordable payment $a(y)$ would depend on family income (rather than own income) and family size for married borrowers and those with children.

[2] All amounts have been translated into Canadian dollars based on exchange rates from September 30, 2014. We assume borrowers are single and childless in calculating repayment amounts.

the standard debt-based amounts, so Canadian and American borrowers with modest debt levels and high incomes may pay much less than the income-based amounts shown in the figure. For example, Figure D1 shows the standard payment (dotted line) for a borrower with an initial debt of \$20,000 assuming a 5.5% interest rate (the relevant floating rate in Canada for several years).[3] These borrowers would pay no more than \$2653 under RAP regardless of their income. Thus, borrowers with high incomes and low debt levels may actually pay less under RAP (and PAYE) than in Australia and the U.K.

Appendix E Technical Details and Proofs

E.1 Government Student Loan Program

Implicit differentiation of equation (4) yields the following:

$$\begin{aligned}\frac{\partial G}{\partial d} &= Ru'(c_2^S) > 0 \\ \frac{\partial G}{\partial y} &= u'(c_2^I)\,(1-\xi'(y)) - u'(c_2^S) \\ \frac{\partial G}{\partial \tau} &= u'(c_2^I) - u'(c_2^S).\end{aligned}$$

If $G(y,d;\tau) > 0$, then $\frac{\partial G}{\partial y} < 0$ and $\frac{\partial G}{\partial \tau} < 0$. This follows from strict concavity in $u(\cdot)$ and $\xi'(\cdot) \geq 0$. The assumptions that $\xi(\underline{y}) = 0$ and $d > 0$ imply that $G(\underline{y}, d; \tau) > 0$, so the gains from applying for income-contingent repayments are positive and decreasing in earnings at the very low end. As income rises, the gains may turn negative if $\xi(y)$ becomes sufficiently high.[4]

Implicit differentiation of equation (5), yields the following:

$$\begin{aligned}\frac{\partial \hat{y}}{\partial d} &= \left[\frac{u'\left(c_2^S(\hat{y})\right)}{u'\left(c_2^S(\hat{y})\right) - (1-\xi'(\hat{y}))\,u'\left(c_2^I(\hat{y})\right)}\right] R > 0 \\ \frac{\partial \hat{y}}{\partial \tau} &= -\left[\frac{u'\left(c_2^S(\hat{y})\right) - u'\left(c_2^I(\hat{y})\right)}{u'\left(c_2^S(\hat{y})\right) - (1-\xi'(\hat{y}))\,u'\left(c_2^I(\hat{y})\right)}\right] < 0 \\ \frac{\partial \hat{y}}{\partial \psi} &= -\frac{1}{u'\left(c_2^S(\hat{y})\right) - (1-\xi'(\hat{y}))\,u'\left(c_2^I(\hat{y})\right)} < 0,\end{aligned}$$

where the inequalities follow from strict concavity in $u(\cdot)$, $c_2^I(\hat{y}) > c_2^S(\hat{y})$, $0 \leq \xi(\hat{y}) < Rd$, and $\xi'(\cdot) > 0$.

During the schooling period, students choose borrowing d and effort e to maximize expected utility U defined in equation (1) subject to the borrowing constraint (3) and repayment decision rule given by equation (6). We leave the conditioning of $\tilde{y}$ on $(d;\tau,\theta)$ implicit in some cases to simplify expressions.

[3] The standard payment would be about \$150 less in the U.S. due to its lower interest rate (4.29%).

[4] It is possible that the gains are increasing in earnings (or parental transfers) over some regions at which the gains are negative; however, once the gains become negative, they cannot become positive again by further increases in earnings (or transfers).

The first order condition (FOC) for student debt d is:

$$u'(c_1)+\beta\left[\frac{\partial\tilde{y}}{\partial d}\phi(\tilde{y}|e)\left[u(\tilde{y}+\tau-\xi(\tilde{y}))-\psi\right]-R\int\limits_{\tilde{y}}^{\infty}u'(y+\tau-Rd)\phi(y|e)dy-\frac{\partial\tilde{y}}{\partial d}\phi(\tilde{y}|e)u(\tilde{y}+\tau-Rd)\right]=\lambda$$

where $\lambda \geq 0$ is the Lagrange multiplier on (3). Because $\frac{\partial\tilde{y}}{\partial d}[u(\tilde{y}+\tau-\xi(\tilde{y}))-\psi-u(\tilde{y}+\tau-Rd)]=0$,[5] this expression simplifies considerably to:

$$\begin{aligned}u'(c_1) &= R\beta\int\limits_{\tilde{y}}^{\infty}u'(c_2^S(y,d))\phi(y|e)dy+\lambda\\ &= R\beta(1-\Phi(\tilde{y}|e))E[u'(c_2)|y\geq\tilde{y},e]+\lambda,\end{aligned}$$

as shown in equation (7). If borrowing is unconstrained, then $\lambda = 0$ and $u'(c_1) \leq R\beta E[u'(c_2)|e]$. If $\lambda = 0$, $R\beta \geq 1$ and $u'''(\cdot) \leq 0$, then

$$u'(c_1)\leq E[u'(c_2)|e]\leq u'(E[c_2|e]) \qquad \text{and} \qquad c_1\geq E[c_2|e].$$

When preferences are neutral with respect intertemporal consumption allocations in terms of time discounting (i.e. $\beta R = 1$) and prudence (i.e. $u'''(\cdot) = 0$), expected consumption falls after school in the absence of any borrowing constraints.

Optimal effort choices must satisfy the following interior FOC:

$$\begin{aligned}v'(e) &= \frac{\partial}{\partial e}\left[\int\limits_{\underline{y}}^{\tilde{y}(d;\tau)}\left[u(y+\tau-\xi(y))-\psi\right]\phi(y|e)dy+\int\limits_{\tilde{y}(d;\tau)}^{\infty}u(y+\tau-Rd)\phi(y|e)dy\right]\\ &= \frac{\partial}{\partial e}\left[\int\limits_{\underline{y}}^{\tilde{y}(d;\tau)}u(y+\tau-\xi(y))\phi(y|e)dy+\int\limits_{\tilde{y}(d;\tau)}^{\infty}u(y+\tau-Rd)\phi(y|e)dy\right]-\psi\frac{\partial\Phi(\tilde{y}|e)}{\partial e}\\ &= \frac{\partial}{\partial e}\int\limits_{\underline{y}}^{\infty}u(c_2(y))\phi(y|e)dy-\psi\frac{\partial\Phi(\tilde{y}|e)}{\partial e}\\ &= \frac{\partial E\left[u(c_2(y))|e\right]}{\partial e}-\psi\frac{\partial\Phi(\tilde{y}|e)}{\partial e}.\end{aligned}$$

E.1.1 $\partial \mathbf{E}[\mathbf{u}'(\mathbf{c_2}(\mathbf{y}))|\mathbf{e}]/\partial \mathbf{e} < 0$ Condition

We now discuss conditions that guarantee that the expected marginal utility of post-school consumption is decreasing in effort: $\partial E[u'(c_2(y))|e]/\partial e < 0$.

The following known result is useful and is written as a lemma for reference below.

[5] This result holds, because $u(\tilde{y}+\tau-\xi(\tilde{y}))-u(\tilde{y}+\tau-Rd)=\psi$ for $\tilde{y}=\hat{y}$; otherwise, $\frac{\partial\tilde{y}}{\partial d}=0$.

Lemma 6 *Let $g(y)$ be a non-negative absolutely continuous function of y with $y \geq \underline{y}$. Suppose $\Phi(y|e')$ first order stochastically dominates $\Phi(y|e)$. If $g'(y) < 0$, then $\int_{\underline{y}}^{b} g(y)\phi(y|e')dy < \int_{\underline{y}}^{b} g(y)\phi(y|e)dy$ for all $b > \underline{y}$.*

Proof:

Using integration by parts,

$$\int_{\underline{y}}^{b} g(y)\phi(y|e')dy \; - \int_{\underline{y}}^{b} g(y)\phi(y|e)dy = g(b)[\Phi(b|e') - \Phi(b|e)] - \int_{\underline{y}}^{b} g'(y)[\Phi(y|e') - \Phi(y|e)]dy,$$

which is strictly negative due to assumptions on $g(y)$, $g'(y)$, and FOSD. □

Based on this lemma and our assumptions that $u(\cdot)$ is strictly increasing and strictly concave, it is clear that if $c_2(y)$ is positive, strictly increasing, and absolutely continuous in y, then $\partial E[u'(c_2(y))|e]/\partial e < 0$.

We also consider cases for which $c_2(y)$ is not continuous and strictly increasing in y. In particular, when $0 < \psi < G(\theta, d; \tau)$, consumption drops at the eligibility threshold θ (i.e. $c_2^I(\theta) > c_2^S(\theta)$) but is everywhere else strictly increasing and continuous in y. We now derive conditions that continue to ensure that $\partial E[u'(c_2(y))|e]/\partial e < 0$ even with the discontinuous drop at θ.

For $0 < \psi < G(\theta, d; \tau)$, we have $\tilde{y} = \theta$ and integration by parts yields:

$$\begin{aligned} E[u'(c_2(y))|e] &= \int_{\underline{y}}^{\theta} u'(c_2^I(y))\phi(y|e)dy + \int_{\theta}^{\infty} u'(c_2^S(y,d))\phi(y|e)dy \\ &= u'(c_2^I(y))\Phi(y|e)\Big|_{\underline{y}}^{\theta} - \int_{\underline{y}}^{\theta} u''(c_2^I(y))[1-\xi'(y)]\Phi(y|e)dy \\ &\quad + u'(c_2^S(y))\Phi(y|e)\Big|_{\theta}^{\infty} - \int_{\theta}^{\infty} u''(c_2^S(y))\Phi(y|e)dy. \end{aligned}$$

Differentiating this with respect to effort yields

$$\begin{aligned} \frac{\partial E[u'(c_2(y))|e]}{\partial e} &= \left[u'(c_2^I(\theta)) - u'(c_2^S(\theta))\right] \frac{\partial \Phi(\theta|e)}{\partial e} \\ &\quad - \int_{\underline{y}}^{\theta} u''(c_2^I(y))[1-\xi'(y)]\frac{\partial \Phi(y|e)}{\partial e}dy \; - \int_{\theta}^{\infty} u''(c_2^S(y))\frac{\partial \Phi(y|e)}{\partial e}dy. \end{aligned} \tag{15}$$

Since $\frac{\partial \Phi(y|e)}{\partial e} < 0$ for all y by FOSD, $c_2^I(\theta) > c_2^S(\theta)$, $u(\cdot)$ is strictly concave, and $0 \leq \xi'(y) < 1$, the first term is positive while the two integral terms are strictly negative.

