Online Appendix for The Out-of-State Tuition Distortion

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1 Theory Proofs and Extensions

1.1 Derivation of $\frac{\partial r_W}{\partial n}$ and $\frac{\partial r_E}{\partial n}$

We derive expressions for the change in resident tuition given a uniform increase in non-resident tuition. Note that, for state W, the budget constraint $f_W r_W + (1-f_W)n_W = m$ can be re-written as:

$$P_W(r_W, n_E)[r_W - m] + [1 - P_E(r_E, n_W)][n_W - m] = 0$$

Then, considering a change in n_E, we have that:

$$\left(\frac{\partial P_W}{\partial r_W}\frac{\partial r_W}{\partial n_E} + \frac{\partial P_W}{\partial n_E}\right)[r_W - m] + P_W\frac{\partial r_W}{\partial n_E} - \frac{\partial P_E}{\partial r_E}\frac{\partial r_E}{\partial n_E}[n_W - m] = 0$$

Similarly, considering a change in n_W, we have that:

$$\left(\frac{\partial P_W}{\partial r_W}\frac{\partial r_W}{\partial n_W}\right)[r_W - m] + P_W\frac{\partial r_W}{\partial n_W} - \left(\frac{\partial P_E}{\partial r_E}\frac{\partial r_E}{\partial n_W} + \frac{\partial P_E}{\partial n_W}\right)[n_W - m] + (1 - P_E) = 0$$

Now, direct effects are given by $\frac{\partial P_E}{\partial r_E} = -\rho P_E(1-P_E)$ and cross-effects are given by $\frac{\partial P_E}{\partial n_W} = \rho P_E(1-P_E)$. Thus, $\frac{\partial P_E}{\partial r_E} = -\frac{\partial P_E}{\partial n_W}$, and, plugging this into the expressions above, we have:

$$\left(\frac{\partial P_W}{\partial r_W}(\frac{\partial r_W}{\partial n_E} - 1)\right)[r_W - m] + P_W\frac{\partial r_W}{\partial n_E} - \frac{\partial P_E}{\partial r_E}\frac{\partial r_E}{\partial n_E}[n_W - m] = 0$$

$$\left(\frac{\partial P_W}{\partial r_W}\frac{\partial r_W}{\partial n_W}\right)[r_W - m] + P_W\frac{\partial r_W}{\partial n_W} - \left(\frac{\partial P_E}{\partial r_E}(\frac{\partial r_E}{\partial n_W} - 1)\right)[n_W - m] + (1 - P_E) = 0$$

Adding these two conditions together, we have:

$$\left(\frac{\partial P_W}{\partial r_W}(\frac{\partial r_W}{\partial n_E} + \frac{\partial r_W}{\partial n_W} - 1)\right)[r_W - m] + P_W(\frac{\partial r_W}{\partial n_E} + \frac{\partial r_W}{\partial n_W}) - \frac{\partial P_E}{\partial r_E}(\frac{\partial r_E}{\partial n_W} + \frac{\partial r_E}{\partial n_E} - 1)[n_W - m] + (1 - P_E) = 0$$

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Letting $\frac{\partial r_W}{\partial n} = \frac{\partial r_W}{\partial n_E} + \frac{\partial r_W}{\partial n_W}$ and $\frac{\partial r_E}{\partial n} = \frac{\partial r_E}{\partial n_E} + \frac{\partial r_E}{\partial n_W}$, we have

$$\left(\frac{\partial P_W}{\partial r_W} (\frac{\partial r_W}{\partial n} - 1) \right) [r_W - m] + P_W \frac{\partial r_W}{\partial n} - \frac{\partial P_E}{\partial r_E} (\frac{\partial r_E}{\partial n} - 1) [n_W - m] + (1 - P_E) = 0$$

Now, by symmetry, for the case of state E, we have:

$$\left(\frac{\partial P_E}{\partial r_E} (\frac{\partial r_E}{\partial n} - 1) \right) [r_E - m] + P_E \frac{\partial r_E}{\partial n} - \frac{\partial P_W}{\partial r_W} (\frac{\partial r_W}{\partial n} - 1) [n_E - m] + (1 - P_W) = 0$$

