Valuing the benefits of the education provided by public universities: A case study of Minnesota

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ABSTRACT

This study estimates the value of the private and public benefits that accrue to Minnesota residents from state government subsidies to higher education. In 2005, the University of Minnesota and the Minnesota State Colleges and Universities system received $832 million from Minnesota's state government to support educational programs. These subsidies allow these institutions to offer lower tuition rates, increasing the number of Minnesotans with bachelor and graduate degrees. We calculate that removing these subsidies would eventually lead to 14,000 fewer graduate degree holders in Minnesota, and reduce those with bachelor's degrees or "some college" by 42,000. The annual economic cost of these subsidies is about $326 million; this is less than annual state appropriations because most of those appropriations are income transfers from taxpayers to students, not an economic cost. We estimate that the annual value of the benefits of these subsidies is between $531 and $786 million ($381 and $570 million) when a 3% (5%) discount rate is used. We also discuss some of the income distribution consequences.

1. Introduction

The United States has a wide variety of public and private higher education institutions. Each state subsidizes at least one public university system. Tuition at public colleges and universities is usually much lower than at private institutions. Most of this difference is financed by state government subsidies to public colleges and universities, which clearly benefit the students enrolled in these public institutions. Yet taxpayers who never attend, and whose children do not attend, public colleges and universities may question why they should be taxed to benefit the individuals enrolled in those institutions.

There are three economic justifications for state subsidies to higher education. First, the educational services provided by public colleges and universities may generate public benefits beyond the private benefits their graduates receive. Second, these subsidies may redistribute resources from higher to lower income citizens, and provide access to higher education to individuals who otherwise may be excluded. Finally, public universities' research may benefit the general public.

This paper examines in detail the first justification; it investigates whether the subsidies to the bachelor and graduate degree programs at Minnesota's public universities benefit the general public beyond the benefits to students who receive degrees from these institutions. It attempts to quantify both the private and public benefits, and compare them to the cost of Minnesota's state support to public higher education. The paper also examines the redistributive impact of the educational programs of

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Minnesota's public universities. The main omission of this assessment is that we do not calculate the public benefits from research done at Minnesota's public universities. We also ignore benefits that accrue to other states or countries due to migration of graduates of Minnesota's public universities to those states or countries; for simplicity, and due to lack of information to the contrary, we assume that migration of educated labor out of Minnesota is equal to migration of educated labor into Minnesota. Thus this paper underestimates the national and global benefits provided by Minnesota's public universities.

Most previous studies of the economic impact of public universities focus on student or state government spending in the municipality or county where the university is located, estimating "multiplier effects" of that spending (e.g. Bloom, Hartley, & Rosovsky, 2006; MHEC, 2005). Yet both student and government spending are only a redistribution of, not an increase in, overall economic activity in the state. Another problem with many studies is that they fail to distinguish private benefits – benefits enjoyed by college or university graduates – from public benefits, which accrue to all members of society. Finally, almost all previous studies ignore what students at public institutions of higher education would do if those institutions ceased to exist or increased tuition in response to reduced state government support. If most, or all, of these students still obtain a degree at a public or private institution there will be little effect on aggregate economic activity, though there will be a change in who pays for education costs. Thus previous studies do not provide accurate estimates of the public benefits of government subsidies to higher education.

The rest of the paper is organized as follows. Section 2 describes higher education in Minnesota, after which Section 3 presents a general methodological framework. Sections 4 and 5 discuss the private and public benefits, respectively, of higher education, and Section 6 examines the distributional impact of public spending on higher education. Section 7 presents estimates of the private and public benefits of the educational services of Minnesota's public universities, compares them to the state subsidies for those services, and discusses the distributional consequences of public funding for higher education. A final section summarizes the findings and gives suggestions for future research.

2. Higher education in Minnesota

This section describes higher education in Minnesota, reviewing enrollment, tuition, and state financial support. It focuses on bachelor and graduate degree programs, rather than less advanced degrees (associate degrees or vocational/technical certificates). Before going into these details, it is worth noting that Minnesota has a long history of strong support for higher education. One consequence of this is that Minnesotans are above average in terms of obtaining bachelor and graduate degrees: in 2006, 23.7% of Minnesotans age 25–60 had a bachelor's degree, and another 11.6% had a graduate degree; the analogous figures for the U.S. as a whole are 16.2% and 8.3%, respectively.

2.1. Enrollment

In 2005, nearly 200,000 individuals, 3.8% of the state's population, were enrolled in bachelor or graduate degree programs in Minnesota's public and private colleges and universities. About two thirds were in public institutions, either the University of Minnesota or one of the seven state universities in the Minnesota State Colleges and Universities (MnSCU) system.[1] Enrollment in bachelor (4-year) and graduate degree programs in Minnesota has risen by 1.5% annually over the past 10 years, from about 171,000 in 1996–1997 to about 196,000 in 2005–2006. The University of Minnesota currently accounts for about 33% of this enrollment, the MnSCU system for about 32%, and private colleges and universities for about 34%.

The University of Minnesota is a publicly funded, land grant, research university. In the fall of 2006, it had an enrollment of 65,489 students. From the mid 1990s to 2006, undergraduate enrollment increased from about 35,000 to about 40,000, while graduate and professional school enrollment increased at a faster rate, from about 12,000 to about 19,000. Approximately 61% of University of Minnesota alumni of working age in 2005 resided in Minnesota, representing 8.7% of Minnesota's workforce. The University of Minnesota attracts students from other, mostly neighboring, states; 22% of its graduates are from other states. About 37% of these students stay in Minnesota after they graduate.

The MnSCU system is a separate higher education entity that is comprised of 32 institutions located throughout the state. It focuses on undergraduate education, but does have some graduate programs, such as teaching degrees. In the 2005–2006 academic year, the MnSCU system enrolled 175,000 students (MnSCU, 2006). About 112,000 were enrolled in 2-year degree (vocational or technical) or non-degree programs, while about 57,000 were in bachelor's degree programs, and about 6000 were in graduate programs. MnSCU's seven state universities grant only bachelor's and graduate degrees. The other 25 MnSCU institutions grant only 2-year degrees and/or vocational/technical diplomas.

While the number of bachelor's and graduate degrees granted by the University of Minnesota has grown since the 1960s, its share of the bachelor's and graduate degrees granted in Minnesota has steadily declined (Fig. 1). It granted 38% of all bachelor's degrees in 1966, but only 30% in 2004. In contrast, the private share increased from about 30% in the 1970s to 35–40% from 2000 to 2004. The MnSCU state universities' share has fluctuated between 30 and 40% in the past 40 years. An even sharper decline occurred in the University of Minnesota's share of graduate degrees, again despite a gradual increase in those degrees granted by that institution. In 1966 it granted 71% of all graduate degrees awarded in the state, but by 2004 its share had fallen to 38%. This reflects a large expansion into graduate degrees by private institutions; their share rose from about 15% in the late 1960s to nearly 50% since 2000 (Fig. 1, middle

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[1] All MnSCU students in bachelor's or graduate degree programs are in one of MnSCU's 7 state universities.
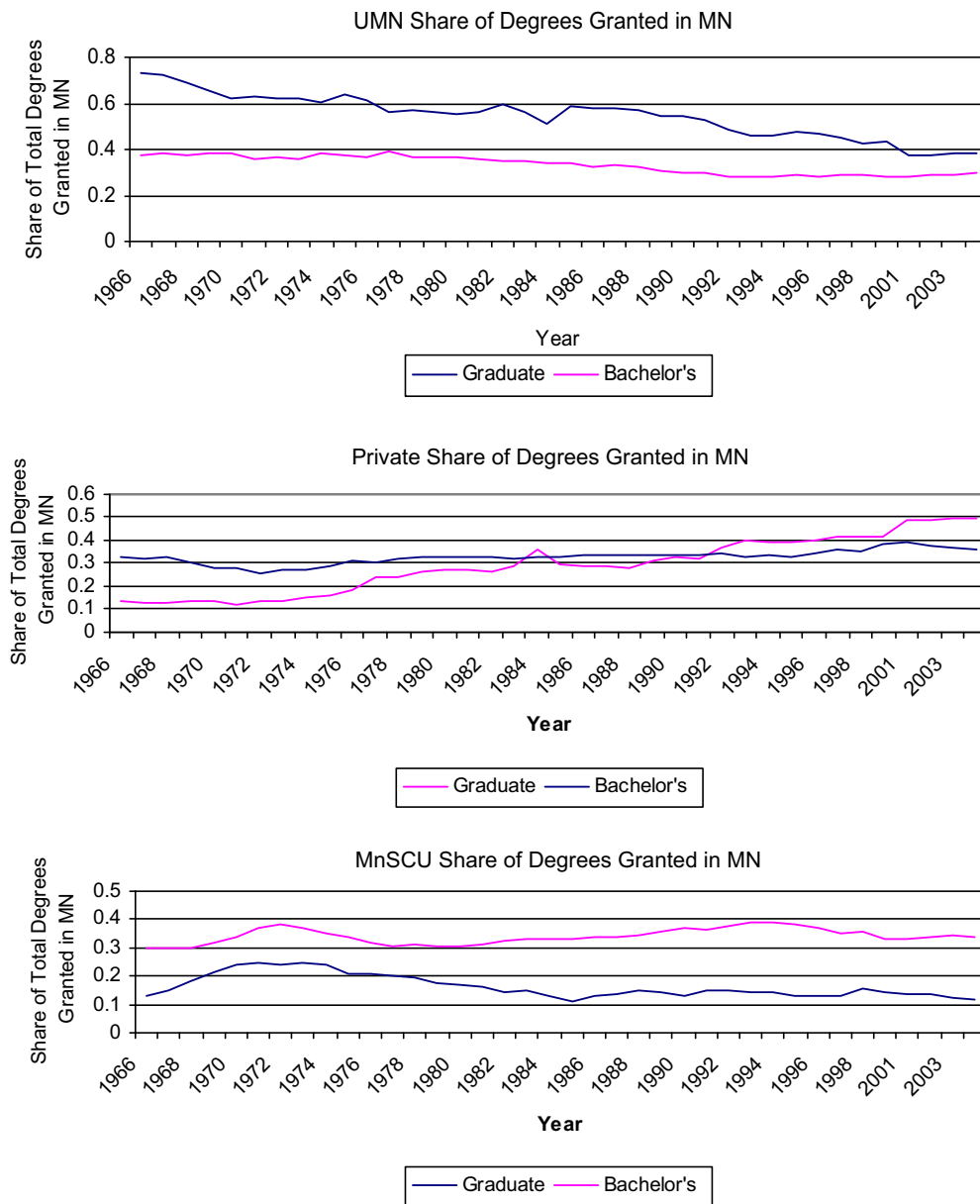
Source: National Science Foundation, 2006.