Now, consider two separate decompositions of this equation to derive conditions that ensure that $\frac{\partial E[u'(c_2(y))|e]}{\partial e} < 0$. First, define $y_L(\theta, d)$ as the solution to $c_2^S(\theta) = c_2^I(y_L)$. If we define the function $\omega(x) \equiv x - \xi(x)$, then

$$y_L(\theta, d) = \omega^{-1}(\theta - Rd) < \theta,$$

which is strictly increasing in and less than θ and strictly decreasing in d. Use this to decompose the first integral in equation (15):

$$-\int_{\underline{y}}^{\theta} u''(c_2^I(y))[1-\xi'(y)]\frac{\partial\Phi(y|e)}{\partial e}dy = \int_{\underline{y}}^{y_L} -u''(c_2^I(y))[1-\xi'(y)]\frac{\partial\Phi(y|e)}{\partial e}dy + \int_{y_L}^{\theta} -u''(c_2^I(y))[1-\xi'(y)]\frac{\partial\Phi(y|e)}{\partial e}dy,$$

where both terms on the right are strictly negative. If $\frac{\partial\Phi(y|e)}{\partial e} \leq \frac{\partial\Phi(\theta|e)}{\partial e}$ for all $y \in (y_L, \theta)$, then the second term is

$$\begin{aligned}
\int_{y_L}^{\theta} -u''(c_2^I(y))[1-\xi'(y)]\frac{\partial\Phi(y|e)}{\partial e}dy \quad &\leq \quad \int_{y_L}^{\theta} -u''(c_2^I(y))[1-\xi'(y)]dy \; \frac{\partial\Phi(\theta|e)}{\partial e} \\
&= \quad -u'(c_2^I(y)) \,{}_{y_L}^{\theta} \cdot \frac{\partial\Phi(\theta|e)}{\partial e} \\
&= \quad - \;\; u'(c_2^I(\theta)) - u'(c_2^I(y_L)) \;\; \frac{\partial\Phi(\theta|e)}{\partial e} \\
&= \quad - \;\; u'(c_2^I(\theta)) - u'(c_2^S(\theta)) \;\; \frac{\partial\Phi(\theta|e)}{\partial e}.
\end{aligned}$$

Returning to equation (15), this inequality implies that

$$\frac{\partial E[u'(c_2(y))|e]}{\partial e} \leq -\int_{\underline{y}}^{y_L} u''(c_2^I(y))[1-\xi'(y)]\frac{\partial\Phi(y|e)}{\partial e}dy - \int_{\theta}^{\infty} u''(c_2^S(y))\frac{\partial\Phi(y|e)}{\partial e}dy < 0.$$

A second decomposition follows an analogous approach, defining $y_H(\theta, d)$ as the solution to $c_2^S(y_H) = c_2^I(\theta)$:

$$y_H(\theta, d) = \theta + Rd - \xi(\theta) > \theta,$$

which is strictly increasing in and greater than θ and strictly increasing in d. Decompose the second integral in equation (15):

$$-\int_{\theta}^{\infty} u''(c_2^S(y))\frac{\partial\Phi(y|e)}{\partial e}dy = \int_{\theta}^{y_H} -u''(c_2^S(y))\frac{\partial\Phi(y|e)}{\partial e}dy + \int_{y_H}^{\infty} -u''(c_2^S(y))\frac{\partial\Phi(y|e)}{\partial e}dy,$$

where both terms on the right are strictly negative. Focus on the first term and follow the same logic as above. If $\frac{\partial\Phi(y|e)}{\partial e} \leq \frac{\partial\Phi(\theta|e)}{\partial e}$ for all $y \in (\theta, y_H)$, then

$$\begin{aligned}
\int_{\theta}^{y_H} -u''(c_2^S(y))\frac{\partial\Phi(y|e)}{\partial e}dy \quad &\leq \quad \int_{\theta}^{y_H} -u''(c_2^S(y))dy \; \frac{\partial\Phi(\theta|e)}{\partial e} \\
&= \quad - \;\; u'(c_2^I(\theta)) - u'(c_2^S(\theta)) \;\; \frac{\partial\Phi(\theta|e)}{\partial e}.
\end{aligned}$$

Returning to equation (15), this inequality implies that

$$\frac{\partial E[u'(c_2(y))|e]}{\partial e} \leq -\int_{\underline{y}}^{\theta} u''(c_2^I(y))[1-\xi'(y)]\frac{\partial \Phi(y|e)}{\partial e}dy - \int_{y_H}^{\infty} u''(c_2^S(y))\frac{\partial \Phi(y|e)}{\partial e}dy < 0.$$

Altogether, if (A) $\frac{\partial \Phi(y|e^*)}{\partial e} \leq \frac{\partial \Phi(\theta|e^*)}{\partial e}$ for all $y \in (y_L(\theta, d^*), \theta)$ or (B) $\frac{\partial \Phi(y|e^*)}{\partial e} \leq \frac{\partial \Phi(\theta|e^*)}{\partial e}$ for all $y \in (\theta, y_H(\theta, d^*))$, then $\frac{\partial E[u'(c_2(y))|e^*]}{\partial e} < 0$.

Notice $\frac{\partial}{\partial y}\ \frac{\partial \Phi(y|e^*)}{\partial e} = \frac{\partial \phi(y|e^*)}{\partial e}$. Therefore, if $\frac{\partial \phi(y|e^*)}{\partial e} \geq 0$ for all $y \in (y_L(\theta, d^*), \theta)$, then condition (A) holds; if $\frac{\partial \phi(y|e^*)}{\partial e} \leq 0$ for all $y \in (\theta, y_H(\theta, d^*))$, then condition (B) holds.

Now, assume the Monotone Likelihood Ratio Property (MLRP) for $\Phi(y|e)$:

$$\frac{\partial}{\partial y}\left[\frac{\partial \phi(y|e)/\partial e}{\phi(y|e)}\right] = \frac{\partial}{\partial y}\left[\frac{\partial ln[\phi(y|e)]}{\partial e}\right] > 0.$$

Since the sign of $\frac{\partial ln[\phi(y|e)]}{\partial e}$ is the same as the sign of $\frac{\partial \phi(y|e)}{\partial e}$, the MLRP implies the following: if $\frac{\partial \phi(y_L|e^*)}{\partial e} \geq 0$, then condition (A) holds; if $\frac{\partial \phi(y_H|e^*)}{\partial e} \leq 0$, then condition (B) holds. Altogether, if $\frac{\partial \phi(y|e^*)}{\partial e} \neq 0$ for all $y \in (y_L(\theta, d^*), y_H(\theta, d^*))$, then $\frac{\partial E[u'(c_2(y))|e^*]}{\partial e} < 0$.

Further, notice that $y_L < \theta < y_H$, so the MLRP and conditions (A) or (B) rule out zero effect of effort on earnings for all earnings values in a region around the eligibility threshold θ. More intuitively, we can determine regions of θ relative to the value of earnings where effort has zero effect on its probability (i.e. where effort goes from reducing the likelihood to increasing the likelihood of earnings) that ensure either condition (A) or (B) is met.

Define $\check{y}(e^*)$ as the earnings value satisfying $\frac{\partial \phi(\check{y}|e^*)}{\partial e} = 0$. The MLRP ensures that this is unique. Condition (A) is satisfied if $\check{y} \leq y_L$, while condition (B) is satisfied if $\check{y} \geq y_H$. Using our definitions of y_L and y_H, we have the following. If $\theta \geq \check{y}(e^*) - \xi(\check{y}(e^*)) + Rd^* \equiv \check{\theta}_A(e^*, d^*)$, then condition (A) is satisfied. If $\theta \leq \omega^{-1}(\check{y}(e^*) - Rd^*) \equiv \check{\theta}_B(e^*, d^*)$, then condition (B) is satisfied.

Altogether, these results imply the following lemma.

Lemma 7 *Suppose* $0 < \psi < G(\theta, d; \tau)$. *If* $\Phi(y|e)$ *satisfies the MLRP and (i)* $\theta \geq \check{\theta}_A(e^*, d^*)$ *or (ii)* $\theta \leq \check{\theta}_B(e^*, d^*)$, *then* $\frac{\partial E[u'(c_2(y))|e^*]}{\partial e} < 0$.

Finally, we note that $\frac{\partial E[u'(c_2(y))|e^*]}{\partial e} < 0$ is likely to hold for a broader range of θ values, since these only represent sufficient conditions.

E.1.2 Proof of Lemma 1

Define the following partial derivatives of expected lifetime utility:

$$U_d \equiv u'(w - T + d) - R\beta \int_{\tilde{y}}^{\infty} u'(y + \tau - Rd)\phi(y|e)dy \tag{16}$$

$$U_e \equiv \beta\frac{\partial}{\partial e}\left[\int_{\underline{y}}^{\tilde{y}(d;\tau)} [u(y + \tau - \xi(y)) - \psi]\,\phi(y|e)dy + \int_{\tilde{y}(d;\tau)}^{\infty} u(y + \tau - Rd)\phi(y|e)dy\right] - \beta v'(e). \tag{17}$$

Both of these must be zero at an interior optimum with $d < d_{max}$. For $d = d_{max}$, $U_e = 0$ must still hold.

For $d < d_{max}$, the implicit function theorem implies that

$$\frac{de}{d\tau} = \frac{U_{de}U_{d\tau} - U_{dd}U_{e\tau}}{U_{dd}U_{ee} - U_{ed}^2},$$

where:

$$\begin{aligned}
U_{dd} &= u''(c_1) + R^2\beta \int_{\tilde{y}}^{\infty} u''(c_2^S(y,d))\phi(y|e)dy + R\beta u'(c_2^S(\tilde{y},d))\phi(\tilde{y}|e)\frac{\partial \tilde{y}}{\partial d} \\
U_{ee} &= \beta \frac{\partial^2}{\partial e^2}\left[\int_{\underline{y}}^{\tilde{y}} u(c_2^I(y)) - \psi \;\; \phi(y|e)dy + \int_{\tilde{y}}^{\infty} u \;\; c_2^S(y,d) \;\; \phi(y|e)dy\right] - \beta v''(e) \\
U_{de} &= -R\beta \; \frac{\partial}{\partial e}\left[\int_{\tilde{y}}^{\infty} u'(c_2^S(y,d))\phi(y|e)dy\right] \\
U_{d\tau} &= -R\beta \int_{\tilde{y}}^{\infty} u''(c_2^S(y,d))\phi(y|e)dy + R\beta u'(c_2^S(\tilde{y},d))\phi(\tilde{y}|e)\frac{\partial \tilde{y}}{\partial \tau} \\
U_{e\tau} &= \beta \; \frac{\partial}{\partial e}\left[\int_{\underline{y}}^{\tilde{y}} u'(c_2^I(y))\phi(y|e)dy + \int_{\tilde{y}}^{\infty} u'(c_2^S(y,d))\phi(y|e)dy\right] - \beta\psi\frac{\partial \phi(\tilde{y}|e)}{\partial e}\frac{\partial \tilde{y}}{\partial \tau}.
\end{aligned}$$

The second order conditions for a maximum require that $U_{dd}U_{ee} - U_{de}^2 > 0$, $U_{ee} < 0$, and $U_{dd} < 0$. We assume these conditions hold everywhere to ensure unique interior solutions.[6] These SOC imply that the sign of $de/d\tau$ is the same as the sign of $U_{de}U_{d\tau} - U_{dd}U_{e\tau}$. In general, the signs of many of these terms and $de/d\tau$ are ambiguous; however, we are able to sign several terms when $\tilde{y}$ does not depend on d or τ.