In the symmetric case, these simplify to:

$$\left(\frac{\partial P}{\partial r} (\frac{\partial r}{\partial n} - 1) \right) [r - n] + P \frac{\partial r}{\partial n} + (1 - P) = 0$$

Solving, we have that:

$$\frac{\partial r}{\partial n} = \frac{-(1 - P) - \frac{\partial P}{\partial r}(n - r)}{P - \frac{\partial P}{\partial r}(n - r)}$$

1.2 Proof of Proposition 1

Using some results from the prior section, we have that:

$$\left(\frac{\partial P_W}{\partial r_W} (\frac{\partial r_W}{\partial n_E} - 1) \right) [r_W - m] + P_W \frac{\partial r_W}{\partial n_E} - \frac{\partial P_E}{\partial r_E} \frac{\partial r_E}{\partial n_E} [n_W - m] = 0$$

$$\left(\frac{\partial P_W}{\partial r_W} \frac{\partial r_W}{\partial n_W} \right) [r_W - m] + P_W \frac{\partial r_W}{\partial n_W} - \left(\frac{\partial P_E}{\partial r_E} (\frac{\partial r_E}{\partial n_W} - 1) \right) [n_W - m] + (1 - P_E) = 0$$

When $r_W = n_W = m$, these simplify to:

$$\frac{\partial r_W}{\partial n_E} = 0$$

$$\frac{\partial r_W}{\partial n_W} = \frac{-(1 - P_E)}{P_W}$$

For the case of the budget of state E, we have that, by symmetry:

$$\frac{\partial r_E}{\partial n_W} = 0$$

$$\frac{\partial r_E}{\partial n_E} = \frac{-(1 - P_W)}{P_E}$$

Recall the original formula for the change in welfare:

$$0.5 \left[\{ -P_W \frac{\partial r_W}{\partial n_W} - (1 - P_E) - P_E \frac{\partial r_E}{\partial n_W} \} \Delta n_W + \{ -P_E \frac{\partial r_E}{\partial n_E} - (1 - P_W) - P_W \frac{\partial r_W}{\partial n_E} \} \Delta n_E \right]$$

Plugging in the above expressions, we have that there is no welfare gain when considering changes in non-resident tuition when $r_W = n_W = m$ and $r_E = n_E = m$. Thus, non-discriminatory policies are optimal.

1.3 Proof of Proposition 2

In the symmetric case, we have that $\frac{\partial P}{\partial n} = \rho P(1-P)$ and thus $n-m = 1/\rho P$. Further, using the budget constraint, one can show that $P = (n-m)/(n-r)$. Combining these, we have that:

$$r = n - \rho(n-m)^2$$

Further, note that $P = exp(-\rho r)/[exp(-\rho r) + exp(-\rho n - \rho\delta)]$, which can be re-written as $r = n + \delta - (1/\rho)ln[P/(1-P)]$. Next, note that $n-m = (1/\rho P)$ and thus $P/(1-P) = 1/[\rho(n-m)-1]$. Combining these two expressions, we have that:

$$r = n + \delta + (1/\rho)ln[\rho(n-m)-1]$$

The first expression for r is quadratic in n, with a peak at $n = m + (0.5/\rho)$, at which point $r = m + (0.25/\rho)$. Beyond this peak, the expression in decreasing in n. The second expression for r equals negative infinity when $n = m + (0.5/\rho)$ and is strictly increasing in n. Moreover, when $n = m + (2/\rho)$, $r = m + (2/\rho) + \delta$. This is greater than $m + (0.25/\rho)$, and hence there is a single crossing between $n = m + (0.5/\rho)$ and $n = m + (2/\rho)$. At this single crossing, we have that $r < m < n$.