Fig. 1. Shares of bachelor's and graduate degrees granted by University of Minnesota, private colleges and universities, and the MnSCU system. *Note*: Numbers are percentages of bachelor's and graduate degrees granted by the MNSCU system, as a share of all degrees granted in Minnesota.National Science Foundation, 2006

panel). This also reduced MnSCU's share, from over 20% in the early 1970s to about 12% in 2004. The total number of graduate degrees granted annually in Minnesota increased from about 3000 in the mid 1960s to about 11,000 in 2004 (Fig. 2).

2.2. Tuition, fees and financial aid

Tuition and fees have steadily increased over time for all higher education institutions in Minnesota, especially after 1980. Fig. 3 shows undergraduate tuition at MnSCU, the University of Minnesota, and private colleges and universities (the MnSCU and the University of Minnesota figures are for Minnesota residents). Tuition and fees have increased

sharply; for example, from 2000–2001 to 2006–2007, the University of Minnesota's tuition and fees rose by 66% in constant dollars.

In 2006–2007, undergraduates who were Minnesota residents paid $9432 in tuition and fees to attend the University of Minnesota, $5656 to attend the seven MnSCU state universities, and (on average) $24,744 at private colleges and universities in the state. While undergraduate tuition and fees have risen dramatically since 1980, financial aid, both need and merit based, has also increased. Using Minnesota Office of Higher Education data we estimate that the average private college student in Minnesota receives tuition reductions and grants from those institutions of about $5700 per year, so actual tuition paid is about
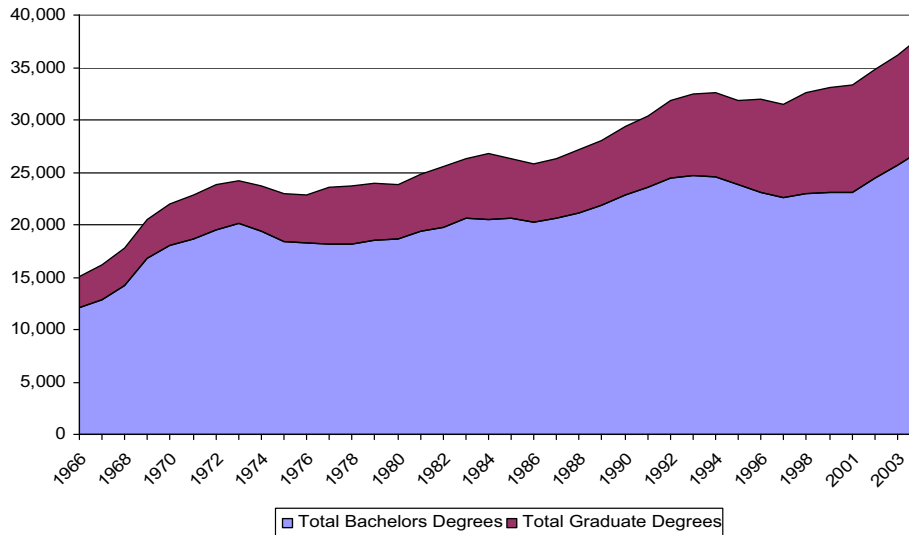
Source: National Science Foundation (2006).

Fig. 2. Graduate and bachelor's degrees granted in Minnesota, 1966–2004.National Science Foundation (2006).
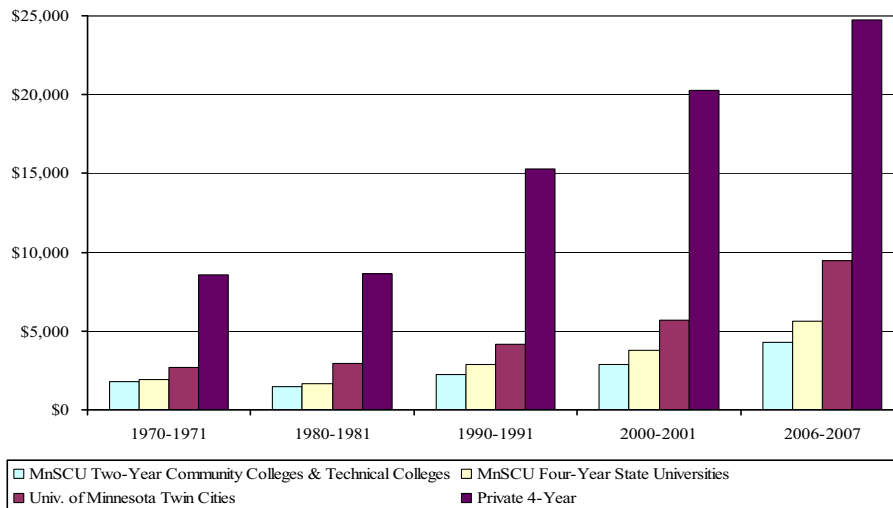
Source: Minnesota Office of Higher Education (2006).

Fig. 3. Average annual resident undergraduate tuition and required fees (constant 2002 $ (Constant dollars based on consumer price index (all urban) through August 2006, with 2007 estimated and converted to fiscal years. United States Department of Labor, Bureau of Labor Statistics.)).Minnesota Office of Higher Education (2006).

$19,300. In contrast, the average University of Minnesota student received only about $1000 in aid, and the average MnSCU student only about $200.

Minnesota state government funds for higher education take three forms: support to the University of Minnesota,

support to the MnSCU system, and scholarships for undergraduates attending either public or private institutions in Minnesota. Table 1 shows figures for three academic years between 1996 and 2006. The University of Minnesota and the MnSCU system each receive about 45% of these state

Table 1
State appropriations for higher education in Minnesota.

Institutions	1996–1997	2000–2001	2005–2006
	Millions of dollars		
University of Minnesota	405.4	607.2	591.2
MN State colleges and universities	476.2	579.8	600.7
MN Higher Education Services Office (grants)	120.3	160.5	172.1
Mayo Medical	0.9	1.6	1.4
Total	1,091.6	1,349.1	1,365.5

Source: Illinois State University, Grapevine Minnesota, 2007.

Table 2
Sources of operating revenues for the University of Minnesota.

| | University of Minnesota | | MnSCU |
	1996	2006	2006
Total budget	$1.4 billion	$2.5 billion	$1.5 billion
Budget share, by revenue source (%)			
Tuition and fees	15.6	21.3	41.1
Gifts and endowment earnings	16.7	10.8	N/A
Sponsored grants and contracts	20.2	21.4	16.4
State appropriation	33.8	25.0	40.4
Other sources	13.7	21.4	2.1

Source: University of Minnesota, 1996, 2006.

appropriations, while the student scholarship program that gives grants directly to students receives about 10%.

Minnesota's public universities' dependence on state appropriations is seen in Table 2. The University of Minnesota's revenues in 2006 were $2.5 billion. Tuition and fees accounted for about one fifth (21%) of total operating revenues. Other sources are gifts and endowment earnings (11%), sponsored grants and contracts (21%), state appropriations (25%), and other sources (21%). Compared to 1996, state appropriations have dropped from one third to one fourth of total costs, while tuition and fees have risen from one sixth to one fifth. Thus in 1996 state appropriations were more than double tuition revenues, but by 2006 they were only slightly higher than tuition revenues.

The MnSCU system's annual operating budget was $1.5 billion in 2005–2006. Of this figure, state appropriations accounted for $606 million (40.4%), tuition and fees were $617 million (41.1%), and most of the rest was from grants and contracts (MnSCU, 2006).[2]

3. Methodological issues from the perspective of welfare economics

Before going into the details of how to evaluate the costs and benefits of public funding for higher education, it is useful to review how the merits of this policy can be analyzed in terms of standard economic theory. In a general equilibrium setting, any new activity that generates a positive social surplus (profit), measured in terms of current equilibrium prices of inputs and outputs, has the potential to increase social welfare. Indeed, if the surplus were distributed so that each member of society received a share, for example if each member received an equal share, everyone's utility would increase (assuming that no one had reached a satiation point) and social welfare would rise (assuming a social welfare function that is strictly increasing in each individual's utility). Thus when evaluating the social benefit of any policy or activity it is useful to begin by assessing whether the benefits exceed the costs, without regard to how those costs and benefits are distributed across the population. If the benefits are less than the costs, the activity is socially wasteful and should not be pursued; the only exception to this recommendation would be if this

activity is the only possible way to redistribute income in a way that increases social welfare despite the reduction in total income.

If the benefits of the proposed activity exceed the costs, one can then assess how both the costs and the benefits are distributed across the population, and how that distribution affects social welfare. For example, if social welfare is defined as the sum of the (cardinal) utility of each member of society, and each individual has the same utility function that is concave in income (see Layard, Mayraz, & Nickell, 2008), then shifting benefits toward the poor (or shifting costs toward the rich) will increase social welfare. As will be seen below, assessing whether the costs of public funding for higher education exceed the benefits is not a simple task, so most of this paper will focus on evaluating the monetary value of both the costs and the benefits, considering neither how those costs and benefits are distributed across the population nor the properties of any underlying social welfare function. Yet near the end of the paper (Sections 7.5 and 7.6) the distributional consequences of public funding of higher education are examined.