Recall that if $G(\underline{y}, d; \tau) < \psi$, then $\tilde{y} = \underline{y}$, and if $G(\theta, d; \tau) > \psi$, then $\tilde{y} = \theta$. In both cases, $\frac{\partial \tilde{y}}{\partial d} = \frac{\partial \tilde{y}}{\partial \tau} = 0$ and $U_{d\tau} > 0$. Furthermore,

$$\begin{aligned}
U_{e\tau} &= \beta \; \frac{\partial}{\partial e}\left[\int_{\underline{y}}^{\tilde{y}} u'(c_2^I(y))\phi(y|e)dy + \int_{\tilde{y}}^{\infty} u'(c_2^S(y,d))\phi(y|e)dy\right] \\
&= \beta \; \frac{\partial}{\partial e}\left[\int_{\underline{y}}^{\infty} u'(c_2(y))\phi(y|e)dy\right] \\
&= \beta \; \frac{\partial E[u'(c_2(y))|e]}{\partial e},
\end{aligned}$$

[6] Notice that $U_{dd} < 0$ implies that $\partial\tilde{y}/\partial d \geq 0$ cannot be too large. $U_{ee} < 0$ can be ensured with sufficient convexity in effort costs $v(e)$.

which is strictly negative if and only if $\partial E[u'(c_2(y))|e]/\partial e < 0$. We assume this condition is met when $\psi < G(\theta, d; \tau)$ (see Lemma 7 for conditions on θ that ensure this condition is satisfied), while it always holds for $G(\underline{y}, d; \tau) < \psi$, since $c_2(y) = c_2^S(y)$ is positive, absolutely continuous, and strictly increasing for all $y \geq \underline{y}$ in this case (see Lemma 6).

Also, notice that $\frac{\partial \tilde{y}}{\partial d} = \frac{\partial \tilde{y}}{\partial \tau} = 0$ implies that $U_{dd} = u''(c_1) - RU_{d\tau}$ and

$$U_{de} = R\beta \frac{\partial}{\partial e} \left[\int_{\underline{y}}^{\tilde{y}} u'(c_2^I(y))\phi(y|e)dy \right] - RU_{e\tau},$$

where the first term on the right, $N \equiv R\beta \frac{\partial}{\partial e} \int_{\underline{y}}^{\tilde{y}} u'(c_2^I(y))\phi(y|e)dy < 0$, by Lemma 6. Altogether, when $\tilde{y}$ does not depend on d or τ and $d < d_{max}$,

$$U_{de}U_{d\tau} - U_{dd}U_{e\tau} = (N - RU_{e\tau})U_{d\tau} - U_{dd}U_{e\tau} = NU_{d\tau} - (RU_{d\tau} + U_{dd})U_{e\tau} = NU_{d\tau} - u''(c_1)U_{e\tau} < 0$$

and $de/d\tau < 0$.

When $d = d_{max}$, $de/d\tau = -U_{e\tau}/U_{ee}$, which is strictly negative if $\partial\tilde{y}/\partial\tau = 0$. □

E.1.3 Proof of Proposition 2

If $\psi > G(\underline{y}, d^*; \tau)$, then $\tilde{y} = \underline{y}$. Therefore, $\partial\Phi(\tilde{y}|e^*)/\partial e = 0$, so there is no 'effort' effect in equation (9), and $\partial\tilde{y}/\partial\tau = \partial\tilde{y}/\partial d = 0$, so there is no 'threshold' effect in equation (9).

If $\psi < G(\theta, d^*; \tau)$, then $\tilde{y} = \theta$ and there is no 'threshold' effect in equation (9). By Lemma 1, $de/d\tau < 0$ if $\frac{\partial E[u'(c_2(y))|e^*]}{\partial e} < 0$. Since $\partial\Phi(\tilde{y}|e)/\partial e < 0$ by FOSD, the 'effort' effect in equation (9) is positive. □

E.2 Repayment and Parental Transfers when $\psi = 0$

When $\psi = 0$, the repayment decision should only depend on comparison of $\xi(y)$ and Rd. For all $y < \theta$, eligible borrowers pay the reduced income-contingent amount if and only if $\xi(y) < Rd$. This yields a threshold $\hat{y}_0(d) = \xi^{-1}(Rd)$, above which borrowers repay the standard amount and below which they pay the income contingent amount. The implicit function theorem gives $\frac{\partial \hat{y}_0}{\partial d} = \frac{R}{\xi'(\hat{y}_0(d))} > 0$. For this problem, we would have a general income threshold $\tilde{y}_0(d; \theta) = \min\{\hat{y}_0(d), \theta\}$, below which borrowers repay the income-based amount and above which they pay the full/standard amount. Since $\xi'(\cdot) > 0$, we have $\tilde{y}(d; \theta) = \hat{y}_0(d)$ for low levels of debt (i.e. $Rd < \xi(\theta)$), while $\tilde{y}_0(d; \theta) = \theta$ for higher levels of debt (i.e. $Rd \geq \xi(\theta)$). Unlike $\hat{y}(d; \tau)$, the threshold $\hat{y}_0(d)$ does not depend on parental transfers τ; therefore, repayment decisions (conditional on borrowing d and effort e) do not depend on parental transfers in the absence of utility verification costs.

Notice that for all borrowers choosing low debt $d \leq R^{-1}\xi(\theta)$ (or in the absence of any upper earnings eligibility limit θ), the verification threshold is $\hat{y}_0(d) < \theta$ and $c_2^I(\hat{y}_d) = c_2^S(\hat{y})$. In this case, consumption is positive, strictly increasing, and absolutely continuous, so $\frac{\partial E[u'(c_2)|e]}{\partial e} < 0$ is always satisfied (see Lemma 6). For high debt $d > R^{-1}\xi(\theta)$, $\frac{\partial E[u'(c_2)|e]}{\partial e} < 0$ is satisfied under the conditions for θ described in Lemma 7.

E.2.1 Proof of Proposition 3

When $\psi = 0$, the probability of making a reduced payment is $\Phi(\tilde{y}_0(d;\theta)|e)$. For a fixed debt d, the earnings threshold is also fixed, so the probability of a reduced payment varies only with effort e. Due to FOSD, this probability is decreasing in effort: $\partial\Phi(\tilde{y}|e)/\partial e < 0$.

Next consider how effort varies with parental transfers. The FOC for e does not depend on w given d, so for any given d, we can implicitly differentiate the FOC for e (equation 17) with respect to τ to see how optimal effort must differ across individuals with different levels of parental transfers:

$$\frac{\partial e}{\partial \tau}_d = -\frac{U_{e\tau}}{U_{ee}}.$$

If $\frac{\partial E[u'(c_2^*)|e^*]}{\partial e} < 0$ for all (e^*, c_2^*) given debt d, then $U_{e\tau} < 0$ for all (e^*, c_2^*) as shown in the proof to Lemma 1. Since $U_{ee} < 0$ (by assumption of unique interior optima), effort must be lower for higher τ individuals with the same level of debt. (When $d < d_{max}$, the FOC for debt must also hold for individuals, which means that w must also differ accordingly.) Since e is higher for borrowers with greater τ given d and the probability of making a reduced payment is decreasing in e, borrowers with greater transfers have a greater probability of making a reduced payment. □

E.3 Incorporating Default

Suppose individuals also have the option to default, which imposes monetary costs of $\xi_D(y) \geq 0$ and non-monetary costs $\psi_D \geq 0$, where we assume $0 \leq \xi_D'(y) < 1$. Monetary costs may reflect legal or collection fees, wage garnishments, etc., while non-monetary costs may reflect stigma or other costs associated with a poor credit record (e.g. difficulty renting an apartment or obtaining a credit card).

As with income-contingent repayments, we define the gains from default relative to full repayment:

$$G_D(y, d; \tau) \equiv u(y + \tau - \xi_D(y)) - u(y + \tau - Rd),$$

which has the same qualitative properties as $G(y, d; \tau)$ with respect to (y, d, τ). Furthermore, we can define $\hat{y}_D(d, \tau)$ as the value of y that satisfies $G_D(y, d; \tau) = \psi_D$, which has the same properties as $\hat{y}(d, \tau)$. An individual prefers to default if $G_D(y, d; \tau) > \max\{G(y, d; \tau) - (\psi - \psi_D), \psi_D\}$, prefers to make income-contingent payments if $G(y,d;\tau) > \max\{G_D(y,d;\tau)+(\psi-\psi_D),\psi\}$, and prefers to repay in full otherwise (i.e. if $G_D \le \psi_D$ and $G \le \psi$).

Assume that individuals never prefer default to full repayment for earnings realizations above the income-contingent eligibility threshold: $G_D(\theta, d_{max};\tau) \le \psi_D$ or, equivalently, $\hat{y}_D(d_{max},\tau) \le \theta$ for all τ. This simplifies some of the analysis and is generally consistent with very low delinquency/default rates for borrowers with earnings above \$20,000 in our sample. With this assumption, the threshold for any form of reduced payment (i.e. income-contingent payment or default) is

$$\tilde{y}_N(d;\tau,\theta) = \max\{\underline{y}, \min\{\hat{y}_N(d;\tau),\theta\}\},$$

where $\hat{y}_N(d;\tau) = \max\{\hat{y}(d;\tau),\hat{y}_D(d;\tau)\}$. The probability of making a reduced payment is $\Phi(\tilde{y}_N(d;\tau,\theta)|e)$. The first order condition for debt d is the same as in the text (equation 7), replacing $\tilde{y}$ with $\tilde{y}_N$.

Further assuming that the non-monetary costs of default and income-contingent payments are the same, $\psi_D = \psi$, simplifies the problem considerably. In this case, the choice between default and income-contingent payments depends only on a comparison of their monetary costs: $\xi_D(y)$ vs. $\xi(y)$. The decision between paying in full vs. some form of reduced payment is basically the same as that in the text, replacing $\xi(y)$ with $\xi_N(y) = \min\{\xi(y),\xi_D(y)\}$.[7] The first order condition for effort e is the same as in the text (equation 8), replacing $\tilde{y}$ with $\tilde{y}_N$ and $\xi(y)$ with $\xi_N(y)$.

If $G(\theta,d;\tau) > \psi$, then income-contingent repayments must be preferred to default at $y=\theta$ given the assumption above that $G_D(\theta,d_{max};\tau) \le \psi_D = \psi$. In this case, $\tilde{y}_N = \theta$, which is independent of d and τ. With $\xi(\underline{y}) = 0$, $\max\{G(\underline{y},d;\tau), G_D(\underline{y},d;\tau)\} = G(\underline{y},d;\tau)$. So, if $G(\underline{y},d;\tau) < \psi$, then $\tilde{y}_N(d;\tau) = \underline{y}$ is independent of d and τ. Altogether, Lemma 1 and Proposition 2 can be naturally modified as follows:

Lemma 1' *If (i) $\psi = \psi_D > G(\underline{y},d^*;\tau)$ or (ii) $\psi = \psi_D < G(\theta,d^*;\tau)$ and $\partial E[u'(c_2^*)|e^*]/\partial e < 0$, then $\frac{\partial \tilde{y}_N}{\partial d} = \frac{\partial \tilde{y}_N}{\partial \tau} = 0$ and $\frac{de^*}{d\tau} < 0$.*

Proposition 2' *If $\psi = \psi_D > G(\underline{y},d^*;\tau)$, then the probability of making a reduced loan payment (default or income-contingent) is zero and unaffected by a marginal change in parental transfers. If $\psi = \psi_D < G(\theta,d^*;\tau)$ and $\partial E[u'(c_2^*)|e^*]/\partial e < 0$, then the probability of making a reduced loan payment (default or income-contingent) is strictly increasing in parental transfers.*

If $\psi = \psi_D = 0$ (i.e. no non-monetary costs of earnings verification or default), then both $\hat{y}$ and $\hat{y}_N$ depend only on debt and not on transfers. Proposition 3 can be naturally modified:

Proposition 3' *Suppose $\psi = \psi_D = 0$. If $\partial E[u'(c_2^*)|e^*]/\partial e < 0$ for all (e^*, c_2^*), then among borrowers with the same level of debt, those with higher levels of parental transfers exert less effort and have a greater probability of making a reduced payment (i.e. default or income-based payments).*

[7] This function maintains the key properties $\xi_N(y) \ge 0$ and $0 \le \xi'_N(y) < 1$ (almost everywhere).