To show the comparative static, combining the two expressions above, note that n can be implicitly defined by:

$$-\rho^2(n-m)^2 = \rho\delta + ln[\rho(n-m)-1]$$

Considering a change in ρ,we have that:

$$-2\rho(n-m)^2 - 2\rho^2(n-m)\frac{\partial n}{\partial \rho} = \delta + \frac{(n-m) + \rho\frac{\partial n}{\partial \rho}}{\rho(n-m)-1}$$

Re-arranging, we have that

$$(-2\rho(n-m)^2 - \delta)[\rho(n-m)-1] - 2\rho^2(n-m)\frac{\partial n}{\partial \rho}[\rho(n-m)-1] = (n-m) + \rho\frac{\partial n}{\partial \rho}$$

Finally, solving, we have,

$$\frac{\partial n}{\partial \rho} = \frac{(-2\rho(n-m)^2 - \delta)[\rho(n-m)-1] - (n-m)}{\rho + 2\rho^2(n-m)[\rho(n-m)-1]}$$

Thus, since $\rho(n-m)-1 > 0$ and $n > m$, we have that the numerator is negative and the denominator is positive. Thus, $\frac{\partial n}{\partial \rho} < 0$.

1.4 Theoretical Extension: Fixed Costs

We next extend the theoretical model to include fixed costs. In particular, continue to assume that educating a student requires a constant expenditure, or marginal cost, equal to m, but that institutions also incur a fixed cost equal to F. Then, college W faces the following budget constraint:

$$P_W r_W + (1-P_E)n_W = (P_W + 1 - P_E)m + F$$

Then, re-deriving $\frac{\partial r_W}{\partial n}$ and $\frac{\partial r_E}{\partial n}$ in the first appendix, we have that the budget constraint can be re-written as:

$$P_W(r_W, n_E)[r_W - m] + [1 - P_E(r_E, n_W)][n_W - m] = F$$

Then, considering a changes in n_E and n_W we have that the key conditions are unchanged:

$$\left(\frac{\partial P_W}{\partial r_W}\frac{\partial r_W}{\partial n_E}+\frac{\partial P_W}{\partial n_E}\right)[r_W-m]+P_W\frac{\partial r_W}{\partial n_E}-\frac{\partial P_E}{\partial r_E}\frac{\partial r_E}{\partial n_E}[n_W-m]=0$$

$$\left(\frac{\partial P_W}{\partial r_W}\frac{\partial r_W}{\partial n_W}\right)[r_W-m]+P_W\frac{\partial r_W}{\partial n_W}-\left(\frac{\partial P_E}{\partial r_E}\frac{\partial r_E}{\partial n_W}+\frac{\partial P_E}{\partial n_W}\right)[n_W-m]+(1-P_E)=0$$

Thus, the key conclusions from the welfare analysis remain unchanged.

We next consider tuition policies set under decentralization with fixed costs. In the symmetric case, Nash equilibrium out-of-state tuition continues to be characterized by:

$$n=m+\frac{(1-P)}{\partial P/\partial n}$$

Using the institutional budget constraint under symmetry $[Pr+(1-P)n=m+F]$ and using the fact that $\partial P/\partial n=\rho P(1-P)$, this can be re-written as:

$$P(n-r)=-F+\frac{1}{\rho P}$$

Thus, non-resident tuition continues to be higher than resident tuition so long as fixed costs are sufficiently small (i.e., $F<(1/\rho P)$).

1.5 Theoretical Extension: Increasing marginal costs

We next extend the theoretical model to increasing marginal costs. In particular, assume that marginal costs are quadratic in enrollment, with the parameter β capturing the degree of convexity. That is, college W faces the following budget constraint:

$$P_W r_W+(1-P_E)n_W=(P_W+1-P_E)m+\beta(P_W+1-P_E)^2$$

Then, re-deriving $\frac{\partial r_W}{\partial n}$ and $\frac{\partial r_E}{\partial n}$ in the first appendix, we have that the budget constraint can be re-written as:

$$P_W(r_W,n_E)[r_W-m]+[1-P_E(r_E,n_W)][n_W-m]=\beta[P_W(r_W,n_E)+(1-P_E(r_E,n_W))]^2$$