A final methodological point is the justification for government involvement in the provision of higher education. If the market for higher education operates efficiently, there is no justification from the viewpoint of economic theory for government involvement, except possibly for distributional objectives. Yet, as discussed further below, there is good reason to believe that higher education generates several types of positive externalities, which justifies public funding of higher education.

Given this clarification of the economic theory underlying the analysis in this paper, we now examine, in detail, the costs and benefits of government subsidies for higher education.

4. Private benefits from a university education

To assess the merits of public funding of higher education in any state or country, the cost of that funding must be compared to the benefits. The cost is relatively simple to calculate, but benefits are harder to quantify. This section reviews the *private* benefits of both undergraduate and graduate education, and Section 5 discusses the *public* benefits.

The private benefits from obtaining a bachelor or graduate degree from a public or private college or university are defined as those benefits that accrue only to the individuals who obtain those degrees. In general, there are two

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[2] These MnSCU figures include all 32 MnSCU colleges and universities. Of the $606 million from state appropriations, $241 million was for the seven MnSCU state universities.

Table 3
Unemployment rates by level of education, 2004.

Level of education	Unemployment rate (%)
Less than high school	7.6
High school graduate	4.7
Some college	4.2
Associate degree	3.3
Bachelor's degree	2.6
Master's degree	2.1
Ph.D.	1.6
Professional degree	1.1

Source: U.S. Bureau of Labor Statistics (2004).

types: direct income benefits via higher wages in the labor market, and non-pecuniary benefits, such as better health and the direct satisfaction of being educated.

4.1. Higher income effects

The first estimates of the causal impact of education on income were the pioneering studies of Becker (1964) and Mincer (1974). Literature reviews by Card (1999, 2001) found that, on average, an additional year of schooling increases earnings by 7–9% in the United States. The few studies with separate estimates by level of schooling (e.g. Ashenfelter & Rouse, 1998) find estimated impacts on wages of an additional year of higher education in the same 7–9% range.

Better educated people are also more likely to be employed. Table 3 shows that the unemployment rate for high-school graduates in 2004, 4.7%, was almost double the 2.6% rate for college graduates. The highest rate, 7.6%, for individuals without a high-school degree, was nearly three times the rate for college graduates. The rates for those with some college or an associate degree were between those of high school and college graduates. Individuals with graduate degrees had very low rates, from 1.1% to 2.1%.

These figures do not necessarily show the *causal* effect of education on unemployment. Yet Ashenfelter and Ham (1979) estimate that an additional year in school reduces white males' unemployment by 0.5–0.8 percentage points, and Mincer (1991) found, again for white males, a 0.8 percentage point decline for each year of schooling. These causal effects match the figures in Table 3; if each year of school reduces unemployment by 0.7 percentage points, high school graduates can reduce their unemployment rate by 2.8 percentage points by obtaining a bachelor's degree, which is similar to the 2.1 percentage point difference in the unemployment rates for those degrees in Table 3.

4.2. Non-income benefits

Educated people also enjoy two non-income benefits. First, Grossman (2006) documents that more educated people tend to be healthier, even after adjusting for their higher income, and that their children are also healthier than those of less educated people. Deaton and Paxson (2001) show that education reduces adult mortality. Second, most people with a post-secondary education would

agree that their education raises their quality of life, in addition to its income and health benefits.[3]

5. Public benefits of university education—conceptual and practical issues

Minnesotans who did not attend the University of Minnesota or one of the MnSCU state universities benefit from others' enrollment in those institutions. First, individuals with higher education generate public benefits for all members of society. Second, government tax and transfer programs redistribute the private benefits obtained by those people to the rest of society. This section describes the public benefits; the next discusses the redistribution of private benefits. Table 4 summarizes both types of benefits.

The public benefits (external benefits) from higher education are the benefits from that education that accrue to *any* members of society *in addition to the private benefits enjoyed by those who obtained that education*. The sum of the private and public benefits is the *social* (total) benefits of that education. Note that graduates of institutions of higher education not only generate, but also receive, these public benefits; a person who obtained higher education may enjoy public benefits from another person who did the same.

Public benefits can be divided into income and non-income benefits. This section describes, and reviews studies that have attempted to measure, both types.

5.1. Higher earnings from others' education

A worker's wages may depend not only on his or her characteristics but also on the characteristics of others with whom he or she works. For example, in a given firm an increase in highly educated employees may make the less educated workers more productive. This *internal* spillover effect occurs if the production function has constant returns to scale and educated and uneducated workers are not perfect substitutes.

Yet Lange and Topel (2006) point out that these relative labor supply effects are *not* public benefits; firms should realize that hiring additional educated labor not only directly raises output but also makes its less educated labor more productive. In a well-functioning labor market, workers will be paid for both impacts. Thus there is no public benefit; all productivity effects of better educated workers accrue to them via their wages.

Still, there is another pathway by which persons without a college or university degree may receive higher wages because others have such degrees: *external* wage spillovers. That is, well-educated citizens make other workers more productive through social interactions *off the job*. For example, a worker's social interactions with well-educated people may directly increase his or her productivity because such interactions bestow useful skills.

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[3] While this effect is hard to quantify, the happiness literature has found only small direct effects of education on happiness (Layard, 2005, p. 62), so omitting it in the calculations in this paper is unlikely to greatly underestimate the non-income benefits of education.

Table 4
Public and private benefits of education.

	Public benefits	Private benefits
Income benefits	1. Higher incomes due to diffusion of income generating skills from educated individuals to others via social interactions off the job	1. Higher wages due to skills acquired from schooling 2. Lower rate of unemployment.
Non-income benefits	1. Increased civic participation 2. Reduced crime 3. Learning from, and more pleasant social engagement with, better educated individuals	1. Better health 2. Direct enjoyment from learning and use of skills acquired from schooling

These external (extra-firm) wage spillovers imply a market failure; less educated workers who benefit from off-the-job interactions with more educated individuals do not pay for those benefits. Thus the private value of higher education is less than the social value, which leads to under-investment in higher education.

Moretti (2004a) examined the wage spillover effects of university educated labor, using 1980 and 1990 U.S. Census data and 16 years of household survey data from over 200 cities. He estimated that a one percentage point increase in the proportion of a city's labor force with bachelor degrees raises high-school dropouts' wages by 1.2%, the wages of high-school graduates and those with some college by 1.4%, and the wages of college graduates and graduate degree holders by 1.2%. He also estimated that a one percentage point rise in the labor force with graduate degrees raises high-school dropouts' wages by 2.7%, high-school graduates' wages by 2.2%, the wages of those with some college by 1.9%, college graduates' wages by 1.1%, and graduate degree holders' wages by 0.8%.

Moretti's estimates reflect both labor composition and wage spillover effects; he could not identify each effect separately. Yet his results imply that, from spillover effects alone, college educated workers' wages rise by at least 1.2% for a one percentage point increase in the proportion of the labor force with that level of education, and probably by more for the less educated (who likely learn more from college graduates than do other college graduates). That is, labor composition effects should be negative (a higher supply of any type of labor should reduce its wages), so if the combined effect is 1.2% the spillover effect must exceed 1.2%. Similarly, his results for graduate degrees suggest a spillover effect that raises graduate degree holders' wages by at least 0.8% for a percentage point increase in the labor force with such degrees, and probably more for the less educated.

However, this interpretation assumes that all bachelor's degrees are identical, a doubtful assumption. If college graduates are imperfect substitutes, it could be that, even without wage spillover effects, more workers with bachelor's degrees could *increase* the average wage of those workers. That is, workers with different bachelor's degrees may be different kinds of labor, so that the overall impact of an increased supply of one or more types of college graduates is ambiguous. Thus the spillover effect of an increase in bachelor's degree holders on their own wages could be less than 1.2%.

Indeed, Moretti's estimates indicate that something else is taking place. Suppose the true spillover effect were 1.3% or higher, as suggested by his results (assuming that bachelor's degree holders are perfect substitutes). One would expect larger spillovers from college graduates to high school graduates and high school dropouts, so the total effect of a one percentage point increase in the labor force with a bachelor's degree on the wages of high school graduates and dropouts should exceed 1.3%; yet Moretti finds effects of only 1.4% and 1.2%, respectively. Thus the true spillover effect of an increase in workers with bachelor's degrees on their own wages may be less than 1.0%.

Lange and Topel (2006) provide a general assessment of the (small) literature on education spillovers. Based on a model of spatial equilibrium in labor markets, they argue (p. 478) that the finding of Acemoglu and Angrist (2001) that education spillovers are close to zero likely underestimates the true spillovers. Yet they also dispute Moretti's estimates. First, they argue that his estimates are implausibly high since they imply that the impact of a person's education on others' wages exceeds the impact on his or her own wages. Second, they point out that Moretti also used instrumental variable (IV) methods, and one implication of their model is that almost any IV estimates are likely to be biased.

Lange and Topel then analyze U.S. Census data to "make some headway" on estimating education spillovers. Instead of using IV methods they try to avoid bias due to unobserved heterogeneity by adding an indicator of labor force quality (derived from state of birth and cohort fixed effects) to their regression. They regress growth in state-level total factor productivity on changes in labor force quality and in state level years of education. They estimate (see their Table 6) that an additional year of education in the population raises total factor productivity by 2.3–4.0% via education spillovers. Assuming that these effects reflect increased labor productivity, they suggest an increase in labor productivity of 3.5–6.0% (about two thirds of total output is paid to labor). This implies that a one percentage point increase in the population with a bachelor's degree will raise others' wages via spillovers by about 0.2%, much smaller than the estimated impacts in Moretti (2004a).[4] The analysis below uses these (admittedly rough) estimates as a "very conservative" assumption of the spillover effects of education onto others' wages.