Even if $\psi_D > \psi = 0$, this result is still likely to hold. Assume $\hat{y}_D(d,\tau) \leq \hat{y}_0(d)$ for all (d,τ), so those on the margin of making a reduced payment prefer the income-contingent payment over default. Furthermore, assume that $\xi(\underline{y}) > \xi_D(\underline{y})$ and $\partial(G_D(y,d;\tau) - G(y,d;\tau))/\partial y < 0$, so default occurs for the lowest income realizations, if at all. These assumptions imply that default occurs for $y < \bar{y}(\tau)$, where $\bar{y}(\tau)$ solves

$$u(\bar{y} + \tau - \xi_D(\bar{y})) - u(\bar{y} + \tau - \xi(\bar{y})) = \psi_D.$$

Letting $c_2^D(y) \equiv \bar{y} + \tau - \xi_D(\bar{y})$,

$$\frac{\partial \bar{y}}{\partial \tau} = \frac{u'(c_2^I(\bar{y})) - u'(c_2^D(\bar{y}))}{u'(c_2^D(\bar{y}))(1 - \xi_D'(\bar{y})) - u'(c_2^I(\bar{y}))(1 - \xi'(\bar{y}))} < 0,$$

since $c_2^D(\bar{y}) > c_2^I(\bar{y})$ for $\psi_D > 0$ and the denominator equals $\partial(G_D - G)/\partial y < 0$. For $\bar{y}(\tau) \leq \underline{y}$, there would be no default, and the only form of reduced payment would be income-contingent payment. Proposition 3 applies in this case. For $\bar{y}(\tau) > \underline{y}$, default occurs for $y \in [\underline{y}, \bar{y}(\tau))$, income-contingent repayment for $y \in [\bar{y}(\tau), \tilde{y}_0(d;\theta))$, and full repayment for $y \geq \tilde{y}_0(d;\theta)$. In this case, we have

$$U_{e,\tau} = \beta \quad \frac{\partial E[u'(c_2(y))|e]}{\partial e} - \psi_D \bar{y}'(\tau) \frac{\partial \phi(\bar{y}(\tau)|e)}{\partial e} \quad ,$$

which is negative if either (i) $\frac{\partial \phi(\bar{y}(\tau)|e)}{\partial e} \leq 0$, or (ii) $\psi_D < \frac{\partial E[u'(c_2(y))|e]/\partial e}{\bar{y}'(\tau)[\partial \phi(\bar{y}|e)/\partial e]}$. Condition (i) is likely to hold if $\bar{y}(\tau)$ is at the low end of the earnings distribution where increases in effort make that realization less likely. If either of these assumptions hold, then the conclusions in Proposition 3' continue to hold even with $\psi_D > 0$.

E.4 Altruistic Parents and Endogenous Transfers

Suppose total family utility within a period is given by $(1-\alpha)u(c^p) + \alpha u(c^c)$, where $\alpha \in (0,1)$ reflects the level of parental altruism towards children and c^p and c^c reflect parent's and child's consumption, respectively.

Ignoring any constraints on transfers across generations, families would allocate total resources C across generations (within a period) as follows:

$$U^F(C) = \max_{c^c} (1-\alpha)u(C - c^c) + \alpha u(c^c), \tag{18}$$

which implies that allocations would satisfy:

$$\alpha u'(c^c) = (1-\alpha)u'(C - c^c).$$

Assuming W reflects total family initial wealth and y^p reflects parental income after the child leaves school, we can write the parent/family utility under the government student loan program described earlier as:

$$U^F(W+d-T)+\beta\left[\int_{\underline{y}}^{\tilde{y}} U^F(y+y^p-\xi(y))-\psi \;\; \phi(y|e)dy+\int_{\tilde{y}}^{\infty} U^F(y+y^p-Rd)\phi(y|e)dy\right],$$

where $U^F(\cdot)$ is defined in equation (18). This problem is identical to that with exogenous transfers, where we have replaced parental transfers by parental income y^p, initial youth resources w by initial parental wealth and income W, and individual utility $u(\cdot)$ by "family utility" $U^F(\cdot)$. Since $U^F(\cdot)$ is strictly increasing and strictly concave, for any given level of altruism α, all qualitative results with respect to transfers now apply directly to parental income y^p.

It is also possible to consider how parental transfers τ would be determined, since consumption allocations under the government loan program must satisfy:

$$\alpha u'(y+\tau-D(y,d))=(1-\alpha)u'(y^p-\tau), \tag{19}$$

where

$$D(y,d)=\begin{array}{ll}\xi(y) & \text{if } y<\tilde{y}\\ Rd & \text{otherwise.}\end{array}$$

Notice that equation (19) implicitly defines transfers $\tau(y,d,\alpha,y^p)$ as a function of child earnings and borrowing, altruism, and parental income. Implicit differentiation of this equation yields the following:

$$\begin{aligned}\frac{\partial\tau}{\partial y} &= \frac{-\alpha u''(y+\tau-D)}{\alpha u''(y+\tau-D)+(1-\alpha)u''(y^p-\tau)}\left(1-\frac{\partial D}{\partial y}\right)\leq 0\\ \frac{\partial\tau}{\partial y^p} &= \frac{(1-\alpha)u''(y^p-\tau)}{\alpha u''(y+\tau-D)+(1-\alpha)u''(y^p-\tau)}>0\\ \frac{\partial\tau}{\partial\alpha} &= -\frac{u'(y+\tau-D)+u'(y^p-\tau)}{\alpha u''(y+\tau-D)+(1-\alpha)u''(y^p-\tau)}>0.\end{aligned}$$

Parental transfers are weakly declining in own earnings and strictly increasing in parental earnings and altruism.

Empirically, we will consider individuals with different access to parental support. Within the context of this model, we can consider this parental support level as the value of transfers available when own earnings are at their worst, $\underline{y}$. This support, $\hat{\tau}(d,\alpha,y^p)$, is implicitly defined from the following:

$$\alpha u'(\underline{y}+\hat{\tau}-D(\underline{y},d))=(1-\alpha)u'(y^p-\hat{\tau}).$$

Of course, this support access level $\hat{\tau}$ is increasing in parental income and altruism.

We will sometimes differentiate borrowers based on whether they could receive any help from their parents if they needed it, i.e. $\hat{\tau}(d,\alpha,y^p)>0$. Given concavity of $u(\cdot)$, this is true if and only if

$$u'(\underline{y}-D(\underline{y},d))>\frac{1-\alpha}{\alpha}u'(y^p). \tag{20}$$

This shows the combination of parental altruism and income that ensure positive transfers under at least some circumstances. Thus, our measure of access to parental support reflects a combination of parents having both the means and willingness to support their children. Parental support should be positively correlated with parental transfers (assuming parental income and altruism are not strongly negatively correlated); however, the correlation could be weak if there is considerable heterogeneity in parental altruism.

To the extent that transfers are constrained to be non-negative, individuals not satisfying equation (20) will receive zero parental transfers for all earnings realizations. These individuals would solve the individual problem with exogenous transfer $\tau = 0$. Those for whom $u'(\theta - D(\theta, d)) > \frac{1-\alpha}{\alpha} u'(y^p)$ would receive positive transfers for all earnings realizations for which they are eligible for reduced income-based payments. Their repayment decisions would be based on the family problem with y^p taking on the role of τ in the individual problem. Those with more intermediate levels of family income/altruism would solve this problem constrained by $\tau > 0$.

E.5 Proof of Proposition 4

Building on the first part of Lemma 1, we can define the following derivatives of U_d and U_e (defined in equations (16) and (17), respectively):

$$\begin{aligned} U_{d\psi} &= R\beta u'(\tilde{y} + \tau - Rd)\phi(\tilde{y}|e)\frac{\partial \tilde{y}}{\partial \psi} \leq 0 \\ U_{e\psi} &= -\beta\frac{\partial \Phi(\tilde{y}|e)}{\partial e} > 0. \end{aligned}$$

Notice that $U_{d\psi} < 0$ when $G(\theta, d; \tau) < \psi < G(\underline{y}, d; \tau)$, since $\frac{\partial \hat{y}}{\partial \psi} < 0$ as shown earlier in Appendix E.1. Otherwise, $U_{d\psi} = 0$, since $\tilde{y}$ is either $\underline{y}$ or θ. $U_{e\psi} > 0$, since $\frac{\partial \Phi(\tilde{y}|e)}{\partial e} < 0$ by FOSD.

For $d < d_{max}$, the implicit function theorem implies that $\frac{de}{d\psi} = \frac{U_{de}U_{d\psi} - U_{dd}U_{e\psi}}{U_{dd}U_{ee} - U_{ed}^2}$ and $\frac{dd}{d\psi} = \frac{U_{de}U_{e\psi} - U_{ee}U_{d\psi}}{U_{dd}U_{ee} - U_{ed}^2}$, where the second order conditions for a maximum imply that $U_{dd} < 0$, $U_{ee} < 0$, and $U_{dd}U_{ee} - U_{ed}^2 > 0$ (see Appendix E.1 for these expressions). This directly implies that $\frac{de}{d\psi} > 0$ if $\psi < G(\theta, d; \tau)$. Alternatively, if $U_{ed} < 0$, then $\frac{dd}{d\psi} < 0$ and $\frac{de}{d\psi} > 0$. To show conditions that ensure $U_{ed} < 0$, rewrite U_{ed} as

$$U_{ed} = -R\beta \int_{\tilde{y}}^{\infty} u'(c_2^S(y, d))\frac{\partial ln[\phi(y|e)]}{\partial e}\phi(y|e)dy.$$

As noted earlier, the MLRP implies that $\frac{\partial}{\partial y} \frac{\partial ln[\phi(y|e)]}{\partial e} > 0$. Thus, if the MLRP holds and $\frac{\partial ln[\phi(\tilde{y}|e)]}{\partial e} = 0$, then $\frac{\partial ln[\phi(y|e)]}{\partial e} > 0$ for all $y > \tilde{y}$, which implies that $U_{ed} < 0$. Notice that $\frac{\partial ln[\phi(\tilde{y}|e)]}{\partial e} = 0$ if and only if $\frac{\partial \phi(\tilde{y}|e)}{\partial e} = 0$. Thus, for $d < d_{max}$ we have shown the stated results.

When $d = d_{max}$, $de/d\psi = -U_{e\psi}/U_{ee} > 0$ by the implicit function theorem. □

E.6 Value of Reducing Verification Costs

Let $U^*(\psi, R)$ reflect the maximized utility for an individual with initial wealth and parental transfers (w, τ) under the government student loan program. Assuming no population heterogeneity in (w, τ), a government choosing ψ and R to maximize welfare subject to a fixed budget B maximizes

$$U^*(\psi, R) = u(w - T + d^*) + \beta \left[\int_{\underline{y}}^{\tilde{y}^*} [u(y + \tau - \xi(y)) - \psi]\phi(y|e^*)dy + \int_{\tilde{y}^*}^{\infty} u(y + \tau - Rd^*)\phi(y|e^*)dy - v(e^*) \right]$$

subject to:

$$\beta \left[\int_{\underline{y}}^{\tilde{y}^*} \xi(y)\phi(y|e^*)dy + [1 - \Phi(\tilde{y}^*|e)]Rd^* \right] - d^* \geq B,$$

where $\tilde{y}^* = \tilde{y}(d^*; \tau, \theta, \psi, R)$. While not explicit before, we highlight here that the threshold $\tilde{y}$ depends on loan policy parameters ψ and R. Letting $\eta \geq 0$ reflect the Lagrange multiplier on the budget restriction, the FOC for ψ is

$$-\Phi(\tilde{y}^*|e^*) + \eta\phi(\tilde{y}^*|e^*)[\xi(\tilde{y}^*) - Rd^*]\frac{\partial \tilde{y}^*}{\partial \psi} = 0$$

where the first term reflects the (direct) costs of raising ψ, which must be paid whenever borrowers have their income verified, and the second term reflects the benefits in terms of increased loan payments associated with the reduction in the verification threshold.[8] If $\psi = 0$, then either $\xi(\tilde{y}^*) = Rd^*$ or $\frac{\partial \tilde{y}^*}{\partial \psi} = 0$, and there would be no marginal benefit from raising ψ. In this case, the second term is zero, and $\psi = 0$ is locally optimal. However, it may also be possible that a higher welfare could be attained with sufficiently high verification costs, $\psi > 0$, satisfying the first order conditions for both ψ and R.