Then, considering a changes in n_E and n_W we have that the key conditions are given by:

$$\left(\frac{\partial P_W}{\partial r_W}\frac{\partial r_W}{\partial n_E}+\frac{\partial P_W}{\partial n_E}\right)[r_W-m]+P_W\frac{\partial r_W}{\partial n_E}-\frac{\partial P_E}{\partial r_E}\frac{\partial r_E}{\partial n_E}[n_W-m]=$$
$$2\beta[P_W(r_W,n_E)+(1-P_E(r_E,n_W))]\left(\frac{\partial P_W}{\partial r_W}\frac{\partial r_W}{\partial n_E}+\frac{\partial P_W}{\partial n_E}-\frac{\partial P_E}{\partial r_E}\frac{\partial r_E}{\partial n_E}\right)$$

$$\left(\frac{\partial P_W}{\partial r_W}\frac{\partial r_W}{\partial n_W}\right)[r_W-m]+P_W\frac{\partial r_W}{\partial n_W}-\left(\frac{\partial P_E}{\partial r_E}\frac{\partial r_E}{\partial n_W}+\frac{\partial P_E}{\partial n_W}\right)[n_W-m]+(1-P_E)=$$
$$2\beta[P_W(r_W,n_E)+(1-P_E(r_E,n_W))]\left(\frac{\partial P_W}{\partial r_W}\frac{\partial r_W}{\partial n_W}-\frac{\partial P_E}{\partial r_E}\frac{\partial r_E}{\partial n_W}-\frac{\partial P_E}{\partial n_W}\right)$$

In the symmetric case ($P_E = P_W$), these can be written as:

$$\left(\frac{\partial P_W}{\partial r_W}\frac{\partial r_W}{\partial n_E}+\frac{\partial P_W}{\partial n_E}\right)[r_W-m-2\beta]+P_W\frac{\partial r_W}{\partial n_E}-\frac{\partial P_E}{\partial r_E}\frac{\partial r_E}{\partial n_E}[n_W-m-2\beta]=0$$

$$\left(\frac{\partial P_W}{\partial r_W}\frac{\partial r_W}{\partial n_W}\right)[r_W-m-2\beta]+P_W\frac{\partial r_W}{\partial n_W}-\left(\frac{\partial P_E}{\partial r_E}\frac{\partial r_E}{\partial n_W}+\frac{\partial P_E}{\partial n_W}\right)[n_W-m-2\beta]+(1-P_E)=0$$

Thus, all of the previous results in the symmetric case follow, with m replaced by $m+2\beta$. Since the key results do not depend upon m, they thus do not depend upon β.

Under decentralization, the relevant version of equation (14) in the symmetric case ($P_W = P_E$) is given by:

$$\frac{\partial P_W}{\partial r_W}\frac{\partial r_W}{\partial n_W}[r_W-m-2\beta]+P_W\frac{\partial r_W}{\partial n_W}+(1-P_E)-\frac{\partial P_E}{\partial n_W}[n_W-m-2\beta]=0$$

Since $\frac{\partial r_W}{\partial n_W}=0$ in equilibrium, we have that non-resident tuition can be characterized by:

$$n=m+2\beta+\frac{(1-P)}{\partial P/\partial n}$$

Moreover, the budget constraint under symmetry is equal to:

$$P(r-m)+(1-P)(n-m)=\beta$$

Thus, under non-distortionary tuition, we have that $n=r=m+\beta$. Since $n>m+\beta$, it is the case that $n>r$.

1.6 Theoretical Extension: State subsidies

Assume that colleges receive a subsidy for each resident student from the state government equal to σ_c. These subsidies are financed via non-distortionary taxes that must be paid by families regardless of college choice. These subsidies are assumed to be exogenous and thus do not respond to changes in tuition policy. In this case, the inclusive value for a resident from state W is given by:

$$V_W(r_W,n_E)=(1/\rho)\ln[\exp(\alpha\rho q_W-\rho r_W)+\exp(\alpha\rho q_E-\rho n_E-\rho\delta)]-P_W\sigma_W$$

where the new term represents welfare costs associated with taxes required to finance subsidies and depend upon the likelihood of all residents attending in-state colleges.