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[4] If 1% of the population increases their education from 12 years to 16 years, average years of education increases by 0.04 years, so any impact of increasing average education by 1 year must be divided by 25 to calculate the impact from 1% of the population increasing their education from 12 years to 16 years.
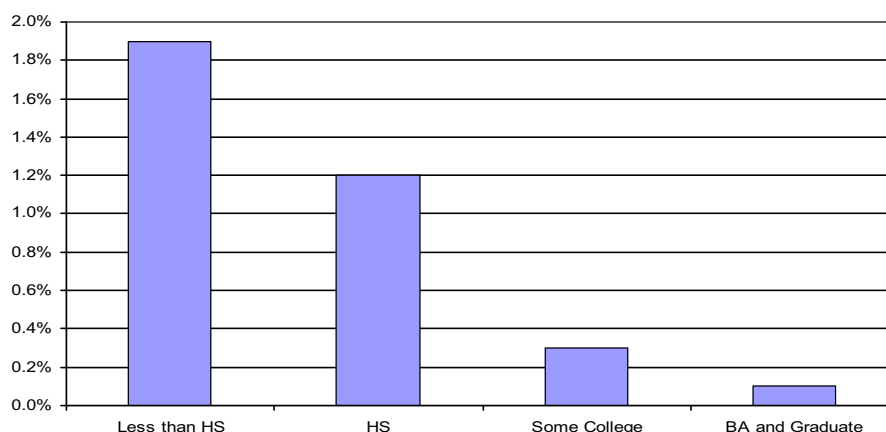
Source: Baum and Payea (2005).

Fig. 4. Incarceration rates by education level.Baum and Payea (2005).

Finally, in another paper Moretti (2004b) uses a different method to estimate education spillovers. He obtains somewhat lower estimates than those in Moretti (2004a). More specifically, he estimates that an extra percentage point in the share of the population with a college education will induce education spillovers that increase total manufacturing productivity by 0.5–0.7%. Using the midpoint, 0.6%, and recalling that labor receives about two thirds of total output, implies an average increase in wages of 0.9%. These somewhat lower estimates are the basis of our "moderately conservative" assumption about spillover effects. Yet note that Lange and Topel briefly criticize these estimates as well, since they are based on IV estimates (see their footnote 19), but they imply that these estimates suffer from fewer problems than those in Moretti (2004a).

5.2. Non-income benefits

We consider three "non-income" pathways by which one person's education may benefit others, and the empirical evidence on these effects.

5.2.1. Civic participation and voting
Dee (2004) found that education raises voter participation and membership in civic and social groups. It is difficult to assign a value to increased civic behavior given the wide variety of such activities, yet to assign a value to higher voter participation one can use the cost of increased voter participation incurred by voter mobilization and education campaigns. Based on a randomized experiment in New Haven, Gerber and Green (1999) estimate that canvassing to increase voter turnout costs $16 per each additional voter.

5.2.2. Crime
Education reduces criminal behavior. Crime reductions from education are a social benefit for the community where the educated individual lives. Lochner and Moretti (2004) estimate that finishing high school reduces the probability of incarceration by 0.8 percentage points for whites and 3.4 points for blacks. They find that the negative

effect of high-school graduation on crime is strongest for murder, assault, and car theft.

There is little research relating crime to post-secondary education. Incarceration rates are much lower for college graduates than for high-school graduates, and for high-school graduates relative to people who did not finish high school (Fig. 4). The 0.7 percentage point difference in high school dropout and high school graduate incarceration rates in Fig. 4 is very close to the causal impact Lochner and Moretti estimated for whites, though lower than that for blacks. This suggests that the 1.1 percentage point difference in incarceration rates of high school and college graduates in Fig. 4 may approximate the causal effect; if so, inducing a high-school graduate to obtain some college or a bachelor's or graduate degree would reduce his or her probability of incarceration by one percentage point. Incarcerating a person for one year costs about $20,000 (Administrative Office of the U.S. Courts, 2004), so transforming a high-school graduate into a college graduate would save society, on average, about $200 per year.

Reducing crime has other benefits, such as lower spending on police and courts and a reduction in the direct harm to crime victims. It is difficult to value these costs, yet a recent comprehensive assessment by McCollister, French, and Fang (2010, see Table 3) suggests that criminal justice system costs are at most only half of the total crime costs. Since criminal justice system costs include not only incarceration costs but also police and court costs, a rough (and somewhat conservative) estimate is that incarceration costs are only one fourth of total crime costs, so this paper will assume that transforming a high-school graduate into a college graduate would save society about $800 per year.

5.2.3. Learning and enhanced social interactions
A final public benefit of a more educated populace is intuitive; most people agree that they enjoy social interactions with well-educated individuals. Unfortunately, it is hard to assign this a money value, and to our knowledge no one has tried. Yet it is a genuine benefit, and the overall social benefit is underestimated if one examines only the benefits that can be quantified.

6. Distribution of private and public benefits

The private and public benefits of a more educated population are not equally distributed to the general public. Indeed, the argument that taxpayers who did not attend public colleges and universities should not be taxed to support those institutions is, in essence, a complaint about the distribution of those benefits (and of the tax payments that finance them). This section describes how the benefits generated by increased public funding to higher education are distributed, and who pays for that increased funding.

To begin, one must distinguish between two kinds of students currently attending public colleges and universities. Without state funding, those institutions would need to raise tuition to the levels charged by private institutions. Yet many students in public institutions will stay in them, despite the higher cost, or will switch to private institutions. These "non-marginal" students will not change their education levels if state subsidies to higher education end, so these subsidies generate no new benefits from these students.

In contrast are people who obtain more education when states subsidize higher education. They are "marginal" students. The redistributional impacts (and public and private benefits) of such subsidies differ for marginal and non-marginal students.

There are five pathways by which public funding for higher education distributes, and redistributes, income and other resources among different members of the population. The first is the distribution of benefits resulting from the increased schooling levels of marginal students. When subsidies induce those students to attain additional education, society's stock of human capital rises, as does total output when these students enter the labor market. These individuals will be paid higher wages for their higher human capital, and will be more likely to be employed, thus much of the increase in output will accrue to them. In addition, the wage spillover effects will allocate most of the rest of the increased output to the rest of the working population.

The other four pathways operate by *redistributing* income and other resources among the general population. Of these, the first is redistribution of income from the general public (taxpayers) to *non-marginal* students who attend public colleges and universities. These students would still attend those institutions, or switch to private ones, if state funding for higher education is ended. Their education levels do not change, so neither do the public (or private) benefits provided by their education. They (or their parents) simply pay much less for their education, so some of the funding for public higher education is simply redistributed from taxpayers to non-marginal students.

There is also redistribution toward *marginal* students. State subsidies induce them to obtain more education. The financial cost is paid by these students and by taxpayers. Marginal students pay the tuition rates of public universities, while taxpayers pay the difference between these rates and those that would prevail without state subsidies. More generally, additional students will require more academic resources (professors, staff, classrooms, etc.). These resources are diverted from the activities they would have

been used for in the absence of subsidies; this is a real resource cost to society. The drop in these other activities is a cost borne by marginal students and taxpayers.

The second redistribution pathway reverses directions; some private benefits of marginal students are redistributed to taxpayers. In particular, part of their increased wages is paid in taxes and so benefits the general public (either increasing government services or reducing tax rates to maintain current levels of government services). This redistribution concerns only *marginal* students; the education levels of non-marginal students do not change, so their income and the taxes they pay do not change.

Of course, some taxpayers are graduates of Minnesota's public universities, so part of both pathways (from taxpayers to both marginal and non-marginal students and from marginal students to taxpayers) is not really redistribution. Yet only 8.7% of adults in Minnesota have a degree from the University of Minnesota, and only another 5.7% have a 4-year or graduate degree from the seven MnSCU state universities, so most of the redistribution to (or from) Minnesota taxpayers involves people who did not obtain a bachelor or graduate degree from Minnesota's public universities.

A third redistributive pathway is that education reduces the use of government services, such as unemployment benefits, welfare programs and medical aid. As discussed above, individuals with a bachelor's degree are less likely to be unemployed; this reduces state spending on unemployment benefits.[5] Most of the benefits of such reductions in state spending accrue to individuals without a degree from a public college or university. Education also reduces use in welfare programs and medical assistance. Yet TANF (Temporary Assistance to Needy Families), Food Stamps and Medicaid are financed from federal, not state, funds and so Minnesotans benefit little from this impact of education (most of the benefits, whether via lower tax rates or higher federal spending in other areas, are shared by all 50 states), and so this paper will not investigate this effect.

The last redistributive pathway concerns charitable giving and volunteerism. Andreoni, Brown, and Rischall (2003) found a significantly positive effect of education on both the probability, and the amount, of charitable giving. For single males, obtaining a bachelor's degree raises charitable contributions by 120%, relative to single males with a high school degree. The analogous figure for single females is 230%.[6] Educated people also do more volunteer work. Vaillancourt (1994) found a positive effect of education on volunteering in Canada. Yet it is unclear how to value volunteer time, so this paper will not attempt to do so.

In summary, state government funding for public colleges and universities yields both private and public benefits, and also redistributes income and other resources from some citizens to others. This section has explained the five main pathways through which the latter occurs.

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[5] Strictly speaking, taxes that pay for unemployment benefits are paid for by employers, not taxpayers. Yet employers will raise prices and/or lower wages to cover these costs, so they are borne by the general public.

[6] More specifically, Andreoni et al. found that, for single males (females), a bachelor's degree increased the log of total charitable contributions by 0.8 (1.2), relative to single males (females) with a high school degree.

Section 7 presents estimates of the size (in dollars) of each of these pathways, as well as estimates of the overall private and public benefits.

7. Estimates of the benefits of Minnesota's higher education subsidies

This section presents estimates of the benefits to Minnesotans from the educational services offered by the University of Minnesota and the seven MnSCU state universities. These benefits are generated through individuals who obtain bachelor or graduate degrees from those universities. It uses Card and Lemieux's (2001) estimates to calculate the impact of state subsidies to Minnesota's public universities on the number of Minnesotans with undergraduate (bachelor) and graduate degrees, after which the consequent benefits, both private and public, are assessed. These estimated benefits are then compared to state government support to these universities. Next, the overall economic costs and benefits of this support are compared. Finally, the distributional consequences of state subsidies to Minnesota's public universities are examined.