E.6.1 Proof of Proposition 5

Pure loan forgiveness implies $\xi(y) = 0$ for all y, so individuals either repay their debt in full or zero in the case of verification. Abstract from moral hazard and assume that interest rates R

[8]This result does not depend on R being the only other policy parameter that must adjust to maintain a fixed budget. The FOC for ψ is qualitatively the same if the government responded by adjusting the eligibility threshold θ instead. In the case above, the FOC for R is:

$$d^*[1 - \Phi(\tilde{y}^*|e^*)]E[u'(y + \tau - Rd^*)|y \geq \tilde{y}^*] = \eta \quad d^*[1 - \Phi(\tilde{y}^*|e^*)] + \phi(\tilde{y}^*|e^*)[\xi(\tilde{y}^*) - Rd^*]\frac{\partial \tilde{y}^*}{\partial R} \quad . \tag{21}$$

Combining the two FOCs and using the fact that $\frac{\partial \tilde{y}^*}{\partial R} = -d^* u'(\tilde{y}^* + \tau - Rd^*)\frac{\partial \tilde{y}^*}{\partial \psi}$ yields

$$\Phi(\tilde{y}^*|e^*) = \frac{E[u'(y + \tau - Rd^*)|y \geq \tilde{y}^*]\phi(\tilde{y}^*|e^*)[\xi(\tilde{y}^*) - Rd^*]\frac{\partial \tilde{y}^*}{\partial \psi}}{1 - \frac{\phi(\tilde{y}^*|e^*)}{1 - \Phi(\tilde{y}^*|e^*)}[\xi(\tilde{y}^*) - Rd^*]u'(\tilde{y}^* + \tau - Rd^*)\frac{\partial \tilde{y}^*}{\partial \psi}}.$$

are set so that (discounted) expected repayments cover the amount borrowed. Define $V(\psi, \theta)$ as the maximized utility given verification costs ψ and eligibility threshold θ. Notice that when verification costs are zero, individuals would always apply for forgiveness when eligible, so

$$V(0,\theta) = \max_d u(w - T + d) + \beta \left[\int_{\underline{y}}^{\theta} u(y+\tau)\phi(y)dy + \int_{\theta}^{\infty} u(y + \tau - R(\theta)d)\phi(y)dy \right],$$

where the interest rate can be written as a function of θ,

$$R(\theta) \equiv \frac{1}{\beta[1-\Phi(\theta)]} \geq \beta^{-1},$$

due to the lender's break-even constraint $d \leq \beta[1 - \Phi(\theta)]Rd$. The FOC for d satisfies

$$\begin{aligned} u'(w - T + d) &= R(\theta)\beta[1-\Phi(\theta)]E[u'(y + \tau - R(\theta)d)|y \geq \theta] \\ &= E[u'(y+\tau - R(\theta)d)|y \geq \theta], \end{aligned}$$

where the second equality follows from the definition of $R(\theta)$. Let $d^*(\theta)$ denote the solution to this FOC.

Now, we can see how the choice of θ affects welfare using the envelope theorem:

$$\begin{aligned} \frac{\partial V(0,\theta)}{\partial \theta} &= \beta\phi(\theta)\left[u(\theta+\tau) - u\left(\theta + \tau - R(\theta)d^*(\theta)\right)\right] - \beta R'(\theta)d^*(\theta)\int_{\theta}^{\infty} u'\left(y + \tau - R(\theta)d^*(\theta)\right)\phi(y)dy \\ &= \beta\phi(\theta)\left[u(\theta+\tau) - u(\theta+\tau - R(\theta)d^*(\theta))\right] - \beta\ \frac{R(\theta)\phi(\theta)}{1-\Phi(\theta)}\ d^*(\theta)\int_{\theta}^{\infty} u'(y+\tau - R(\theta)d^*(\theta))\phi(y)dy \\ &= \beta\phi(\theta)\left\{[u(\theta+\tau) - u(\theta+\tau-R(\theta)d^*(\theta))] - R(\theta)d^*(\theta)E[u'(y+\tau-R(\theta)d^*(\theta))|y\geq\theta]\right\} \\ &< \beta R(\theta)d^*(\theta)\phi(\theta)\left\{u'(\theta+\tau-R(\theta)d^*(\theta)) - E[u'(y+\tau-R(\theta)d^*(\theta))|y\geq\theta]\right\}, \end{aligned}$$

where the inequality comes from concavity in $u(\cdot)$, which implies that $u(\theta+\tau) - u(\theta+\tau-Rd^*) < Rd^*u'(\theta+\tau-Rd^*)$. Concavity of $u(\cdot)$ implies that the right hand side is positive, making the sign of $\partial V(0,\theta)/\partial\theta$ ambiguous.

With $u''(c) = -\kappa < 0$ for all c (i.e. quadratic utility),

$$\begin{aligned} \frac{\partial V(0,\theta)}{\partial \theta} &= \beta\phi(\theta)\quad Rd^*u'(\theta+\tau-Rd^*) - (Rd^*)^2\frac{\kappa}{2}\quad - Rd^*\left[u'(\theta+\tau-Rd^*) - \kappa E[y-\theta|y\geq\theta]\right] \\ &= \beta\phi(\theta)Rd^*\kappa\quad -\frac{Rd^*}{2} + E[y-\theta|y\geq\theta]\quad, \end{aligned}$$

which is negative if and only if $R(\theta)d^*(\theta) > 2E[y-\theta|y\geq\theta]$. For $\theta = \underline{y}$,

$$\frac{\partial V(0,\theta)}{\partial\theta}\Big|_{\theta=\underline{y}} = \phi(\underline{y})d^*(\underline{y})\kappa\quad -\frac{\beta^{-1}d^*(\underline{y})}{2} + E[y-\underline{y}]\quad,$$

which is negative if and only if $d^*(\underline{y}) > 2\beta E[y - \underline{y}]$.[9] Thus, for large enough optimal debt levels, $V(0, \theta)$ is at least locally decreasing in θ at $\theta = \underline{y}$. In this case, welfare is higher under a standard debt repayment contract (with no option for loan forgiveness) than with a student loan contract characterized by a low income eligibility threshold θ for forgiveness, since the costs of modest loan forgiveness in terms of higher interest rates more than offset the insurance benefit in terms of reduce payments for very low earnings realizations. This is important, since a contract with sufficiently high ψ would eliminate any application for forgiveness even among eligible individuals. Denote such a high verification cost by $\hat{\psi}$.[10] This implies identical values associated with eliminating forgiveness through either high verification costs or zero eligibility: $V(\hat{\psi}, \theta) = V(0, \underline{y})$. Thus, for $d^*(\underline{y}) > 2\beta E[y - \underline{y}]$, we have that $V(\hat{\psi}, \theta) = V(0, \underline{y}) > V(0, \theta)$ for (at least) small θ. Since an optimal choice of ψ must (weakly) dominate $\hat{\psi}$, it must be the case that welfare is strictly higher under optimally chosen $\psi > 0$ than under $\psi = 0$. Altogether, this implies the stated result. $\square$

E.7 Efficient Student Loan Contracts

This appendix provides details on the derivation of efficient student loan contracts discussed in Section 6 of the main text.

E.7.1 Observable Transfers

Consider the first order conditions for d, $D^v(y)$, and $\bar{y}$ for the contracting problem with observable parental transfers in Section 6.1.

Let $\lambda \geq 0$ reflect the Lagrange multiplier on the break-even constraint (12), $\mu \geq 0$ the (discounted by β) Lagrange multiplier on the incentive compatibility constraint (13), and define the likelihood ratio $\ell(y) \equiv \phi(y|e_L)/\phi(y|e_H)$. The first order conditions for d and $D^v(y)$ are, respectively:

$$\begin{aligned} u'(c_1) &= \lambda \\ u'(c_2^v(y))[1 + \mu(1 - \ell(y))] &= \lambda, \quad \forall y < \bar{y}, \end{aligned}$$

where $c_1 = w - T + d$ and $c_2^v(y) = y + \tau - D^v(y)$ for $y < \bar{y}$. As in the text, these conditions imply that $u'(c_1) = u'(c_2^v(y))[1 + \mu(1 - \ell(y))]$ for low earnings realizations.

Finally, consider the optimal earnings threshold $\bar{y}$. The first order condition implies that at an optimum,

$$\frac{\partial \bar{D}}{\partial \bar{y}} = \frac{\phi(\bar{y}|e_H)}{1 - \Phi(\bar{y}|e_H)} \quad \frac{u'(c_1)[\bar{D} - D^v(\bar{y})]}{u'(c_1) - E \quad u'(y + \tau - \bar{D})[1 + \mu(1 - \ell(y))]|y \geq \bar{y}} \quad .$$

[9] Notice that $R(\underline{y}) = \beta^{-1}$ and $\Phi(\underline{y}) = 0$.

[10] Any $\hat{\psi} \geq u(\underline{y} + \tau - \beta^{-1} d^*(\underline{y})) - u(\underline{y} + \tau)$ would ensure full repayment under all earnings realizations.

The left hand side reflects the tradeoff between higher payments $\bar{D}$ and a higher verification threshold $\bar{y}$ that leaves borrowers indifferent between having their earnings verified or not. The right hand side combines costs of verification (in the form of compensating consumption) with a measure of the consumption distortion when earnings are not verified.

E.7.2 Unobserved Transfers

Next, consider the case of K potential unobserved parental transfer levels $(\tau_1, ..., \tau_K)$. When high effort is optimal, it must be induced. Since parental transfers are unverifiable, contracts must also be written to elicit truthful reporting.