Also, the college budget constraint for college W is adjusted as follows:

$$f_W(r_W+\sigma_W)+(1-f_W)n_W=m$$

In the symmetric case, we have that the change in welfare is given by:

$$\Delta n\left[-P\frac{\partial r}{\partial n}-(1-P)-\sigma\frac{\partial P}{\partial r}\frac{\partial r}{\partial n}-\sigma\frac{\partial P}{\partial n}\right]$$

where the two new terms represents the change in taxes required to fund the appropriations due to a response in in-state enrollment probabilities. Under symmetry, we have that $\frac{\partial P}{\partial n}=-\frac{\partial P}{\partial r}$, and the expression can be written more compactly as:

$$\Delta n\left[-P\frac{\partial r}{\partial n}-(1-P)-\sigma\frac{\partial P}{\partial r}(\frac{\partial r}{\partial n}-1)\right]$$

The required change in resident tuition in this case can be written as:

$$\frac{\partial r}{\partial n} = \frac{-(1-P) - \frac{\partial P}{\partial r}(n-r-\sigma)}{P - \frac{\partial P}{\partial r}(n-r-\sigma)}$$

When $n = r + \sigma$, we have that the required change in tuition equals $-(1-P)/P$, and the welfare gain takes the simple form:

$$\Delta n \left[\frac{\partial P}{\partial r} \frac{\sigma}{P} \right]$$

Since $\frac{\partial P}{\partial r} < 0$, we have that reductions in non-resident tuition from $n = r + \sigma$ lead to an increase in welfare.

With portable subsidies, all residents receive subsidies, regardless of which institution they attend, and taxes simply equal the subsidy. Assume that in-state students pay r_c and the institution receives a subsidy equal to σ_c. For out-of-state students, assume that colleges charge a higher tuition equal to $n_c > r_c$ but that students can use their portable subsidy to help to cover their tuition. Thus, the net payment, for example, for students from W attending college E equals $n_E - \sigma_W$. In this case, the inclusive value for a resident from state W equals:

$$V_W(r_W, n_E) = (1/\rho)\ln[\exp(\alpha\rho q_W - \rho r_W) + \exp(\alpha\rho q_E - \rho(n_E - \sigma_W) - \rho\delta)] - \sigma_W$$

Moreover, the college budget constraint is given by:

$$f_W(r_W + \sigma_W) + (1 - f_W)n_W = m$$

In the symmetric case, we have that the key welfare expressions can be written as:

$$\Delta n \left[-P\frac{\partial r}{\partial n} - (1-P) \right]$$

$$\frac{\partial r}{\partial n} = \frac{-(1-P) - \frac{\partial P}{\partial r}(n-r-\sigma)}{P - \frac{\partial P}{\partial r}(n-r-\sigma)}$$

Thus, when $n = r + \sigma$, we have that the required change in tuition again equals $-(1-P)/P$. Given this, there is no welfare gain when reducing non-resident tuition from this higher level.

1.7 Theoretical Extension: More Than Two States

We next extend the model from two states to S states, indexed by s. Let $P_s(t)$ denote the likelihood that a student from state s attends institution t. Then, in-state attendance probabilities are given by:

$$P_s(s) = \frac{\exp(\alpha\rho q_s - \rho r_s)}{\exp(\alpha\rho q_s - \rho r_s) + \sum_{t \neq s} \exp(\alpha\rho q_t - \rho n_t - \rho\delta)}$$

Likewise, attendance at an out-of-state institution $t \neq s$ occurs with the following probability:

$$P_s(t) = \frac{\exp(\alpha\rho q_t - \rho r_t - \delta)}{\exp(\alpha\rho q_t - \rho r_t - \delta) + \exp(\alpha\rho q_s - \rho r_s) + \sum_{r \neq s, r \neq t} \exp(\alpha\rho q_r - \rho n_r - \rho\delta)}$$