7.1. Impact of higher education subsidies on education levels

As explained above, the benefits of the educational services provided by public universities result from the increase in the adult population with undergraduate and graduate degrees. In the absence of state subsidies to Minnesota's public universities at least some – and perhaps most – of the individuals with bachelor and graduate degrees from those universities may obtain degrees from the "newly privatized" public universities, or from private colleges and universities. Estimates of the effect of ending subsidies to public universities on the number of people with bachelor or graduate degrees must account for this behavior.

Card and Lemieux (2001) estimated the impact of state-funded universities' tuition on undergraduate enrollment.[7] They found that a one unit increase in the log of annual tuition (about $1500 in 1988 dollars) charged by public colleges and universities reduces the college/university enrollment rate of 19–21 year old men by 1.1 percentage points, and of 19–21 year old women by 3.8 percentage points. Averaging these estimates implies a 2.5 percentage point drop in college enrollment.[8]

We use these estimates to simulate the impact of withdrawing state subsidies to Minnesota's public universities on the proportion of that state's population with bachelor or graduate degrees. Specifically, we assume that removing those subsidies causes those universities to raise tuition to the levels of private colleges and universities in order to raise funds to replace current state subsidies. As seen in Section 2, average annual tuition and fees (excluding room and board) at private colleges and universities in Minnesota is about $25,000. Yet many students receive financial aid, greatly reducing the average cost incurred by students. The average amount of aid (including students not receiving financial assistance) given to students at private institutions in Minnesota is about $5700 per year; so actual tuition paid is, on average, about $19,300.[9] This is still much more than full-time undergraduate tuition and fees at the University of Minnesota (about $9400 per year) and at the MnSCU state universities (about $5650).

The University of Minnesota is more selective than the MnSCU state universities, and its tuition is higher. The annual tuition (and presumably the quality) of private 4-year colleges in Minnesota also varies, from $20,000 to over $30,000. To simulate the effect of raising tuition at Minnesota's public universities, we assume that: (a) the University of Minnesota's annual tuition rises to $22,500 (i.e. it competes with private institutions that charge $25,000 or more, but also give about $6000 in tuition reductions); and (b) tuition at the MnSCU state universities rises to $14,000 per year (i.e. it competes with private institutions that charge below $25,000 but also give about $6000 in tuition reductions).[10]

This scenario is plausible; raising the University of Minnesota's tuition to $22,500 would generate revenue roughly equal to the annual state government subsidies for its educational activities. If enrollment were unaffected by a $13,100 tuition hike (from $9400 to $22,500), it would generate $655 million per year.[11] Similarly, a $8350 tuition increase for 4-year students at the MnSCU state universities (from $5650 to $14,000) would increase revenues by about $418 million.[12] The $655 million revenue increase for the University of Minnesota from this higher tuition exceeds the state subsidy it received in 2006–2007 ($591 million), and the $418 million generated for the MnSCU system easily exceeds its 2005–2006 state subsidy ($241 million). Assuming some enrollment reduction from these tuition increases – as Card and Lemieux found – the actual

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[7] One other paper attempted such estimates, using within-state variation over time: Kane (1994). Yet Kane focused on black students, and his estimates for whites varied widely by estimation method. Fortin (2006) estimated the impact of tuition at public colleges and universities on enrollment rates *at those institutions*, not overall enrollment (i.e. she excluded private institutions). She found stronger effects than did Card and Lemieux. There is no inconsistency; some students may transfer to private institutions if public tuition rises. Finally, Coelli (2009) and Neill (2009) estimated the impact of tuition on college enrollment in Canada, but Canada's higher education system has no private sector, so these estimates are unlikely to apply to the U.S.

[8] One reason for averaging is that the estimates by sex are imprecise, e.g. the estimate for men was not statistically significant; regrettably, Card and Lemieux do not give results aggregated over men and women. Note

also that University of Minnesota alumni are very evenly split between men (52%) and women (48%).

[9] There are about 50,000 students in bachelor's degree programs at private colleges and universities in Minnesota, and institutionally funded grants and tuition discounts for all of these institutions were about $284 million in 2004, implying a per student amount (including students not receiving assistance) of $5680.

[10] Grants and tuition reductions at the University of Minnesota are rather small, on average only $1000, and they are even smaller at the MnSCU system (about $200), so they are ignored in this simulation.

[11] The University of Minnesota raised tuition by 66 percent from 2000 to 2006 with no fall in enrollment.

[12] The 65,000 4-year students in MnSCU state universities are equivalent to about 50,000 fulltime students.

Table 5
Estimated effect large tuition increases on the distribution of university degrees among the working age population in Minnesota.

	Current distribution of degrees (%)	Distribution after large tuition increases (%)	
		Bachelor's programs Only	Adding graduate programs
Less than high school	5.1	5.1	5.1
High school diploma	26.8	29.0	29.0
Some college	32.8	31.7	31.7
Bachelor's	23.7	22.6	23.2
Master's	8.0	8.0	7.6
Professional degree	2.2	2.2	2.1
Doctorate	1.4	1.4	1.3
Working age population	100.0	100.0	100.0

Source: Current Population Survey, 2006, and authors' calculations.
Notes: Column 2 divides 2.2 percentage point reduction in college enrollment equally across the working age population in the bachelor's and some college categories, and assumes that these reductions lead to a 2.2 percentage point increase in the population with a high school diploma. Column 3 adds the assumption that the decline in graduate degrees is proportionate to the decline in undergraduate degrees, and assumes that all those who no longer obtain a graduate degree instead obtain a bachelor's degree.

revenue generated by these tuition hikes would be closer to current state subsidies.

Raising tuition from $9400 to $22,500 at the University of Minnesota is a 0.87 increase in the log of tuition (from 9.15 to 10.02). Similarly, raising MnSCU's tuition from $5650 to $14,000 implies a 0.91 increase in log tuition (8.64–9.55). Averaging these figures gives a 0.89 increase in the log of tuition. Using Card and Lemieux's results, and assuming that changes in college enrollment lead to similar changes in the adult population with a college degree, a 0.89 increase in log tuition leads to a 2.2 percentage point (0.89×2.5) decline in the population with a college degree.

Card and Lemieux examined the effect of tuition on college enrollment, not on a college degree; we apply their results to both people with "some college" and people with bachelor's degrees in Table 5.[13] The former category combines people with 2-year degrees and people who attended college but did not obtain a degree. We split the 2.2 percentage point enrollment drop equally among those with some college and those with a bachelor's degree, so these tuition hikes reduce the population with some college from 32.8% to 31.7%, and the population with a bachelor's degree from 23.7% to 22.6%. These individuals then become high school graduates; this implies a 2.2 percentage point increase in the population with a high school degree, from 26.8% to 29.0% (Table 5, second column).

Tuition increases will also reduce the number of Minnesotans with graduate or professional degrees. Card and Lemieux (2001) did not address this. We assume that the impact is proportionate to that on college enrollment. That is, the fall in college graduates from 23.7% to 22.6% due to the above tuition increases is a 5% reduction, so the same percentage decline is assumed for Minnesotans with masters, professional and doctoral degrees. For example, the proportion of the population with masters' degrees is assumed to drop from 8.0% to 7.6%. All these people are

assumed to end up with bachelors' degrees. The overall impact on the distribution of education of raising tuition is given in the last column of Table 5. The rest of this section uses these changes to estimate the private and public benefits of state subsidies to Minnesota's public universities.

7.2. Private benefits

Section 3 presented two types of private income benefits and two types of private non-income benefits for individuals with undergraduate or graduate degrees. We begin with the income benefits. Economists estimate that a year of schooling raises wages by 8%, on average. Applying this to the differences between columns 1 and 3 in Table 5, and noting that there are 2.57 million working age adults in Minnesota, the total wage losses of marginal students (those whose education falls if subsidies to higher education are ended) is $517 million per year (before taxes). Regarding unemployment, these changes in education levels lead to 819 more unemployed Minnesotans at any given point in time. The wage losses from this higher unemployment are about $34 million per year.[14]

Overall, lower levels of education reduce the (before tax) incomes of marginal students by $551 million per year, almost all due to lower wages. Yet these lower private benefits are *not* an argument for public subsidies to higher education; only *public* benefits justify such subsidies. We now turn to those benefits.

7.3. Public benefits: income effects

Workers who never enrolled in public colleges and universities benefit from those who did because of spillover effects, such as acquiring skills from those institutions' graduates through social interactions outside of work. Moretti's (2004a) estimates do not distinguish between these effects and wage effects that operate through

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[13] Of course, some people who obtain college or graduate degrees from Minnesota's public universities eventually move to another state, while others who obtain degrees from out-of-state institutions move to Minnesota. For simplicity, and due to lack of information to the contrary regarding these phenomena, we assume that these flows of educated labor cancel each other out, both before and after any tuition increases.

[14] For any marginal student, the overall impact of a lower level of education is the combined effect of lower wages and a higher probability of unemployment; together these reduce the student's *expected* income.

Table 6
Assumptions used for wage spillover effects.

Percentage change in wages for labor force with	One percentage point increase in labor force with			
	Bachelor's degree		Graduate degree	
	Moderately conservative assumption	Very conservative assumption	Moderately conservative assumption	Very conservative assumption
Less than high school education	0.75	0.3	1.0	0.5
High school degree	0.75	0.3	1.0	0.5
Some college	0.5	0.2	0.75	0.3
Bachelor's degree	0.5	0.2	0.75	0.3
Graduate degree	0.0	0.0	0.5	0.2

Source: Authors' assumptions based on Moretti (2004a, 2004b) and Lange and Topel (2006).

changes in labor composition (via imperfect substitution). If spillover effects do not exist, an increase in college graduates would reduce their wages if they are all perfect substitutes. If a positive effect is estimated, the spillover effect must be at least as large as that positive effect (assuming college graduates are perfect substitutes).