For any borrower reporting parental transfers τ_j, the lender will offer a loan amount d_j with a fixed amount $\bar{D}_j$ to be repaid unless earnings are verified to be less than the threshold $\bar{y}_j$, in which case payments are set to the earnings-contingent amount $D_j^v(y)$. Assuming high effort is efficient, these contract parameters $(d_j, \bar{y}_j, \bar{D}_j, D_j^v(y))$, all specific to the reported transfer level, are chosen to maximize expected utility:

$$u(w-T+d_j)+\beta\left[\int_{\underline{y}}^{\bar{y}_j}[u(y+\tau_j-D_j^v(y))-\psi]\phi(y|e_H)dy+\int_{\bar{y}_j}^{\infty}u(y+\tau_j-\bar{D}_j)\phi(y|e_H)dy-v(e_H)\right], \tag{22}$$

subject to the following break-even constraint:

$$d_j \leq \beta\left[\int_{\underline{y}}^{\bar{y}_j} D_j^v(y)\phi(y|e_H)dy+\int_{\bar{y}_j}^{\infty}\bar{D}_j\phi(y|e_H)dy\right], \tag{23}$$

no-shirking incentive compatibility constraint (ICC):

$$\int_{\underline{y}}^{\bar{y}_j}[u(y+\tau-D_j^v(y))-\psi][\phi(y|e_H)-\phi(y|e_L)]dy+\int_{\bar{y}_j}^{\infty}u(y+\tau-\bar{D}_j)[\phi(y|e_H)-\phi(y|e_L)]dy \geq v(e_H)-v(e_L). \tag{24}$$

truth-telling constraints for all $k = j$ and e:

$$\begin{aligned}
&u(w-T+d_j)+\beta\left[\int_{\underline{y}}^{\bar{y}_j}[u(y+\tau_j-D_j^v(y))-\psi]\phi(y|e_H)dy+\int_{\bar{y}_j}^{\infty}u(y+\tau_j-\bar{D}_j)\phi(y|e_H)dy\right]\\
&-\left\{u(w-T+d_k)+\beta\left[\int_{\underline{y}}^{\bar{y}_{jk}}[u(y+\tau_j-D_k^v(y))-\psi]\phi(y|e)dy+\int_{\bar{y}_{jk}}^{\infty}u(y+\tau_j-\bar{D}_k)\phi(y|e)dy\right]\right\}\\
&\geq \beta[v(e_H)-v(e)]
\end{aligned} \tag{25}$$

where the $\bar{y}_j$ and $\bar{y}_{jk}$ reflect verification thresholds discussed next.

Borrowers must be indifferent between verifying their income to receive a reduced payment and paying the fixed amount $\bar{D}_j$ at the threshold $\bar{y}_j$, so

$$u(\bar{y}_j + \tau_j - D^v_j(\bar{y}_j)) - u(\bar{y}_j + \tau_j - \bar{D}_j) = \psi \quad \text{for all } j = 1, ..., K, \tag{26}$$

which implicitly defines $\bar{D}_j$ as a function of $\bar{y}_j$.

When borrowers mis-report their transfers, they may choose to have their income verified at a different point than the optimal contract specifies. For $\tau_j \leq \tau_k$, concavity in $u(\cdot)$ implies that $u(\bar{y}_k + \tau_j - D^v_k(\bar{y}_k)) - u(\bar{y}_k + \tau_j - \bar{D}_k) \geq \psi$. These borrowers would have non-negative utility gains from having their income verified at $\bar{y}_k$ under the τ_k contract. This implies that $\bar{y}_{jk} = \bar{y}_k$ for all $\tau_j \leq \tau_k$.[11] For $\tau_j > \tau_k$, the threshold $\bar{y}_{jk}$, solves $u(\bar{y}_{jk} + \tau_j - D^v_k(\bar{y}_{jk})) - u(\bar{y}_{jk} + \tau_j - \bar{D}_k) = \psi$. In this case, $\bar{y}_{jk} < \bar{y}_k$ and borrowers may choose not to apply for income-contingent payments even though they would qualify given their reported transfers and earnings. Notice that $\bar{y}_{jk}$ is not a free choice variable but is given by contracts specified for reported transfers τ_k.

Substituting in for $\bar{D}_j$ into the contracting problem (based on equation (26)) and taking contracts for all other reported parental transfer amounts as given, lenders choose d_j, $D^v_j(y)$ for all $y < \bar{y}_j$, and $\bar{y}_j$ to maximize equation (22) subject to equations (23), (24), and (25). When solving for the loan contract for any τ_j, contracts for all other transfer levels are taken as given (determined optimally in the same way as in a Nash equilibrium).

Define the likelihood ratio $\ell(y) \equiv \phi(y|e_L)/\phi(y|e_H)$, and let $\lambda_j \geq 0$ reflect the Lagrange multiplier on the break-even constraint (23), $\mu_j \geq 0$ the (discounted by β) Lagrange multiplier on the incentive compatibility constraint (24), and $\xi^e_{j,k} \geq 0$ Lagrange multipliers on the truth-telling constraints of equation (25) for all $k = j$ and e. The first order conditions for d_j and $D^v_j(y)$ for $y < \bar{y}_j$ are, respectively:

$$\begin{aligned} u'(c_{1,j}) \quad 1 + \sum_{k,k\neq j} (\xi^{e_H}_{j,k} + \xi^{e_L}_{j,k}) \quad &= \quad \lambda_j \\ u'(c^v_{2,j}(y)) \quad 1 + \sum_{k,k\neq j} (\xi^{e_H}_{j,k} + \xi^{e_L}_{j,k}) + \mu_j(1 - \ell(y)) \quad &= \quad \lambda_j, \quad \forall y < \bar{y}_j, \end{aligned}$$

where $c_{1,j} = w - T + d_j$ and $c^v_{2,j}(y) = y + \tau_j - D^v_j(y)$ for $y < \bar{y}_j$. These conditions imply that

$$u'(c_{1,j}) = u'(c^v_{2,j}(y))[1 + m_j(1 - \ell(y))], \ \forall y < \bar{y}_j, \tag{27}$$

where $m_j \equiv \frac{\mu_j}{1 + \sum_{k,k\neq j} (\xi^{e_H}_{j,k} + \xi^{e_L}_{j,k})} \geq 0$. Notice that this structure is nearly identical to that of the case with observable parental transfers.

The following lemma shows that the truth-telling constraints associated with high effort are always slack. Borrowers never wish to mis-represent transfers alone. They will only mis-report transfers if they also mis-report high effort while exerting low effort.

[11] Notice that the contract specifies that repayments are $\bar{D}_k$ above $\bar{y}_k$, so no borrowers would ever want to verify at higher levels.

Lemma 8 *For all $k = j$, constraints in equation (25) are always slack for $e = e_H$ and $\xi_{j,k}^{e_H} = 0$.*

Proof: We show that if the contract associated with τ_j is optimal given constraints (23), (24), and (25) for e_L, the contract also satisfies constraint (25) for e_H. We prove this by showing that if the dropped constraint (equation (25) for e_H) were violated, then this would lead to a contradiction. Thus, constraint (25) for e_H must be slack.

Define maximized utility for someone exerting effort e with parental transfers τ_j under optimal loan contract (satisfying constraints (23), (24), and (25) for $e = e_L$) associated with high reported effort and reported transfers τ_k, $L_k = (d_k, D_k^v(\cdot), \bar{D}_k)$:

$$U(e, \tau_j, L_k) \equiv u(w-T+d_k)+\beta\left[\int_{\underline{y}}^{\bar{y}_{jk}}[u(y+\tau_j-D_k^v(y))-\psi]\phi(y|e)dy+\int_{\bar{y}_{jk}}^{\infty}u(y+\tau_j-\bar{D}_k)\phi(y|e)dy-v(e)\right],$$

where the thresholds $\bar{y}_{jk}$ are defined above.

Consider a contract $L_l = L_j$, for reported high effort and transfers τ_l. Clearly, the break-even constraint (23) is satisfied for contract L_l given effort e_H and any actual transfer level. Assume (incorrectly) that $U(e_H, \tau_j, L_l) > U(e_H, \tau_j, L_j)$, so constraint (25) for e_H is violated. Since constraints (24) and (25) for e_L imply that $U(e_H, \tau_j, L_j) \geq U(e_L, \tau_j, L_k)$ for all L_k, it must be the case that $U(e_H, \tau_j, L_l) \geq U(e_L, \tau_j, L_k)$ for all L_k. This means that contract L_l is feasible and incentive-compatible when effort is e_H and transfers are τ_j. By maximization, contract L_j must dominate contract L_l for effort e_H and transfers τ_j, so $U(e_H, \tau_j, L_l) \geq U(e_H, \tau_j, L_j)$, which contradicts our initial assumption. $\square$

To understand the relationship between contracts that would arise with observable vs. unobservable parental transfers, let $\tilde{L}_j$ represent optimal contract for reported effort e_H and transfer τ_j when all truth-telling constraints (25) are ignored (i.e. when transfers are observed).

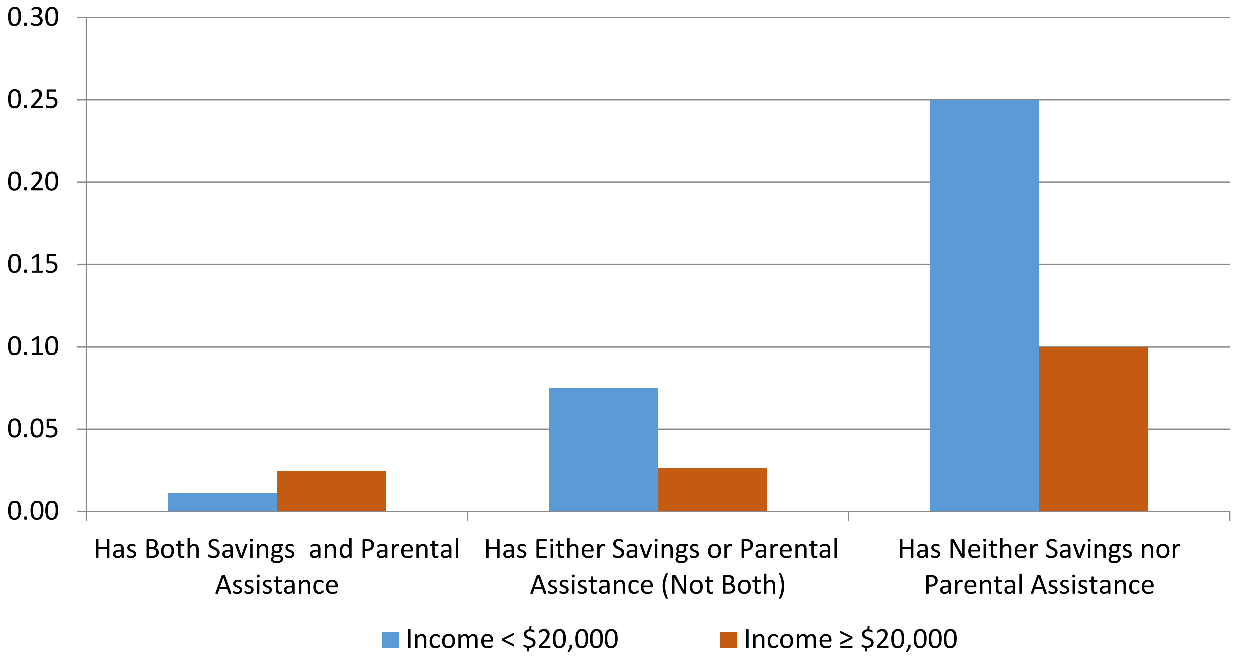
If truthfully reporting transfers dominates mis-reporting transfers when shirking (i.e. reporting high effort but exerting low effort) under $\tilde{L}_j$ (i.e. $U(e_L, \tau_j, \tilde{L}_j) \geq U(e_L, \tau_j, \tilde{L}_k)$ for all $k = j$), then the truth-telling constraints would always be non-binding and contracts would be identical under observable and unobservable transfers.