Then, the change in welfare given a uniform increase in non-resident tuition equals:

$$(1/S)\Delta n\left[\sum_s -P_s(s)\frac{\partial r_s}{\partial n}-\sum_{t\neq s}(1-P_s(t))\right]$$

Under symmetry, this reduces to:

$$\Delta n\left[-P\frac{\partial r}{\partial n}-(1-P)\right]$$

where P represents the likelihood of in-state attendance and $1-P$ represents the likelihood of out-of-state attendance, aggregated over all out-of-state institutions. Moreover, it remains the case that:

$$\frac{\partial r}{\partial n}=\frac{-(1-P)-\frac{\partial P}{\partial r}(n-r)}{P-\frac{\partial P}{\partial r}(n-r)}$$

Thus, the welfare calculations are unchanged with more than two states, under the interpretation that $1-P$ is the out-of-state attendance probability, aggregated over all possible out-of-state institutions.

Turning to decentralization, we have that state s again chooses non-resident tuition to minimize resident tuition. That is, $\partial r_s/\partial n_s=0$. The institution budget constraint for college s in this case is given by:

$$P_s(s)(r_s-m)+\sum_{t\neq s}P_t(s)(n_s-m)=0$$

Taking the derivative with respect to non-resident tuition (n_s), we have that:

$$\frac{\partial P_s}{\partial r_s}\frac{\partial r_s}{\partial n_s}[r_s-m]+P_s\frac{\partial r_s}{\partial n_s}+\sum_{t\neq s}P_t(s)+\sum_{t\neq s}\frac{\partial P_t(s)}{\partial n_s}[n_s-m]=0$$

Since $\frac{\partial r_s}{\partial n_s}=0$ in equilibrium and using the fact that $\frac{\partial P_t(s)}{\partial n_s}=-\rho P_t(s)[1-P_t(s)]$, we have that:

$$\sum_{t\neq s}P_t(s)=\sum_{t\neq s}\rho P_t(s)[1-P_t(s)][n_s-m]$$

In the symmetric case, we have that $P_t(s)=(1-P)/(S-1)$ for $t\neq s$, where P is the probability of in-state attendance. Then, this can be written as:

$$(1-P)=\frac{\rho(1-P)(S+P-2)(n-m)}{S-1}$$

Solving for non-resident tuition, we have that:

$$n=m+\frac{1}{\rho}\frac{S-1}{(S+P-2)}$$

Since $P\leq 1$, we have that $n\geq m+1/\rho$, and, moreover, non-resident tuition converges to $m+1/\rho$ as the number of states grows large.

To further investigate how tuition policies change with the number of states, we next calibrate the model to match current tuition and in-state attendance probabilities. To do so, we first invert the above non-resident pricing rule to solve for ρ as follows:

$$\rho=\frac{1}{n-m}\frac{S-1}{(S+P-2)}$$

We use in-state attendance probabilities of $P = 0.75$. Tuition is taken from the overall averages in Table 1 of the main document, yielding $n =$15.511 and $r = 6.358$. This implies that $m = 8.646$. Finally, using $S = 50$, we have that $\rho = 0.1464$. With this estimate of ρ, we then choose δ to match $P = 0.75$. This yields $\delta = 24.947$.

With these parameters in hand, we can then estimate how pricing changes given a change in the number of states. As shown in Table 1 below, increasing the number of states beyond 50 does yield a reduction in non-resident tuition, falling from 15.512 to 15.503 for 90 states. This decrease is quite small however, and, as noted above, non-resident tuition is bounded from below by $m + 1/\rho$, which equals 15.477. Thus, there is little scope in the model for reducing non-resident tuition via an increase in the number of states. In addition, while non-resident tuition does fall as the number of states increases, the gap between non-resident and resident tuition actually rises. This reflects the fact that the choice set also increases for students, yielding an increase in non-resident attendance, allowing universities to reduce in-state tuition. Likewise, as the number states decreases below 50, non-resident tuition increases but so does resident tuition, leading to a reduction in the gap between non-resident and resident tuition.