Moretti estimated that a one percentage point increase in the share of the labor force with a bachelor's degree raises wages of workers with that degree by 1.2%. Assuming all workers with that degree are perfect substitutes, the spillover effect of a one percentage point increase in that type of the labor exceeds 1.2%. Yet this could be an overestimate as bachelor's degree holders are unlikely to be perfect substitutes. Moreover, as discussed above in Section 5.1, Moretti (2004b) found somewhat lower effects, and Lange and Topel (2006) found even lower effects. This paper presents two scenarios based on two sets of more conservative assumptions of the size of these spillover effects.

The "moderately conservative" scenario starts with the very specific estimates of Moretti (2004a) for different levels of education, but bearing in mind that these are likely to overestimate the true impacts this scenario assumes that a one percentage point increase in the labor force with a bachelor's degree raises the wages of those workers by only 0.5%, which is slightly less than half of the Moretti (2004a) estimate. The same wage impact is assumed for workers with some college. For those with a high-school diploma or less, the spillover effect is set at 0.75%, and for those with graduate degrees there is assumed to be no effect at all; these effects are based on the assumption that individuals with these lower credentials have more to learn from college graduates than do other college graduates, while those with graduate degrees have little to learn from those with bachelor's degrees. Regarding the impact of an increase in the population with graduate degrees, a conservative estimate is that the wage effects of a one percentage point increase in the share of the labor force with such degrees are 0.5% for graduate degree holders (recall that Moretti estimated an effect of 0.8%), 0.75% for people with bachelor degrees or some college, and 1.0% for high-school graduates and dropouts. These assumptions are summarized in Table 6, columns 1 and 3.

Now turn to the "very conservative" scenario. These are based on Lange and Topel's estimate that a one percentage point increase in the population with a bachelor's degree

will raise others' wages by about 0.2%. Assuming that these impacts vary by levels of education of those other individuals, the very conservative scenario assumes that this finding holds for those with some college or a bachelor's degree. It further assumes that there are no spillovers onto individuals with a graduate degree, while the impact is 0.3% for those with a high school degree or lower, again assuming that those with graduate degrees learn little or nothing from those with bachelor's degrees, while those with a high school degree or less can learn more from a bachelor's degree holder than can another person with a bachelor's degree. As in the moderately conservative scenario, the impact of one percentage point increase in the population with a graduate degree is assumed to be slightly larger: 0.2% for those with graduate degrees, 0.3% for those with some college or a bachelor's degree, and 0.5% for those with a high school degree or lower. These assumptions are summarized in columns 2 and 4 of Table 6.

The top half of Table 7 presents estimates, based on the moderately conservative assumptions, of the reduced value of wage spillovers due to ending public subsidies to Minnesota's public universities, separately for each education group. To see how each row is calculated, consider high school graduates, who currently number about 690,000. Their annual earnings are, on average, about $31,000. The removal of public subsidies increases the labor force with only a high-school degree to about 746,000.

Columns 4–6 in Table 7 show how each group's wages will fall due to a lower fraction of workers with bachelor and graduate degrees. For example, the drop in bachelor's degree holders from 23.7% to 23.2% (Table 5) reduces high-school graduates' wages by about 0.38% (0.5 × 0.75). A fall in graduate degree holders from 11.6% to 11.0% reduces high school graduates' wages by 0.6% (0.6 × 1.0). Combining both effects implies an annual earnings reduction of 1.0%, or $310. Summing over all 746,000 high school graduates gives a total annual loss of about $232 million.[15] Repeating these calculations for all education groups yields the moderately conservative estimate of the loss of spillover

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[15] The total in the lower right of the top half of Table 7 changes little if one uses the population distribution after (as done here) or before the tuition change; differences due to some groups increasing are offset by differences due to others decreasing.

Table 7
Estimates of the reduction in wage spillovers from withdrawal of public subsidies to Minnesota's public universities.

Education level	Current number (thousands)	Annual WAGES (dollars)	Estimated number after tuition increase (thousands)	Percent change in wages due to fewer bachelor and graduate degrees	Drop in wages (dollars per worker)	Drop in wages (total, in million of dollars)
	(1)	(2)	(3)	(4)	(5)	(6)
A. Moderately conservative estimate						
Less than high school	132,028	21,645	132,028	−1.01	−218	−28.8
High school diploma	689,709	30,766	746,463	−1.01	−310	−231.5
Some college	843,394	35,714	814,926	−0.72	−258	−209.9
Bachelors	609,633	49,889	595,202	−0.72	−360	−214.1
Masters	204,601	59,508	196,203	−0.30	−176	−34.5
Professional degree	57,072	95,699	53,803	−0.30	−283	−15.2
Doctorate	35,333	79,403	33,143	−0.30	−235	−7.8
Total	2,571,770	–	2,571,770	–	–	−741.8
B. Very conservative estimate						
Less than high school	132,028	21,645	132,028	−0.46	−100	−13.2
High school diploma	689,709	30,766	746,463	−0.46	−142	−106.2
Some college	843,394	35,714	814,926	−0.29	−103	−84.0
Bachelors	609,633	49,889	595,202	−0.29	−144	−86.0
Masters	204,601	59,508	196,203	−0.12	−70	−13.8
Professional degree	57,072	95,699	53,803	−0.12	−113	−6.1
Doctorate	35,333	79,403	33,143	−0.12	−94	−3.1
Total	2,751,770	–	2,751,770	–	–	−312.0

Sources: Median Earnings by Education level, 2003 are from the US Census Bureau.
Note: Wage change assumptions are shown in Table 6; see text for details.

Table 8
Cost of reduced voter participation and increased crime rates from withdrawal of public subsidies to Minnesota's public universities.

Education level	Change in population, by degree	Decrease in number of voters	Estimated cost of lower education levels (thousands of dollars)	Cost of increased crime (thousands of dollars)
High school graduates	+56,754			
Some college	−28,468	−2,323	1,115	22,774,224
Bachelors	−14,431	−2,355	1,130	11,544,556
Masters	−8,398	−685	329	6,718,004
Professional degree	−3,269	−400	192	2,615,200
Doctorate	−2,189	−357	171	1,751,320
Total		−6,120	2,938	45,403,304

Source: Dee (2004), and authors' calculations.
Note: The decrease in voting assumes an average 60% rate of voter participation, and each vote is valued at $16.

effects due to ending state subsidies: about $742 million per year.

These estimated spillover effects are conservative as they are based on estimates that are lower than those reported by Moretti (2004a, 2004b), yet given Lange and Topel's (2006) arguments that Moretti's estimates are far too high, the spillover effects are recalculated using the very conservative parameter estimates in Table 6. The results show a total loss in wage spillovers of about $312 million per year (bottom half of Table 7).

7.4. Public benefits: non-income effects

Non-income benefits of state subsidies to public universities are difficult to value; we present estimates only for increased voting and reduced crime. Table 8 presents estimates of lower voter participation, and of the cost of that reduction, from ending state subsidies. The first column shows the changes in the population's education levels, based on Table 7 (columns 1 and 3). The second shows the associated drop in votes in a given election, using Minnesota's 60% voter participation rate and assuming that each post-secondary year of education raises voter participation by 6.8% (see Dee, 2004). Gerber and Green (1999) estimated a $16 cost per additional voter, so the total value of the increased voter participation (assuming 30 elections over a voter's lifetime) is small—only $2.9 million.

Changing the distribution of education also affects crime. Recall that inducing a high-school graduate to obtain some college or complete a higher degree reduces annual crime costs by about $800. Thus removing state subsidies for higher education would raise Minnesota's annual crime costs by $45.4 million (Table 8, column 4).

7.5. Distributional impacts

State subsidies to Minnesota's public universities also alter the distribution of income. Three distributional effects of ending these subsidies are: (1) lower state taxes paid by marginal and non-marginal students due to lower wages[16]; (2) increased use of state unemployment benefits; and (3) reduced charitable giving.

7.5.1. State taxes

Minnesota's state government collects income, sales, property and excise taxes. Except for those in the bottom 30% of the income distribution, Minnesotans pay about 8.8% of their income in state taxes (Minnesota Department of Revenue, 2007).[17] The lower incomes of both marginal and non-marginal students from removing state support for higher education will reduce state tax revenues.

For marginal students, the effect of ending state subsidies to higher education on income tax revenues is given in Table 9. The first column shows the impact on the distribution of degrees, and the second shows the drop in wages for marginal students due to removing state subsidies, assuming that an additional year of schooling raises earnings by 8%. On average, these students pay 8.8% of their income in state taxes; the third column shows the fall in state tax revenue per worker, and the fourth calculates the total drop in tax revenues. Overall, ending subsidies to Minnesota's public universities would reduce state tax revenues paid by marginal students by $89.7 million per year. This would occur gradually over about 40 years as the new, lower enrollment gradually reduces the population's education levels. This fall in tax revenues from the lower incomes (due to lower education levels) of marginal students is a loss to the general population of Minnesota.

Regarding non-marginal students, the lower wages of the general population due to reduced wage spillover effects will also reduce tax revenues. In particular, the lower wages among the general population will lead to lower tax revenues, either $65.3 million (moderately conservative scenario, with its total wage loss of $741.8 million) or $27.5 million (very conservative estimate, with a wage loss of $312.0 million) per year.

7.5.2. Unemployment benefit payments

A drop in the population with bachelor and graduate degrees will raise unemployment rates and thus increase state government unemployment benefit payments. We estimate that ending state subsidies to Minnesota's public universities will raise unemployment by 819 people. In Minnesota in 2005, the average annual payment to an

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[16] Federal tax receipts will also fall; this is ignored since the federal spending is spread over all 50 states.

[17] Total state taxes paid for households in deciles 4–10 vary from 7.3% to 9.4% of their incomes; the average for these deciles is 8.8%. Almost all bachelor's or graduate degree holders are in these deciles; households in deciles 1–3 have incomes below $23,135, far lower than the average for college and graduate degree holders.

Table 9
Additional social costs of withdrawal of public subsidies to Minnesota's public universities.