It is, however, possible that, under $\tilde{L}$ contracts, mis-reporting transfers dominates truthful reporting when shirking: $U(e_L, \tau_j, \tilde{L}_j) < U(e_L, \tau_j, \tilde{L}_k)$ for some k. If the ICC (24) is binding under $\tilde{L}_j$, it is impossible to adjust the contract to improve the borrower's utility under full truth-telling without violating the ICC. That is, $\tilde{L}_j$ already maximizes $U(e_H, \tau_j, \tilde{L}_j)$ subject to constraints (23) and (24). With the ICC binding, we have $U(e_H, \tau_j, \tilde{L}_j) = U(e_L, \tau_j, \tilde{L}_j) < U(e_L, \tau_j, \tilde{L}_k)$, so borrowers with transfers τ_j would prefer to mis-report both effort and transfers rather than report truthfully. In this case, a loan contract could not be written to induce high effort for parental transfers of τ_j if transfers were unobserved; the unobservability of parental transfers results in a breakdown leading to low effort. (With low effort, there would be full consumption smoothing across all verified post-school earnings and in-school consumption: $c^v_{2,j}(y) = c_{1,j}$ for all $y < \bar{y}_j$.)

If the ICC (24) is non-binding when transfers are observable, then $U(e_H, \tau_j, \tilde{L}_j) > U(e_L, \tau_j, \tilde{L}_j)$ and the truth-telling constraints (25) may not bind even if mis-reporting transfers dominates truthfully reporting transfers when shirking. In this case, loan contracts would be identical regardless of the observability of transfers with $m_j = \mu_j = 0$ and full consumption smoothing across verified earnings states and during school (i.e. $c^v_{2,j}(y) = c_{1,j}$ for all $y < \bar{y}_j$). If any truth-telling constraint is not satisfied under $\tilde{L}_j$, then high effort cannot be induced and the unobservability of transfers leads to a breakdown of the contract $\tilde{L}_j$.

Altogether, if it is possible to induce high effort when transfers are unobservable, then contracts will be identical regardless of whether parental transfers are observed. However, if mis-reporting transfers is optimal when shirking, then the unobservability of parental transfers can lead to a breakdown of effort-inducing contracts.

Figure A1: Probability of Delinquency or Default at CSS by Earnings and Additional Financial Resources



Notes: `Savings' implies savings of at least $1,000. `Parental Assistance' implies expected parental transfers of at least $2,500. Sampling weights are used.

Table A1: Delinquency or Default at CSS by Earnings, Expected Parental Transfers, and Savings

	Mean	Std. Error
A. by current earnings		
earnings < \$20,000	0.162	0.027
\$20,000 ≤ earnings < \$40,000	0.049	0.013
earnings ≥ \$40,000	0.022	0.016
B. by expected parental support		
expected parental transfer < \$2,500	0.125	0.019
expected parental transfer ≥ \$2,500	0.040	0.016
C. by savings		
savings < \$1,000	0.176	0.027
savings ≥ \$1,000	0.028	0.009

Notes: Based on main sample of 689 individuals with non-missing responses to baseline variables, current earnings, expected parental support and savings. Sample weights used in calculating all statistics.

Table A2: Estimates for Probability of Delinquency or Default

Variables	(1)	(2)	(3)	(4)	(5)
constant	0.206	0.004	0.330	0.182	0.181
	(0.153)	(0.167)	(0.164)	(0.193)	(0.193)
CSLP loan amount outstanding at consolidation (in $10,000)	0.049	0.049	0.036	0.039	0.039
	(0.031)	(0.030)	(0.030)	(0.030)	(0.030)
CSLP loan amount (in $10,000) squared	-0.007	-0.007	-0.006	-0.006	-0.006
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
vocational/technical school graduate or more	-0.052	-0.060	-0.046	-0.054	-0.053
	(0.052)	(0.050)	(0.050)	(0.050)	(0.050)
4-year university graduate or post-graduate degree	-0.027	0.005	0.010	0.026	0.026
	(0.032)	(0.032)	(0.031)	(0.031)	(0.031)
would stop paying CSLP loan first if unable to repay all loans	-0.005	-0.002	-0.007	-0.005	-0.005
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
male	-0.043	-0.026	-0.019	-0.011	-0.010
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
age	-0.005	0.002	-0.006	-0.001	-0.001
	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)
indigenous	0.014	0.033	-0.013	0.007	0.003
	(0.053)	(0.050)	(0.052)	(0.050)	(0.050)
private for profit post-secondary institution (CSS loan type)	0.116	0.112	0.096	0.098	0.097
	(0.043)	(0.042)	(0.044)	(0.043)	(0.044)
current earnings: none		0.108		0.062	0.059
		(0.049)		(0.052)	(0.053)
current earnings: $1 to less than $10,000/year		0.134		0.082	0.071
		(0.063)		(0.066)	(0.070)
current earnings: $10,000/year to less than $20,000/year		0.128		0.080	0.075
		(0.043)		(0.041)	(0.041)
current earnings: $20,000/year to less than $30,000/year		-0.002		-0.026	-0.026
		(0.026)		(0.029)	(0.029)
current earnings: $30,000/year to less than $40,000/year		-0.001		-0.001	-0.005
		(0.035)		(0.034)	(0.036)
expected parental transfer ≥ $2,500			-0.050	-0.043	-0.078
			(0.026)	(0.026)	(0.052)
savings ≥ $1,000			-0.133	-0.115	-0.133
			(0.029)	(0.031)	(0.039)
has both savings ≥ $1,000 and parental transfer ≥ $2,500					0.060
					(0.059)
R-squared	0.055	0.088	0.105	0.121	0.123

Notes: Linear probability model estimated using OLS. Specifications also include indicators for CSS cohort and province. Based on main sample of 689 individuals with non-missing responses to baseline variables, current earnings, expected parental support and savings. Sampling weights are used. Robust standard errors in parentheses.

Table A3: Estimates for Probability of Delinquency or Default: Low-Earning Borrowers

Variables	(1)	(2)
constant	0.253	0.247
	(0.384)	(0.382)
CSLP loan amount outstanding at consolidation (in $10,000)	0.103	0.105
	(0.062)	(0.062)
CSLP loan amount (in $10,000) squared	-0.014	-0.014
	(0.012)	(0.012)
vocational/technical school graduate or more	-0.075	-0.076
	(0.079)	(0.078)
4-year university graduate or post-graduate degree	-0.002	0.001
	(0.057)	(0.057)
would stop paying CSLP loan first if unable to repay all loans	-0.068	-0.067
	(0.047)	(0.047)
male	-0.081	-0.081
	(0.052)	(0.052)
age	-0.001	0.000
	(0.016)	(0.016)
indigenous	0.143	0.141
	(0.115)	(0.116)
private for profit post-secondary institution (CSS loan type)	0.039	0.039
	(0.072)	(0.073)
current earnings < $10,000/year	-0.003	-0.004
	(0.057)	(0.057)
expected parental transfer ≥ $2,500	-0.059	-0.080
	(0.048)	(0.073)
savings ≥ $1,000	-0.151	-0.162
	(0.052)	(0.063)
has both savings ≥ $1,000 and parental transfer ≥ $2,500		0.041
		(0.088)
Observations	356	356
R-squared	0.151	0.152

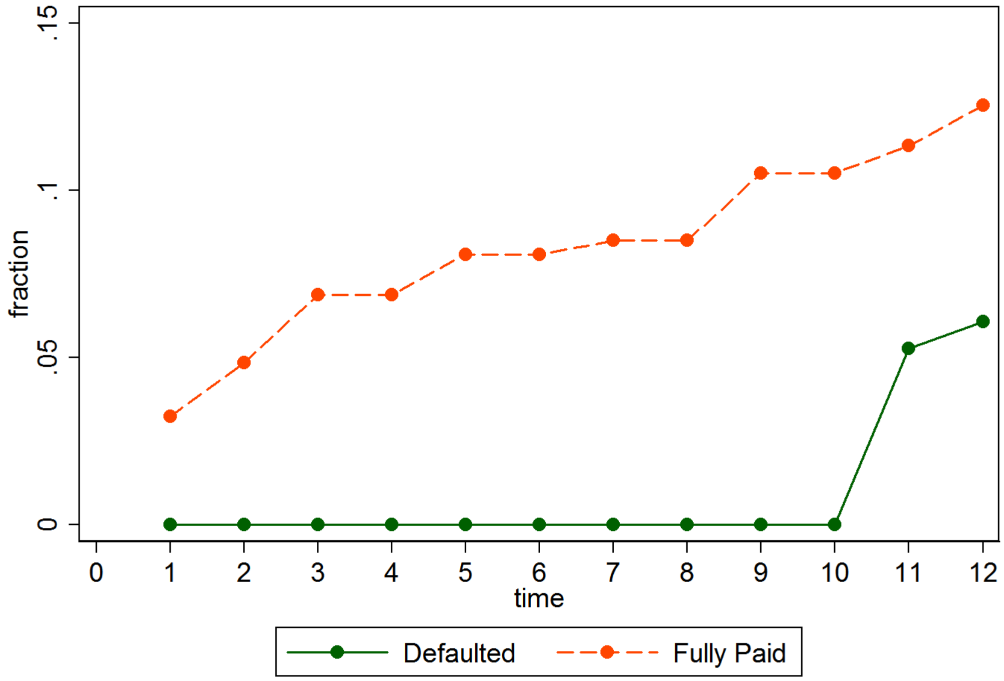
Notes: Linear probability models estimated using OLS. Specifications also include indicators for CSS cohort and province. Sample includes respondents with earnings less than $20,000 per year and is restricted to those with non-missing responses to baseline variables, current earnings, expected parental support and savings. Sampling weights are used. Robust standard errors in parentheses.

Table A4: Estimated Effects of Parental Income on Delinquency or Default

Variables	Full Sample	Expected Parental Transfers = 0	Expected Parental Transfers ≥ 0
constant	-0.007	-0.306	0.110
	(0.166)	(0.231)	(0.216)
CSLP loan amount outstanding at consolidation (in $10,000)	0.056	0.103	0.039
	(0.030)	(0.052)	(0.038)
CSLP loan amount (in $10,000) squared	-0.008	-0.018	-0.003
	(0.006)	(0.009)	(0.007)
vocational/technical school graduate or more	-0.056	-0.115	-0.042
	(0.051)	(0.092)	(0.067)
4-year university graduate or post-graduate degree	0.002	0.030	0.001
	(0.033)	(0.058)	(0.042)
would stop paying CSLP loan first if unable to repay all loans	-0.002	-0.018	0.001
	(0.027)	(0.049)	(0.035)
male	-0.022	0.009	-0.032
	(0.027)	(0.050)	(0.036)
age	0.002	0.014	-0.003
	(0.007)	(0.010)	(0.010)
indigenous	0.024	0.009	0.047
	(0.049)	(0.088)	(0.070)
private for profit post-secondary institution (CSS loan type)	0.109	0.173	0.088
	(0.042)	(0.079)	(0.051)
current earnings: none	0.107	0.070	0.127
	(0.049)	(0.072)	(0.067)
current earnings: $1 to less than $10,000/year	0.126	0.099	0.134
	(0.064)	(0.105)	(0.082)
current earnings: $10,000/year to less than $20,000/year	0.127	0.148	0.127
	(0.042)	(0.104)	(0.053)
current earnings: $20,000/year to less than $30,000/year	0.000	0.016	-0.007
	(0.026)	(0.063)	(0.031)
current earnings: $30,000/year to less than $40,000/year	0.005	-0.039	0.010
	(0.034)	(0.061)	(0.044)
dependent student with parental income < $25,000	0.017	-0.053	0.038
	(0.048)	(0.078)	(0.060)
dependent student with parental income ≥ $25,000	-0.054	-0.058	-0.044
	(0.031)	(0.069)	(0.041)
R-squared	0.094	0.198	0.088
Sample Size	689	207	482

Notes: Linear probability models estimated using OLS. Specifications also include indicators for CSS cohort and province. Based on main sample of individuals with non-missing responses to baseline variables, current earnings, expected parental support and savings. Sampling weights are used. Robust standard errors in parentheses.