Table 1: Competition and Tuition Policies

Number of states (S)	Out-of-state tuition (n)	In-state tuition (r)	In-state attendance (P)
10	15.533	8.097	0.926
20	15.525	7.588	0.867
30	15.520	7.132	0.819
40	15.515	6.728	0.782
50	15.512	6.362	0.750
60	15.509	6.027	0.724
70	15.507	5.718	0.701
80	15.505	5.431	0.681
90	15.503	5.163	0.663

2 Additional Empirical Results

2.1 Student Payments: Private Institutions

In parallel to Section VI.A of the main document, we present in Table 2 below results on student payments to private institutions using NPSAS data. As shown, residents pay a bit less, around \$260, in tuition payments than non-residents. This difference, however, is small when compared to the sample average of over \$20,000 in tuition payments. The gap is larger for net payments, with residents paying roughly \$2,800 less than residents. This implies that residents receive around \$2,500 more in grants than non-residents at private universities. To further explore the source of this difference, we next decompose total grants into their four components: federal grants, state grants, institution grants, and other grants. As shown, the bulk of the difference is explained by state grants. This finding is consistent with several state aid programs that generate financial differences between residents and non-residents at private institutions. For example, the Cal Grant Program is a state-funded program that provides aid to California residents attending California institutions, both public and private.[1] Likewise, the Hope scholarship in Georgia is available to state residents attending either public or private institutions in the state of Georgia. Finally, we note that these differences in payments between residents and non-residents are smaller than those documented for public institutions.

Table 2: Student payments in NPSAS data: private

	(1) Tuition/ fees paid	(2) Net tuition/ fees paid	(3) Federal grants	(4) State grants	(5) Institution grants	(6) Other grants
in-state	-0.259**	-2.847***	0.634***	1.761***	-0.086	0.278***
	(0.113)	(0.213)	(0.041)	(0.039)	(0.142)	(0.063)
LHS mean	21.435	9.63	1.636	1.195	7.721	1.253
R^2	0.587	0.318	0.164	0.283	0.356	0.110

All specifications include institution-by-year, state-of-residence-by-year, and cohort FE.
Net tuition and fees paid is net of all grants received by the student.
All dollar values are in thousands of 2011 dollars.
The sample consists of 32,130 full-time students attending four-year private institutions.
* p<0.1 ** p<0.05 *** p<0.01

2.2 Analysis of Private Institution Acceptance Decisions

In parallel to Section VI.E of the main document, Table 3 below presents results on private institution acceptance decisions using ELS data. As shown, private institutions are also more likely to admit residents, when compared to non-residents. The difference is only statistically significant, however, when including applicant fixed effects. In addition, the magnitude of any differences is smaller than the corresponding differences for public institutions.

Table 3: Analysis of Private Institution Acceptance Decisions

	(1) Accept	(2) Accept
in-state	0.021	0.040**
	(0.017)	(0.020)
sat	0.001***	
	(0.000)	
gpa	0.146***	
	(0.017)	
R^2	0.245	0.821
student FE	no	yes

Linear probability models of acceptance decisions with institution FE
Sample consists of 5,960 students reporting SAT and GPA scores
Four-year institutions with at least 10 appearances in student application sets
* p<0.1 ** p<0.05 *** p<0.01

[1] For further details, see http://www.csac.ca.gov/doc.asp?id=568 (accessed October 16, 2015).