Education level	Change in population with education level	Estimated wage premium (in dollars, assuming 8% increase in earnings per year of schooling)	Decline in tax revenue (per capita)	Total Decline in tax receipts (millions of dollars)	Unemployment rate	Change in number of unemployed	Change in state unemployment insurance payments (millions of dollars)	Average charitable donations (dollars)	Change in charitable donations (millions of dollars)
High school diploma	56,754	0	0	0	0.05	2,838	31.9	1134	64.6
Some college	−28,468	12,153	−1,069	−30.4	0.045	−1,281	−14.4	2938	−83.6
Bachelor's	−14,431	20,400	−1,795	−25.9	0.03	−433	−4.9	3238	−46.7
Masters	−8,398	24,042	−2,116	−17.8	0.025	−210	−2.4	2902	−26.5
Professional degree	−3,269	36,532	−3,215	−10.5	0.017	−56	−0.6	6528	−20
Doctorate	−2,189	36,532	−3,215	−5.1	0.018	−39	−0.4	3664	−7
Total	0	–	–	−89.7	–	819	9.2	–	−119.2

unemployed person was $11,245, so the annual cost to the state of 819 more unemployed persons is about $9.2 million.

7.5.3. Charitable giving

Columns 8 and 9 of Table 9 show the estimated impact on charitable giving of ending state subsidies to Minnesota's public universities. For those who fall from having a bachelor's degree or some college to being high school graduates, the Andreoni et al. (2003) estimates (average over men and women) imply that charitable donations drop by 63% (the log of donations drops by 1.0). This is close to the figures in column 8 of Table 9, from the CPS; average charitable giving of high school graduates ($1134) is about 65% lower than the average of college graduates ($3238). Andreoni et al. did not estimate the impact of moving from a graduate to a bachelor degree, but since the difference in Table 9 for bachelor and high school degrees are very similar to those authors' causal estimates, we assume that the differences for higher degrees in Table 9 reflect the causal impact. Overall, these impacts are quite large; ending state subsidies to Minnesota's public universities will reduce annual charitable giving by $119.2 million.

Combining these three redistributive channels, $218 million of the annual private benefits to marginal students from state subsidies to higher education benefit the general public via higher state tax revenues, lower costs of unemployment benefits and increased charitable giving. This redistribution would not end immediately if state subsidies ended; instead it would gradually shrink over about four decades as the adult population slowly became less educated. Note also that this $218 million figure is very likely an under-estimate as it excludes (due to difficulties in calculation) lower use of other government programs (e.g. public assistance to the poor) and other likely benefits (more educated people smoke less, have fewer automobile accidents, and do more volunteer work).

Recall that 85% of Minnesota's working age population does not have a bachelor or graduate degree from one of Minnesota's public universities. There is little reason to expect either the subsidy-induced charitable giving or the increased tax revenues to accrue disproportionately to either this 85% of the population or to the 15% who have such degrees. So roughly 85%, about $185 million, would be redistributed from the graduates of Minnesota's public universities to the rest of the population.[18]

7.6. Summary, with discounting

This section uses the results of Sections 7.3–7.5 to evaluate the economic return of state government subsidies to public universities in Minnesota. It also discusses the distribution of those subsidies' costs and benefits.

Evaluations of subsidies to higher education must use discounting to compare the costs incurred today with the benefits accruing over several decades. The appropriate discount rate is uncertain, so two rates are used: 3% and

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[18] We are aware of no comprehensive study of who benefits from state government spending in Minnesota.

Table 10
Costs, benefits and redistributive transfers from subsidies to higher education: 2004–2005 (millions of dollars per year).

	Cost	Benefit	Transfer
Costs (and transfers often viewed as costs)			
State government appropriations ($791 million)			
Of which: Transfers to non-marginal students	–	–	765
Payments to marginal students	26	–	–
Tuition payments of marginal students	32	–	–
Opportunity cost of marginal students	149	–	–
Deadweight cost of taxation (15% of revenue)	119	–	–
Benefits (and transfers often viewed as benefits): 3% discount rate			
Lower tuition for non-marginal students (private)	–	–	765
Higher wages for marginal students (private)	–	303	–
Of which: Increased state tax revenue	–	–	27
Increased charitable giving	–	–	71
Wage spillovers of marginal students (public)	–	441/185	–
Of which: Increased state tax revenue	–	–	39/16
Lower unemployment of marginal students (private)	–	14	–
Of which: Compensated by unempl. benefits	–	–	5
Reduced crime/incarceration costs (public)	–	27	–
Increased civic engagement (public)	–	2	–
Benefits of additional research (public)	–	Unknown	–
Total (conservative/very conservative)	326	786/531	N/A
Benefits (and transfers often viewed as benefits): 5% discount rate			
Lower tuition for non-marginal students (private)	–	–	765
Higher wages for marginal students (private)	–	214	–
Of which: Increased state tax revenue	–	–	19
Increased charitable giving	–	–	53
Wage spillovers of marginal students (public)	–	326/137	–
Of which: Increased state tax revenue	–	–	29/12
Lower unemployment of marginal students (private)	–	9	–
Of which: Compensated by unempl. benefits	–	–	5
Reduced crime/incarceration costs (public)	–	20	–
Increased civic engagement (public)	–	1	–
Benefits of additional research (public)	–	Unknown	–
Total (conservative/very conservative)	326	570/381	N/A

Notes: Non-marginal students are students whose education levels would not be affected if tuition rates at public universities were increased, and marginal students are students who would obtain less education if those tuition rates were increased.

5%. The typical person who obtains higher education is assumed to work for 40 years; extending beyond 40 years has little effect as discounting greatly reduces today's value of benefits that far into the future.

Table 10 presents estimates of the costs and two sets of estimates of the benefits of subsidies to higher education in Minnesota, one using a 3% discount rate and another using a 5% rate. Starting with the costs, in 2004–2005 Minnesota's state government provided $791 million in subsidies: $550 million to the University of Minnesota and $241 million to the seven MnSCU state universities. This lowered tuition for both marginal and non-marginal students in those institutions. By definition, the education of the latter would not change if tuition sharply increased, so the lower tuition they enjoy is simply an annual transfer of $765 million[19]; it is *not* a cost to society as a whole.

Marginal students also benefit because this subsidy pays $26 million of their tuition costs (recall that they are only 3.2% of all students attending Minnesota's public universities). More importantly, this $26 million per

year is an economic cost to society. The reasoning is that those funds, when combined with the $32 million in tuition payments of marginal students, pay for the additional academic resources (instructors, classrooms, administrators, etc.) needed for the marginal students, who choose to obtain more education because of the subsidy. The social value of these resources is their market value, the cost of these education services at private colleges and universities, which we approximate as the sum of the state subsidies to marginal students (the difference between public and private tuition) and the tuition marginal students pay at public institutions, which is $58 million per year (Table 10).

There are two other "real" costs of state subsidies to higher education. First, each year society loses the productive employment of the approximately 4800 marginal students whom the subsidies induce to leave work; this cost is about $149 million (based on annual wages of $30,766 for a high school graduate). The second is the deadweight loss of raising $791 million in tax revenues every year. We do not know of any estimates of the deadweight loss of state taxes in Minnesota. Yet estimates for U.S. taxes suggest losses ranging from 7% to 25% of the revenues raised by those taxes, depending on the assumptions used (Fullerton, 1991). We use a rate in the

[19] The analysis of Section 7.1 implies that 96.8% of students at Minnesota's public universities are non-marginal students, and so receive 96.8% of the $791 million in annual tuition subsidies.

middle of this range, 15%, which implies a deadweight loss of $119 million. Adding these two costs to the $58 million cost of providing additional educational services, we estimate that the annual social cost of state subsidies to Minnesota's public universities is $326 million.

The benefits of state subsidies to higher education, assuming a 3% discount rate, are shown in the middle panel of Table 10. While in one sense non-marginal students receive $765 million per year via lower tuition, this is just a transfer, not a benefit to society as whole. The first real benefit is that the higher education levels of marginal students lead to higher wages (an 8% increase for each additional year of schooling) for about the next 40 years. Applying a discount rate of 3%, the present discounted value of these wages is $303 million.[20] Note that 8.8% of this increase in wages, about $27 million in presented discounted dollars, will be paid in state taxes and so is transferred to the general population, and another $71 million is given to charity.

Higher wages for marginal students are private benefits. They alone benefit, not the general public, except for state taxes paid and charitable donations. The cost to these students for their higher education (tuition payments and forgone wages while enrolled) is much smaller, about $181 million. In theory, these students seem not to need subsidies to induce them to obtain higher education because the benefits ($303 million, using a 3% discount rate) are about 67% higher than these costs. Even if subsidies were withdrawn, so that marginal students had to pay an additional $26 million in tuition, their total costs would still be only two thirds of the benefits. Yet these benefits come slowly, over 40 years, and are discounted by a 3% discount rate. As seen below, higher discount rates greatly reduce today's value of those benefits. Perhaps marginal students face relatively high interest rates, which make higher education less attractive. It may also be that their returns to an additional year of schooling are lower than the average of 8%, which would reduce the value of higher education.

Most of the remaining benefits in Table 10 are *public* benefits; they accrue to members of society *other* than marginal students. The first, and largest, is the wage spillovers from social interactions off the job. Our moderately conservative estimate is that the higher education levels induced by state subsidies raise Minnesotan's wages by $742 million per year, while our more conservative estimate is $312 million per year. Both must be discounted since they accrue over the marginal students' entire working life. Using a 3% discount rate, the present value of these benefits is $441 million and $185 million per year,

respectively. Note that 8.8% of each of these figures is channeled into higher tax revenues: $39 million and $16 million, respectively.

There is one final private benefit and two other public benefits. Lower unemployment among marginal students raises the (present discounted value) of wages by about $14 million per year. This is a private benefit, yet about one third of it (about $5 million) is transferred to the general public via lower unemployment payments to marginal students. The two public benefits are lower crime costs (discounted value of $27 million per year) and increased voter participation (discounted value of $2 million per year).