Figure B1: Default and Full Repayment by Months Since Consolidation (1-12 Months)



N=248

Figure B2: Default and Full Repayment by Months Since Consolidation (1-24 Months)

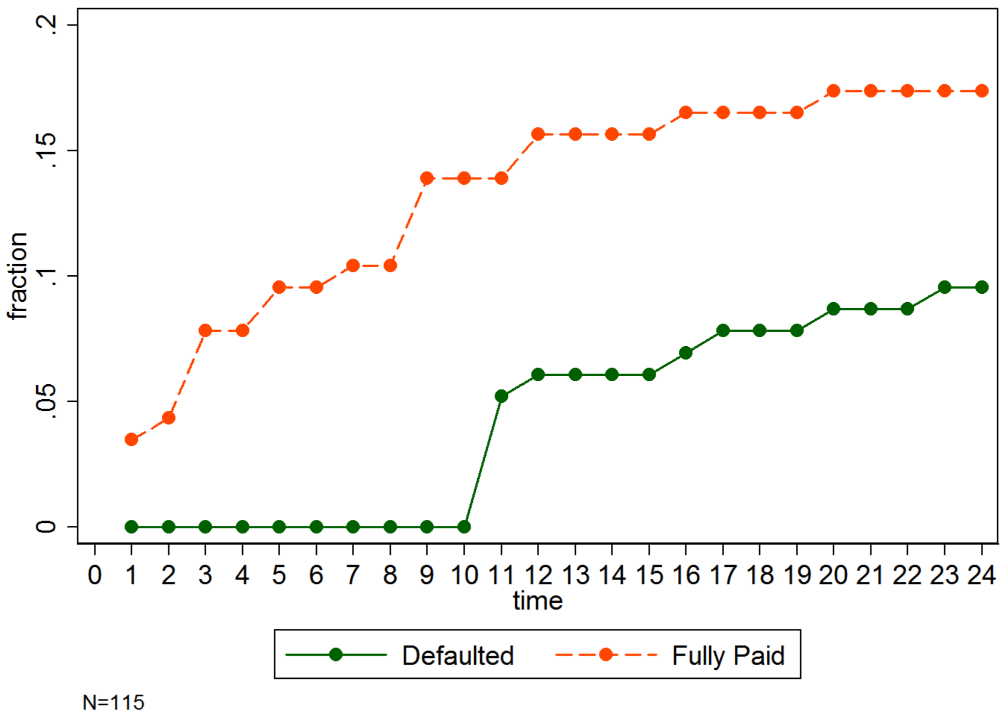


Table B1: Estimates for Probability of Repayment Problems (CSS within 1 Year of Consolidation)

Variables	Any Repayment Problem	Delinquency or Default
constant	-0.219	0.178
	(0.319)	(0.253)
CSLP loan amount outstanding at consolidation (in $10,000)	0.139	0.048
	(0.050)	(0.036)
CSLP loan amount (in $10,000) squared	-0.010	-0.007
	(0.009)	(0.007)
vocational/technical school graduate or more	0.058	-0.057
	(0.087)	(0.069)
4-year university graduate or post-graduate degree	-0.055	0.046
	(0.084)	(0.048)
would stop paying CSLP loan first if unable to repay all loans	0.088	-0.013
	(0.060)	(0.039)
male	0.040	-0.012
	(0.069)	(0.042)
age	0.010	-0.002
	(0.013)	(0.010)
indigenous	0.025	0.048
	(0.131)	(0.076)
private for profit post-secondary institution (CSS loan type)	0.092	0.124
	(0.070)	(0.067)
current earnings: none	0.459	0.028
	(0.109)	(0.068)
current earnings: $1 to less than $10,000/year	0.332	0.072
	(0.106)	(0.084)
current earnings: $10,000/year to less than $20,000/year	0.328	0.114
	(0.099)	(0.062)
current earnings: $20,000/year to less than $30,000/year	0.173	-0.037
	(0.091)	(0.053)
current earnings: $30,000/year to less than $40,000/year	0.165	0.007
	(0.098)	(0.069)
savings ≥ $1,000	-0.249	-0.125
	(0.060)	(0.042)
expected parental transfer ≥ $2,500	-0.147	-0.027
	(0.060)	(0.035)
Observations	430	430
R-squared	0.329	0.129

Notes: Linear probability model estimated using OLS. Specifications also include indicators for CSS cohort and province. Sample only includes respondents taking the CSS within one year of CSLP consolidation. Sampling weights are used. Robust standard errors in parentheses.

Table C1: Repayment Problems at CSS by Earnings and Additional Financial Resources (Includes Living with Parents)

	Has Both Savings and Family Assistance	Has Either Savings or Family Assistance (Not Both)	Has Neither Savings nor Family Assistance
<u>A: Any Repayment Problem</u>			
Earnings < $20,000	0.130	0.497	0.785
	(0.040)	(0.064)	(0.072)
	16.93%	*28.65%*	*5.12%*
Earnings ≥ $20,000	0.055	0.108	0.571
	(0.021)	(0.032)	(0.130)
	28.99%	*16.01%*	*4.29%*
<u>B: Delinquency or Default</u>			
Earnings < $20,000	0.048	0.181	0.367
	(0.023)	(0.042)	(0.083)
	16.93%	*28.65%*	*5.12%*
Earnings ≥ $20,000	0.016	0.060	0.141
	(0.010)	(0.026)	(0.060)
	28.99%	*16.01%*	*4.29%*

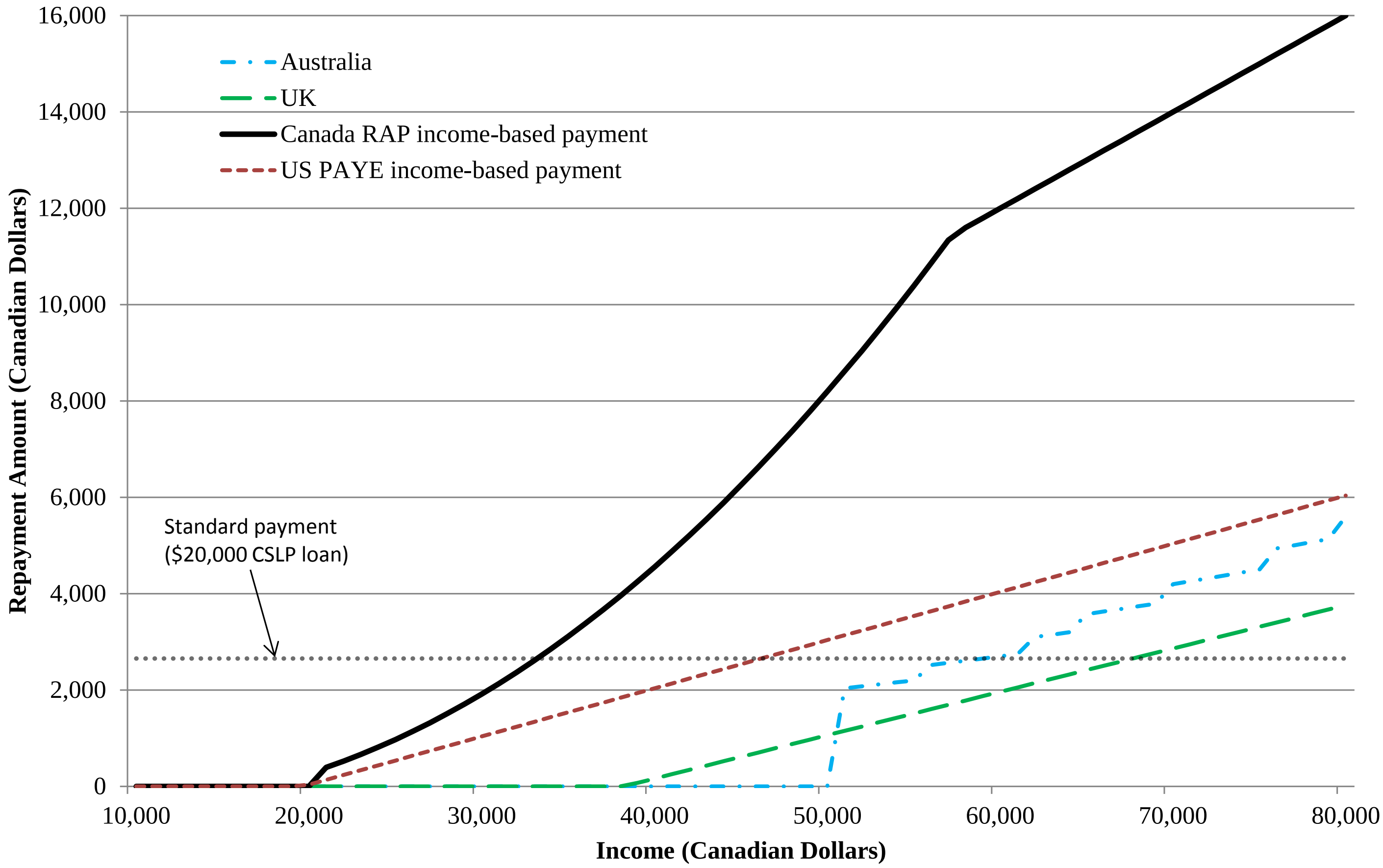
Note: Repayment problem indicator averages by earnings and additional resource measures. 'Savings' implies savings ≥ $1,000. 'Family Assistance' implies at least one of the following: (i) expected parental transfers of at least $2,500, (ii) can move in with parents, or (iii) already living with parents. Standard errors are in parentheses. (Weighted) percent of population in each cell is in italics. Sampling weights are used.

Table C2: The Effect of Savings and Parental Assistance (Includes Living with Parents) on Repayment Problems for Low-Earning Borrowers

Variables	Any Repayment Problem	Delinquency or Default
constant	0.762	0.374
	(0.438)	(0.427)
CSLP loan amount outstanding at consolidation (in $10,000)	0.251	0.102
	(0.077)	(0.059)
CSLP loan amount (in $10,000) squared	-0.020	-0.014
	(0.013)	(0.011)
vocational/technical school graduate or more	-0.035	-0.085
	(0.096)	(0.081)
4-year university graduate or post-graduate degree	0.158	0.009
	(0.091)	(0.057)
would stop paying CSLP loan first if unable to repay all loans	0.051	-0.082
	(0.076)	(0.048)
male	-0.021	-0.077
	(0.074)	(0.050)
age	-0.009	-0.003
	(0.019)	(0.017)
indigenous	0.039	0.104
	(0.141)	(0.108)
private for profit post-secondary institution (CSS loan type)	0.098	0.062
	(0.076)	(0.073)
current earnings < $10,000/year	0.143	0.000
	(0.072)	(0.058)
expected parental transfer ≥ $2,500 OR can move in with parents	-0.195	-0.107
OR already live with parents	(0.061)	(0.072)
savings ≥ $1,000	-0.399	-0.151
	(0.069)	(0.053)
Observations	338	338
R-squared	0.378	0.148

Note: Linear probability model estimated using OLS. Specifications also include indicators for CSS cohort and province. Sample includes respondents with current earnings less than $20,000 per year. Standard errors are in parentheses. Sampling weights are used. Robust standard errors in parentheses.

Figure D1: Income-Contingent Loan Repayment Functions



Notes: All currencies translated to Canadian dollars using Sept, 2014, exchange rates. Repayments for Canada and U.S. are for single childless persons and only reflect the income-contingent repayment amount which may exceed the debt-based payment.