2.3 Additional Robustness Checks of Main Specification

Table 4: Alternative Border-Side Widths

	10km border-sides			30km border-sides		
	(1)	(2)	(3)	(4)	(5)	(6)
	Enroll	Enroll percent	Ln Enroll	Enroll	Enroll percent	Ln Enroll
in-state	32.997***	0.796***	1.455***	78.606***	0.822***	1.913***
	(3.168)	(0.008)	(0.050)	(6.935)	(0.007)	(0.053)
Observations	16422	11820	16422	17286	14336	17286
R^2	0.439	0.870	0.732	0.457	0.906	0.768
#Clusters	2790	2288	2790	2882	2622	2882

Columns 1-3 at border-side level for 10km border-sides, cols 4-6 use 30km border-sides.
All specifications include university-year FE and border-side-year FE.
Sample is public universities, 1997-2011, excluding two-year colleges.
Standard errors clustered at university-border-side level
* p<0.1 ** p<0.05 *** p<0.01

Table 5: Excluding Border Institutions

	(1)	(2)	(3)
	Enroll	Enroll percent	Ln Enroll
in-state	46.736***	0.814***	1.652***
	(5.397)	(0.008)	(0.050)
Observations	16092	12536	16092
R^2	0.462	0.892	0.779
#Clusters	2682	2308	2682

Regressions run at border-side level, 20km border-sides.
Sample is public universities only, 1997-2011;
two-year colleges are excluded.
Sample also drops universities within 30km of border.
All specifications include univ-year and border_side-year FE.
Standard errors clustered at university-border-side level.
* p<0.1 ** p<0.05 *** p<0.01

2.4 Confidence Intervals for Welfare Analysis

The statistic for the required increase in resident tuition equals:

$$S(\rho) = \frac{-(1-P)+\rho(n-r)P(1-P)}{P+\rho(n-r)P(1-P)}$$

This can be written as

$$S(\rho) = \frac{g(\rho)}{h(\rho)}$$

To apply the Delta method, we require $S'(\rho)$. Applying the quotient rule, we have that:

$$S'(\rho) = \frac{g'(\rho)h(\rho) - g(\rho)h'(\rho)}{h(\rho)^2}$$

Using the fact that $g'(\rho) = h'(\rho) = (n-r)P(1-P)$ and that $h(\rho) - g(\rho) = 1$, this can be re-written as:

$$S'(\rho) = \frac{(n-r)P(1-P)}{h(\rho)^2}$$

Then, using the delta method, the standard error for the required change in resident tuition equals $\sigma(\rho)|S'(\rho)|$.

Following similar logic the standard error for the change in welfare for resident students equals $P\sigma(\rho)|S'(\rho)|$ and this is also the standard error for the change in combined welfare.

2.5 Illustration of Identification Strategy

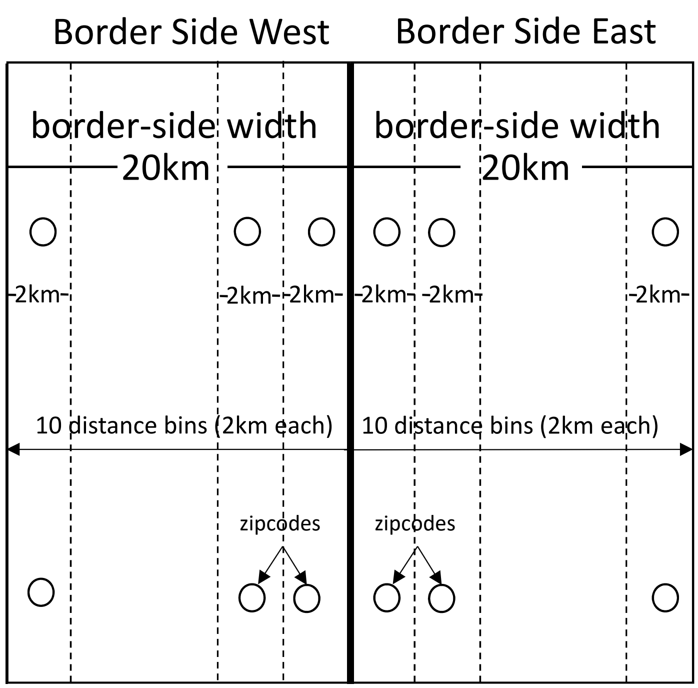

Figure 1: Border-Sides and Distance Bins Diagram