Adding all these benefits yields a total present discounted value of either $531 million (using the very conservative estimate of wage spillovers) or $786 million (using the conservative estimate of wage spillovers). The two largest benefits are the increased wages of marginal students and the wage spillovers from marginal students onto other members of society. The value of the benefits from reduced unemployment, less crime and more civic engagement is much smaller. Given that the cost to society as a whole is $326 million per year, the net benefits to society are between $205 and $460 million per year, depending on the wage spillover assumptions. While these estimates are not very precise, they suggest that the social benefits far exceed the social costs, which implies that current state support to public universities in Minnesota is a worthwhile investment.

The 3% discount rate may be too low. A 5% rate reduces the difference between the costs and benefits, as shown at the bottom panel of Table 10. The present discounted value of annual benefits falls to a range of $381–$570 million (depending on the wage spillover assumptions). Yet these figures still exceed the costs by $55–$244 million. Only when one uses an 8% discount rate (not shown) are the benefits less than the costs, and this occurs only when one uses the very conservative estimates of wage spillover effects. Thus, for a fairly wide range of discount rates, the benefits of public subsidies to higher education exceed the costs.

Finally, consider how the benefits, and costs, of these subsidies are distributed across the population. Table 11 does this for a 3% discount rate (and the moderately conservative estimate of spillover effects). The biggest component is a pure redistribution effect, the annual transfer of $765 million from taxpayers to non-marginal students. It is "pure" in that it changes no educational outcomes and so neither consumes any economic resources (other than deadweight cost of higher taxes) nor creates any economic benefits. This raises the question of whether this pure redistribution is progressive or regressive. Data from the Minnesota Higher Education Services Office (2001) indicate that 15.9% of 1999 high school graduates in families with incomes from $25,000 to $40,000 (lower middle income) enrolled in one of Minnesota's public universities, while the comparable figure for high school graduates from families with incomes from $90,000 to $150,000 (upper middle income) was 27.7%. In general, the per student transfer is the same for both types of students, which suggests that this transfer was regressive (per high school graduate, almost twice as much was going to the better off families).

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[20] This $303 million figure is based on the assumption that an additional year of higher education increases wages by 8%. Yet Dahl (2002) finds that the returns to higher education vary from 7% to 9%, depending on the state and the type of degree (e.g. undergraduate vs. graduate), and Brewer, Eide, and Ehrenberg (1999) find that more "competitive" (in terms of admissions) institutions tend to have higher rates of return, one implication of which is that the return to a degree from the University of Minnesota may be two percentage points higher than the return to obtaining a degree from a MnSCU university. As a robustness check, we examined the sensitivity of our $303 figure to these types of differences in the rate of return; using a 7% rate yields a figure of $283 million, while using a 9% rate yields a figure of $323 million. These differences are relatively small and do not change the overall findings of the paper.

Table 11
Distributional consequences of state subsidies to higher education (millions of dollars per year).

Distributional or redistributional effect	From	To	Amount
A. Pure redistributional effects			
Reduced tuition for non-marginal students	Taxpayers	Non-marginal students	765
B. Redistribution via economic costs			
More academic resources for marginal students	Taxpayers	Marginal students	26
C. Distribution of economic benefits			
Higher (before tax) wages of marginal students	–	Marginal students	303
Additional taxes paid by marginal students	Marginal students	General public	27
Additional charitable contributions of marginal students	Marginal students	Beneficiaries	71
Reduced unemployment of marginal students	–	Marginal students	14
Reduced unemployment benefits to marginal students	Marginal students	Taxpayers	5
Wage spillover effects	–	General public	441
Additional taxes paid from wage spillovers	General public	General public	39
Reduced crime/incarceration costs	–	General public	27
Increased civic engagement	Marginal students	General public	2

Yet recall that state tax rates are very similar across income deciles, so higher income families pay more of the taxes that fund these transfers. In particular, using the midpoints of these two income groups, wealthier families are paying almost four times (3.69) more in the taxes that finance these transfers, so overall this pure redistribution is somewhat progressive.[21]

The one economic cost of state subsidies to Minnesota's public universities that transfers economic resources from one group to another is the $26 million transferred from taxpayers to marginal students to provide new academic resources to those students. In effect, economic resources that had been consumed by taxpayers are diverted to those students. The $32 million in (subsidized) tuition paid by marginal students may seem to be a redistribution. In fact, it is a real diversion of economic resources and it does not involve redistribution since marginal students pay this cost and also receive the benefit.

State support to public universities also generates new benefits for Minnesotans, but they are not evenly distributed across the population. First, there is the higher (before tax) wages of marginal students; their value is $303 million per year (using a 3% discount rate). This is not a transfer from one group to another; it is a new benefit generated by the costs discussed above. Yet some of this annual benefit to marginal students is passed on to others; $27 million is paid in state taxes, benefitting the general public, and another $71 million is given to charities, a transfer to the beneficiaries of those organizations. The second benefit is the $14 million per year that marginal students enjoy from lower unemployment; this is not a transfer, it reflects higher economic activity. Ironically, about one third ($5 million) of this gain benefits the general public via the reduced cost of unemployment payments. The third is much larger, the $441 million in annual wage spillovers (based on the moderately conservative assumption of their size); this is also a real increase in economic output, and it

benefits the general public. Of this, $39 million goes to state taxes, which is a "redistribution" from the general public (or at least taxpayers) to itself. A fourth, slightly smaller benefit is lower crime costs ($27 million per year), which accrues to the general public. A final very small benefit ($2 million per year), increased voting, is a transfer from marginal students to the general population.

To summarize this section, we estimate that the social (public + private) benefits of state subsidies to higher education in Minnesota greatly exceed the costs, for a variety of assumptions about wage spillovers and discount rates. Yet our estimates have several caveats. First, and most importantly, the impact of higher tuition at Minnesota's public universities on adults' education levels in Minnesota, and the impact of others' education on individuals' wages, are based on estimates from Card and Lemieux (2001) and Moretti (2004a, 2004b), respectively. These estimates are imprecise, and they could be biased. Thus our estimates of the benefits should be treated as rough approximations. Second, Table 10 omits some benefits that are hard to quantify, such as increased volunteer work, improved civic engagement other than higher voter participation, and the personal benefits from social interactions with more-educated people. Third, the benefits of research activities at the University of Minnesota are excluded. These last two caveats imply that the benefits are underestimated; calculation of these benefits would strengthen the rationale for state support to Minnesota's public universities.

8. Conclusions and suggestions for future research

This paper provides estimates of the costs and benefits of state government subsidies to higher education in Minnesota. Ignoring purely redistributional effects, we estimate that the annual social cost of these subsidies is $326 million. The two largest estimated benefits are the higher wages of marginal students (students who would obtain less education if subsidies were ended), a private benefit, and the increased wages of all workers due to spillover effects, a public benefit. Discounting these benefits, since they accrue for decades after the subsidies, the estimated total value of benefits (both public and private) is between $531 and $786 million per year (using a 3% discount rate), and between $381 and $570 million

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[21] One implication of this result is that applying a social welfare function that is concave in individuals' incomes (i.e. which increases in value when the distribution of income is more equal) will unambiguously show that subsidies to higher education increase social welfare, since those subsidies both raise average income (the benefits exceed the costs) and redistribute income in a way that reduces income inequality.

per year (using a 5% rate). Thus the estimated benefits easily exceed the estimated costs.

The paper also estimates the distributional effects of these subsidies. Non-marginal students at Minnesota's public universities are the main beneficiaries, receiving each year $765 million from Minnesota's taxpayers. Marginal students, a far smaller group, obtain $26 million per year from taxpayers. Even so, better educated marginal students generate as much as $441 million per year in higher wages for all Minnesotans due to spillovers from social interactions off the job. Each year, those students also pay $27 million more in taxes and donate $71 million to charities, and lower crime costs save another $27 million. Public benefits due to lower unemployment payments and higher civic participation are much smaller.

These calculations strongly suggest that state subsidies to Minnesota's public universities are wise investments, yet the benefit estimates are very imprecise. In particular, the wage spillover effects are based on three studies (Lange & Topel, 2006; Moretti, 2004a, 2004b) that yield a wide range of estimates. Similarly, the estimates of the change in the adult population with bachelor and graduate degrees are also based on a single paper (Card & Lemieux, 2001), and they are imprecise. Moreover, some public benefits could not be calculated, such as increased volunteer work, greater civic participation other than voting, safer drivers, reduced state spending on health services, and pleasant interactions with more educated individuals. Most importantly, the public benefits of research, which are inter-twined with the educational role of a modern university, have not been calculated. For a research intensive institution like the University of Minnesota, where annual research expenditure in 2004 was $515 million (23% of its total expenditure) the public benefits from its research activities are difficult to assess but could be substantial.[22]

This study's benefit estimates are arguably the most comprehensive of any study for a U.S. public university system. Given the above caveats, our cautious conclusion that the benefits outweigh the costs can be made more compelling only with more research. High priority should be given to estimating more precisely the impact of increased public university tuition on both enrollment and on the education levels of the adult population. Estimates are needed for both undergraduate and graduate students. Another high priority is better estimates of wage spillover effects, which are a crucial component of the public benefits of state subsidies to higher education. A final priority is estimates of the benefits of public universities' research.

Once these impacts are more precisely estimated, more research is needed on the distributional impacts of large state subsidies to public universities, which our estimates indicate are quite large. This raises the issue of trade-offs between equity and efficiency goals; while our calculations indicate that the current redistribution each year of

$765 million from taxpayers to non-marginal students is an equalizing transfer, it comes at the cost of a 15% dead-weight loss. In addition, it is likely that marginal students come from lower income households than non-marginal students, so that subsidies that reduce marginal students' costs are more egalitarian than subsidies that benefit non-marginal students. This implies that research is needed on whether one can distinguish marginal from non-marginal students, to target subsidies more to the former. A final point is that the political ramifications of trying to alter the current system of subsidies to public universities could be quite large. We leave this to future research, not only by economists, but also by other social scientists.

Acknowledgements

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[22] See Pardy, Dehmer, and Beddow (2007) for an analysis of research at the University of Minnesota. While this paper has focused on subsidies that reduce tuition, which do not directly subsidize research, the modest rise in enrollment from these subsidies would lead to more faculty, many of whom would also do research.

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